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Editorial

Organic Chemistry: A Call to Action for Diversity and Inclusion

Cite This: *Org. Lett.* 2020, 22, 6223–6228

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INTRODUCTION

By now, most of us in the field of organic chemistry have become aware of the recent Perspective Article by Hudlicky published on the *Angewandte Chemie, International Edition* website[1] and then quickly removed as a result of rapid and strong denunciation on social media and in other forums. We have had complex emotional responses to the opinions expressed in this piece regarding the effects of diversity and inclusion efforts in chemistry: anger, that such regressive views were provided a platform in one of our leading chemistry journals; surprise, that the piece made it through the peer review process; and disappointment, that these views continue to persist, despite our hope that the climate for researchers in organic chemistry had improved since we were all trainees.

The publication of the Hudlicky Perspective has inspired a number of critical responses from other chemists.[2] Each of us who has trained in organic chemistry has heard similar opinions throughout our careers from friends, mentors, and colleagues. Hudlicky is, after all, one of us, and we thought it important to take this opportunity to reflect on whatever progress the field has made and what significant work is still required. The authors of this Editorial (Figure 1) are not experts on the many aspects that surround diversity, equity, and inclusion and represent a relatively narrow slice of the US organic chemistry community. However, as research group leaders in organic chemistry who also serve in leadership roles in professional societies and/or in university settings, we are in a position to influence the climate for members of our research groups, departments, and organizations. Although we would like to think the opinions expressed by Hudlicky do not represent mainstream views in the field of organic chemistry, a deliberate and concerted effort by the field is required to achieve equity and inclusion for researchers from marginalized groups.

The Hudlicky Perspective advances disturbing views surrounding diversity, health, and wellness that have been rejected by many; but clearly not all. Some of the opinions expressed by Hudlicky around "Diversity of Workforce" and "Health and Wellness" include:

(1) Certain individuals and groups, implied to be women and minorities, have been "designated" with "preferential status" over the past few decades. This preference has allegedly disadvantaged those in the majority.

(2) Skill transference between a mentor and student requires "unconditional submission of the apprentice to his/her master," an idea Hudlicky attributes to Polanyi.[3]

(3) Today's students are "unwilling to submit to any level of hard work" as demanded by their mentors.

We have heard similar views to those of Hudlicky expressed by some in the field of organic chemistry throughout our careers. However, we reject these attitudes and claims, and we affirm the following instead.

(1) We view diversity as a strength and assert that the artificial homogeneity of our field is a significant historical weakness that requires rectification.

(2) We find that learning and innovation benefit from collaborative environments where students are trained to work as part of an integrated team.

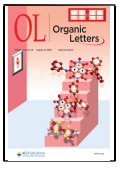
(3) We have observed that the quality of the students with whom we are privileged to work with is exceptional, in part due to our community's efforts to broaden the participation of chemists from diverse backgrounds.

The purpose of this Editorial is to lay out an alternative case for an inclusive and student-focused culture in organic chemistry. First, we argue for the importance of diversifying the chemistry community. We next summarize how far the field still has to go to achieve equity for marginalized groups. Finally, recognizing how difficult it is to change cultural norms, we outline actions that we, as individuals in positions to influence the direction of the organic chemistry community, should take.

First, What Is Diversity, Equity, and Inclusion?

As Kenneth Gibbs, Jr. states in his article *Diversity in STEM: What it is and Why it Matters*,[4] "Diversity refers to difference. As such, diversity is a property of groups, not individuals." Social diversity, which is the focus of this Editorial, runs the spectrum from race and gender identity, to nationality, sexual orientation, disability status, religious affiliation, and socioeconomic background. Each of us reflects an intersection of a number of these identities.[5] Equity is about the fair treatment and equal opportunity for success and advancement for all people, irrespective of their identities. Inclusion refers to an organization's active efforts to invite and nurture the participation of its diverse members. Efforts to diversify the workforce in organic chemistry without ensuring equity and inclusion will not succeed.

Received: July 31, 2020
Published: August 10, 2020



https://dx.doi.org/10.1021/acs.orglett.0c02559
Org. Lett. 2020, 22, 6223–6228

Figure 1. Screen shot of the authors during a writing session for this manuscript. (First row, from left to right: Matthew S. Sigman and Richmond Sarpong. Second row: Sarah E. Reisman and Tehshik P. Yoon.)

Second, Why Do Diversity, Equity, and Inclusion Matter?

At the outset, we find it morally unjustifiable to remain silently complicit with a system that has historically disenfranchised multiple subgroups within our community. Working to dismantle structural barriers that have prevented equitable participation of marginalized groups in STEM should be a mandate. There is also substantial evidence that diverse teams are more successful.[6] Studies show that across many financial sectors, companies with more diverse leadership teams are more innovative and have better financial[7] outcomes than those with lower levels of gender, racial, and ethnic diversity. In fact, evidence shows that homogeneous research teams are crippled by their lack of diversity.[6,8] Many decades of sociological research provide strong evidence that diverse teams are more creative, make fewer factual mistakes, and make better decisions.[6] Moreover, a recent analysis of 2.5 million papers in the Web of Science database found that papers written by diverse teams are more highly cited and have higher impact factors than those written by ethnically homogeneous teams.[9] Diverse teams bring a diversity of experiential information to the table—major scientific breakthroughs predominantly require a combination of first-principles thinking and different problem-solving strategies; the latter is significantly enhanced if diverse opinions and ideas are shared and explored. Social diversity has been demonstrated to contribute substantially to this end.[10]

Historically, individuals have been lionized for important discoveries, which might have resulted from a breakthrough "Eureka!" moment. However, this overemphasis on a single individual does not reflect the way that important scientific discoveries are currently made in our field: they are the product of collaborative insights from teams of scholars. Consider a single facet of diversity that has historically been prevalent in organic chemistry: international diversity has led to incredible advances. For example, the Nobel Laureates in Chemistry often come from a diverse set of countries. A specific example of the fruits of international diversity is the synthesis of vitamin B12, which was a joint effort between groups from North America and Europe and involved 99 people from 19 countries.[11,12] And yet, science in this era was essentially dominated by white men; consider what else might have been discovered if the talent pool available to participate in cutting-edge science had been broader. Even to this day, Frances Arnold is only the fifth woman to receive the Chemistry Nobel Prize (2018),[13] and there have been no Black chemistry laureates.[14]

It is imperative that organic chemistry research laboratories better reflect the diversity of society because otherwise, organic chemistry will remain an enterprise that institutionalizes discrimination of people based on their race, gender, and socioeconomic background, among other marginalized social identities. However, diversity alone is not enough: diverse teams and their constituents need to be intentionally supported by equity and inclusivity in order for both the individuals and the team to benefit.

Current State of the Field: Progress and Challenges

Hudlicky's views represent one extreme of a continuum of problematic views that have presented barriers to the diversification of organic chemistry, among other disciplines. Many who have benefitted from the status quo have not been driven to change. The group of organic chemists who are often put on a pedestal as the genius heroes of our field is not diverse, and this notion is embedded in some of the ways we teach organic chemistry. For example, the practice of using named reactions to teach and categorize synthetically important transformations tends to canonize the inventors, who generally

https://dx.doi.org/10.1021/acs.orglett.0c02559
Org. Lett. 2020, 22, 6223−6228

worked in an era when academic chemistry was dominated by white men. This tacitly sends the message to our students that these are the people who succeed in chemistry. Similarly, the area of total synthesis has a persistent reputation for its toxic masculinity, prizing unhealthy work environments and behaviors. This could account for why the number of female faculty leading research programs in total synthesis has lagged behind other subareas of organic chemistry.

Although there have been signs of positive change, organic chemistry is a long way from rectifying its homogeneous makeup and prejudiced attitudes. As a case study specific to organic chemistry, an analysis of the US faculty listed on the ACS Division of Organic Chemistry Web site "Organic Link",[15] which lists organic faculty at R1 institutions by state, found that 13% of the listed faculty were women, and only 1.4% were Black. While this directory is not comprehensive, it is striking that 19 states did not have any female faculty members listed, given that approximately 49% of chemistry BS and 38% of PhD degree earners are women.[16] These trends are consistent with the data collected by the Oxide project across all of chemistry,[17] which show that chemistry faculty in the top 75 R1 research universities are only 20% women, 2.3% Black, 3.1% Hispanic/Latinx, and 0.3% Indigenous (data collected in 2015). These data are a stark reminder of the attrition of talented chemists that occurs in the academy en route to the professoriate. They are a decisive counterpoint to Hudlicky's view that "preferred status" is leading to significantly decreased opportunities for those in "nonpreferred" groups. In fact, the unnatural demographic skew of chemistry academia has a trickle-down effect that could discourage students who do not see role models that reflect their own identities.

These data are only part of the picture, however. Diversity efforts are frequently disappointingly non-intersectional: they promote gender diversity without acknowledging that non-white women in chemistry face even more challenges specific to their intersecting identities. There are also marginalized groups that are not recognized by federal statistics and for whom data are not available. For example, students who come from low-income families often lack access to resources as they proceed through their education and careers. Additionally, despite recent, hard fought, legal protections for LGBTQ+ Americans,[18] they still suffer from significant stigma and systemic barriers to equitable housing, facilities, and healthcare that prevents their full participation in our discipline. Finally, insinuations that scientific fraud is more prevalent in certain countries are not supported by data and are a dangerous form of racist xenophobia. The rise of a deeply anti-immigrant political climate[19] and regressive immigration policies are antithetical to the transnationality of our discipline and are creating a hostile environment that hampers full creative participation for our noncitizen students, co-workers, colleagues, and friends.

Problematically, many efforts to diversify the field of organic chemistry have only focused on recruiting co-workers from marginalized groups without creating structures to support and recognize their work. Women and underrepresented minority faculty members are often disproportionately burdened with service obligations, especially those that are intended to support diversity. This work can take time away from their scholarship and mentorship, yet committees rarely weigh this service work on par with research productivity in making promotion and award decisions. In addition, women and underrepresented minority chemists experience stereotype threat[20] and higher rates of "imposter syndrome".[21] Years of subtle (or not so subtle) messaging assert that successful individuals are "given" positions, fellowships, or awards as a result of diversity initiatives. This messaging can lead to insecurities as to whether recognitions were earned, or whether it was luck or undeserved favoritism.

The Hudlicky perspective repeats the common misconception that efforts to increase the diversity of the profession constitute discrimination against "more meritorious job candidates". Again, Hudlicky's view is not a new one, and similar perspectives have been voiced in his defense. Nevertheless, the notion that merit can be objectively assessed in a manner that is free of social, historical, and economic context is flawed and has been rebutted in numerous ways. As one example, in a 2012[22] study by Handelsman, STEM principal investigators from US research-intensive universities were asked to evaluate the resume of a candidate for a lab manager position. Half of the resumes used the name "Jennifer" and half used "John" but were otherwise identical. The "Jennifer" resumes were consistently rated lower for their competency and hireability, they were ranked less worthy of faculty mentoring, and they were offered lower salaries. The result of this study of STEM PIs is consistent with other[23] studies demonstrating that resumes featuring distinctively African American or Asian names are substantially disadvantaged in hiring. Clearly, our community is not free from unconscious gender and racial biases. In other words, the community's shared goal of hiring and promoting the most meritorious chemists is held back by the fallacious assertion that race- and gender-agnostic hiring practices are equitable. Efforts to deprogram these inequities are imperative for hiring the most meritorious co-workers.

In addition to Hudlicky's comments related to diversity, equity, and inclusion, we also must address his views on the nature of training and work ethic in organic chemistry. There is no doubt that research in organic chemistry requires persistence, dedication, and rigor. It is also true that many of the luminaries in our field gained a mythical reputation for being devoted to their research, perhaps at the expense of their families, friendships, or hobbies. They expected their graduate students and postdocs to follow suit. Now, fewer faculty, of all genders, are waiting until tenure to start families, eschewing the unhealthy work environments that once forced people (particularly women) to choose between a career and a family. Most universities have supported this change by extending the tenure clock through parental leave programs for assistant professors with families. Young faculty members are collaborating with and supporting each other more as well, which is enabled by social media and fostered by numerous workshops such as the ACS New Faculty Workshop[24] and more recently, the Workshop on Synthetic Organic Chemistry for Young Investigators,[25] sponsored by *Organic Syntheses*.

As faculty, we disagree with the notion that a master–apprentice relationship is required for "skills transference" or that technical skills should even be the primary focus for training in organic chemistry. In our four laboratories, certainly, we take a much broader view of the goals of graduate education, in which we attempt to model the collaborative process of scientific inquiry that characterizes modern organic chemistry. We contend that the nature of mentorship between many faculty advisors and their lab members has evolved for the better over the past three decades. Indeed, for all of us, the most enjoyable interactions with our co-workers arise when they are empowered to ask questions to challenge our assumptions and to propose

https://dx.doi.org/10.1021/acs.orglett.0c02559
Org. Lett. 2020, 22, 6223−6228

their own ideas. These two-way interactions provide opportunities for learning—for both the student and faculty!

More generally, we recognize that as faculty advisors, we must take a comprehensive approach to mentoring our co-workers. Effective mentoring in research skills and professional development also has to acknowledge that graduate school and postdoctoral training can be a stressful time that is challenging to a trainee's mental health. The notion of a strict "master–apprentice" relationship seems to leave little room to take a more holistic approach to the training of our co-workers. Students who lack resources or strong support networks may be driven to drop out by the demanding environment of graduate school. This phenomenon exacerbates the problem of minority representation in the field.[26] Today, there are more opportunities for faculty to improve their mentoring and managerial skills. Over 630 new chemistry faculty have participated in the ACS New Faculty Workshop,[24] which teaches best practices for student mentorship and the implementation of evidence-based teaching in the classroom.

What Can We, as a Community, Do to Foster Diversity, Equity, and Inclusion in Our Field?

For many, if not all, of us working in organic chemistry, this has been a time for reflection. That the Hudlicky Perspective was published during a period when Black Lives Matter demonstrations protesting George Floyd's murder were ongoing crystallized how much further our field and society at large must transform to combat institutional racism and sexism. As part of writing this Editorial, we have discussed and often struggled with how to move from performative allyship toward initiating long-overdue, substantive action.

Learning to be more inclusive toward all of our colleagues and co-workers—across the entire spectrum of social diversity—is uncomfortable but necessary work if we are sincere in our efforts to make meaningful changes to the culture of organic chemistry. For example, we have been learning by reading about the experiences of Black people in academia on social media (e.g., the #BlackInTheIvory hashtag on Twitter) and from published responses to the Hudlicky Perspective such as Melanie Sanford's thoughtful editorial in *JACS* and *ACS Central Science*.[2] Here, we amplify some of the best advice from these sources for what we should do as individuals:

(1) Acknowledge your own biases. Racism, sexism, and homophobia are insidious because we have heard these messages repeated throughout our lives, so even if we personally do not suffer the negative consequences of these biases (or if we have never consciously imposed them), we are not free of them. Listen to corrections without interruptions. Own your mistakes and learn from them.

(2) Continue to educate yourself. Familiarize yourself with the scientific literature on diversity and bias. Attend ally and implicit bias workshops offered by various organizations at your institution. Read books by Black, Latinx, Indigenous, female, and queer authors about how to decenter your own experience, become a better ally, and put the lessons into action. Get trained to make your office a safer and more inclusive environment for all students to feel supported. Prioritize this education and consider it a professional obligation.

(3) Do not expect your colleagues and co-workers from marginalized groups to do the work of educating you.

(4) Use your privilege to speak out to combat discriminatory and abusive behaviors. Believe and advocate for victims of discrimination and other forms of violence.

(5) Be an advocate for early career researchers. Nominate students, postdocs, and faculty from marginalized groups for networking opportunities, conferences, and awards. Insist on a diversity and inclusion mindset in selection committees.

(6) Attend conferences such as those organized by the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) and the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS). Attend the poster sessions and talk with students, postdocs, and young faculty members about their research. Remember them and promote their careers.

(7) Cultivate a collaborative, student-focused, inclusive culture within your own sphere of influence. Seek out opportunities for culturally aware mentor training. Talk with your research group about what diversity, equity, and inclusion (DEI) means to you. Craft a DEI plan for your team and assess its success regularly. In addition to the scientific literature, read and discuss papers on racism, sexism, and homophobia in STEM and more broadly. Empower students to create and lead initiatives centering on climate and diversity issues in your departments. Support the creation of affinity groups in your department.

(8) Think about your research team, and how you assign "group jobs". Ensure that your group jobs are not gendered and that there are not people in your lab disproportionately doing "hidden work". Take action to ensure equity in how group jobs are assigned and valued.

(9) Recognize bias in the curriculum. Highlight individuals from underrepresented groups that have contributed to the field. For example, when teaching an organic chemistry course, highlight named reactions that recognize individuals from marginalized groups.[27]

Nevertheless, individual actions will not be sufficient. Systemic racism, sexism, and homophobia are sustained by institutional structures that were created in a time when the culture of science was essentially white, male, and straight. To a large extent, this culture is still pervasive. Even those of us who do not fit these categories were trained in and have learned to succeed in institutions that are only beginning to acknowledge their biases. Hudlicky's Perspective went through editorial review and peer review before being posted online; its publication in the highly visible medium of *Angewandte Chemie, International Edition*, therefore, is at least as much of an institutional failure as an individual one of editors or reviewers. It follows, then, that combating institutional bias requires us to hold our departments, journals, and scientific societies accountable to the principles of diversity, equity and inclusion that they proclaim as central values. A profound restructuring of these institutions is necessary. One should always ask:

(1) How is an inclusion-oriented mindset represented in the structure and leadership of your department? Is there an inclusion/diversity plan? Is there a group charged with increasing the diversity of your organization, and is it empowered to influence policy?

(2) What factors does your organization use to measure merit? Co-workers from marginalized groups often take

https://dx.doi.org/10.1021/acs.orglett.0c02559
Org. Lett. 2020, 22, 6223−6228

on a disproportionate burden of outreach and service activities. In hiring and promotion decisions, are these activities valued and rewarded appropriately?

(3) Is the diversity work in your organization limited to biases that affect cisgender white women and federally recognized underrepresented minority groups, or does it take an intersectional view that exceeds the narrow perspective prescribed by federal policy?

(4) How are young researchers mentored through your organization? Are scientists from marginalized groups given authentic, substantive leadership roles that enable them to shape policy and gain visibility?

(5) How are recruiting of and outreach to under-represented populations coordinated in your organization? Is there a centralized strategy that encourages participation from a broad cross-section of institutional leadership, or do you rely upon the work of a small number of volunteers?

(6) How does your organization assess its success in recruiting, supporting, retaining, and promoting diverse scientists, and what factors keep it accountable?

CONCLUSION

This Editorial came about after significant private conversations among many of us in the organic chemistry community following the publication of the Hudlicky Perspective. After these discussions about the persistent, baseless premises, we realized that it would be important for members of our field to repudiate them. Although we are all rightfully proud that the science of organic chemistry has made revolutionary advances over the last three decades, we have not yet succeeded in uprooting our field's problematic history of unhealthy, exclusionary practices. We view this moment as an opportunity to initiate substantive change. We must act to realize a more diverse, equitable, and inclusive culture in the field of organic chemistry.

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Notes

Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

This Editorial is jointly published in *The Journal of Organic Chemistry*, *Organic Letters*, *ACS Central Science*, and *Organometallics*.

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ACKNOWLEDGMENTS

We thank the students from each of our groups for their invaluable advice and feedback as we wrote this Editorial, including Hanna Clements (U of Utah), Kristen Gardner (UC Berkeley), Shane Lies (UW Madison), Brandon Wright (UC Berkeley). In addition, we are grateful to all of the students in our groups, who have taught us so much over the years about being better mentors. We are indebted to Prof. Brian Stoltz (Caltech) and Prof. F. Dean Toste (UC Berkeley) for their important contributions in the early stages of writing this Editorial.

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