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COMMENTARY



The intersections of identity and persistence for retention in ecology and environmental biology with personal narratives from Black women

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ABSTRACT

Ecology and environmental (EE) biology has low representation of Black Indigenous and People of Color (BIPOC). Degree completion and career placement in EE often fail due to poor consideration of the intersections among student lived experiences and the academic support, peer community support, mentoring, and leadership development that they receive. The demographic composition of these disciplines, which are situated within the geosciences, differs from the composition of the broader society and will continue to do so until biases associated with the dominant culture are remedied. Lack of diverse representation leaves young people of color unable to visualize themselves in EE careers, which contributes to their not pursuing EE programs, majors, and career placement.

As Black ecologists, we share narratives that include lessons gained from our individual journeys through undergraduate, graduate, and postdoctoral positions emphasizing experiences that supported our successful recruitment into our current academic positions. Throughout, we emphasize intersections of identity and persistence in EE. We assert that colorblind interventions to promote diverse participation in EE will be inadequate to affect meaningful increases in BIPOC participation. We highlight the value of diverse mentors, institutional support, and institutional commitment to diversity across multiple institutions. Additionally, we offer recommendations in support of BIPOC student retention in EE and the geosciences. Increasing diversity in EE will involve reassessment of how ecologists and environmental biologists are defined, interventions that support BIPOC retention at all career stages, and critical assessment of cultural biases in EE education and field experiences.

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Topic and approach

The demographic composition of ecology and environmental (EE) biology, disciplines included in the broad definition of geosciences, historically and presently differs from the composition of the broader society and will continue to do so until biases associated with the dominant culture, predominantly cis-gendered white males, are remedied (Bowser & Cid, 2021; Cid & Bowser, 2015; O'Brien et al., 2020). Although interventions to improve diversity have increased the numbers of women obtaining PhDs in EE, racial diversity has remained stagnant (O'Brien et al., 2020). In an earlier survey, the Ecological Society of America reported in 2014 that only 1% of its members identified as Black or African American (Beck et al., 2014). Recent reports of doctoral recipients in ecology, the geosciences, and related fields including ecology do not suggest that representation of Black or African American is increasing (Table 1). Because low disciplinary representation manifests as isolation for minoritized people in academic settings (e.g. Liu, 2006),

social belonging is also low (Hickcox, 2018; McGee & Bentley, 2017; O'Brien et al., 2020). This decreases retention due to multiple stressors such as microaggressions from students and faculty that exacerbate isolation (Eagan & Garvey, 2015; Miriti, 2020; Ross & Edwards, 2016; Walton & Cohen, 2011). It is important to acknowledge that these stressors affect the lived experience of being minoritized in academic spaces and do not reflect disciplinary apathy, skill-sets, or other measures of capability.

Disparate value systems along racial lines hinder diversity enhancement efforts in disciplines that are overwhelmingly white due to the social components of scientific priorities and communication. Contrary to common perceptions of the objectivity of science, science is a social process that is influenced by social and political biases (Longino, 1990). As such, science and society are “co-produced” with dynamic feedbacks that affect social values and scientific pursuits (Jasanoff, 2004). In other words, assumptions that appear neutral to those who hold them are in fact not universal

Table 1. Race and ethnicity of doctoral recipients in ecology, geosciences and related fields as reported by the National Center for Science and Engineering Statistics, National Science Foundation (2021) Survey of Earned Doctorates, 2020.

Field of study	All doctorate recipients	Race/ethnicity*		
		Black or African American	White	Hispanic or Latino
Ecology	388	12 (3%)	290 (74.7%)	22 (5.6%)
Entomology	124	2 (1.6%)	75 (60.4%)	6 (4.8%)
Evolutionary biology	207	5 (2.4%)	133 (64%)	9 (4.3%)
Wildlife biology, zoology	76	0	58 (76.3%)	5 (6.5%)
Geosciences, atmospheric sciences, and ocean sciences	1243	13 (1%)	646 (51.7%)	59 (4.7%)

*With the exception of the Geosciences, American Indian or Alaska Native representation was 0 for all fields of study. There was 1 doctoral recipient for the Geosciences.

and embed sociocultural biases into disciplinary knowledge, practice, and education. For example, Tolia-Kelly (2017) documents reductions in her research productivity due to the ways quotidian social dynamics throughout academia negatively affected her as a Black, female scholar. In terms of scientific understanding, Schell et al. (2020) reveal variation in the distribution of ecological resources in urban, biological landscapes that are fully understood by integrating the racist practice of redlining. Social science scholarship shows that cultural differences present barriers for recruitment and retention of BIPOC students and scholars (Bhakta, 2019; e.g. Pulido, 2002). This experience is reflected in recent collaborations that assert intersections of identity, scientific inquiry and retention (Halsey et al., 2020; Miriti et al., 2020; Morton & Parsons, 2018; Schell et al., 2020; Yitbarek et al., 2021). Taken together, increasing recruitment and retention of underrepresented students and faculty in EE can benefit from cultural competence (Smith, 1998) and humility on the part of educators and collaborators.

Although the roles of culture and race are typically underexamined relative to color blind, single-axis approaches such as those that focus on gender alone (sensu Cho et al., 2013; Crenshaw, 1989), to achieve diversity in STEM disciplines, it is necessary to confront the complex interactions at the intersection of gender, race, and other underrepresented identities and STEM persistence (Armstrong & Jovanovic, 2017; Miriti, 2019, 2020; Núñez et al., 2020). Such disregard for the role of racial identity is also examined in terms of racial avoidance rather than simple “blindness” (see Annamma et al., 2017). It is not our intention to parse colorblind versus color evasive approaches; our presentation draws from literature using both terms. Rather, our focus is on intersections of identity and persistence in academia, ecology, and STEM broadly as presented in studies that include perceptions of the value of faculty research activities (Ross & Edwards, 2016), research approaches (Yitbarek et al., 2021), impacts of stress on faculty productivity (Eagan & Garvey, 2015), factors that motivate student interests (Carter et al., 2021) and factors that impact student retention (McCoy et al., 2015; Nxumalo & Ross, 2019; Stapleton, 2020). Such studies reveal the ways in which a

singular model defined by dominant culture values does not promote academic success and retention for those with marginalized identities.

Addressing relationships between identity and inquiry does not detract from the value of science. In fact, strategies to reduce isolation of BIPOC or otherwise marginalized individuals can improve scientific advancement by disrupting disciplinary hierarchies and expanding the scope and relevance of research (Liu, 2006; Miriti, 2020; Pulido, 2002; Saini, 2020; Stapleton, 2020). If the relationship between identity, inquiry and retention is not addressed, cultural homogeneity in EE can hinder the ability to develop equitable and effective solutions to current ecological problems that affect everyone regardless of race, gender/non-gender, ethnicity, sexual orientation, or religion (Hansen et al., 2018). To be effective, diversity enhancement efforts need to move beyond “one size fits all,” non-intersectional strategies. So doing will allow the objective of improving recruitment and retention of BIPOC students and faculty to be met and can open new avenues for investigation that lead to new scientific insights and just interventions.

One activity that can assist in developing effective interventions for diversity enhancement is to listen to and respond to personal stories. The value of personal narratives was recognized in early efforts to advance women’s inclusion in STEM (e.g. Lawler, 1999). Storytelling has been an effective tool to advocate for marginalized people in societal (Delgado, 1989) and educational (Solórzano & Yosso, 2002) contexts, including autoethnographic narratives in which individuals examine the intersection of their identity and their activities and experiences in academia including STEM (Henry, 2015; Hernandez-Sanabria, 2020; Spikes, 2020; Subramaniam, 2014). To our knowledge, there are no such published examples (narratives/storytelling) for EE, although Graves (2019) shares personal perspectives in the closely related field of evolutionary science.

Context

Increasing diversity in EE requires confronting racialized practices in disciplinary training and practice (e.g. Miriti, 2020), especially for those who are most underrepresented. Recognition of systemic, racial inequities in the United States increased due to striking racial disparities in the lethality of COVID-19 and broad public exposure to racialized police violence that reached a peak in the global community after the murder of George Floyd in May 2020. In response, the STEM academy reasserted the need to increase recruitment and retention of BIPOC at all career stages and to examine institutionalized racism in journals (Berenbaum, 2020; Editorial team, 2020; Editors, 2020a, 2020b), professional societies including the Ecological Society of America (ESA) and the American Association for the Advancement of Science (AAAS), and numerous academic institutions. In response, a number of high-profile publications by BIPOC scientists documented the occurrences and experiences of racialized practices in STEM and suggested interventions to promote retention in the STEM academy (Arif et al., 2021;

Duc Bo Massey et al., 2021; Halsey et al., 2020; e.g. Miriti, 2020; Miriti et al., 2020; Schell et al., 2020). Articles addressing barriers for BIPOC student retention in STEM have also increased (Ahern-Dodson et al., 2020; Asai, 2020; Bowser & Cid, 2021; Miriti, 2019, 2021), but these contributions emphasize or advocate pedagogical interventions rather than explicitly examining racialized experiences in STEM.

One demographic that remains poorly represented in STEM are Black women (Corneille et al., 2019; McGee & Bentley, 2017). Morton and Parsons (2018), however, show how allowing Black women to contextualize their own STEM experiences is empowering and can foster retention. In what follows, we examine the intersections of identity and persistence through narratives of Black women in EE. All authors of this contribution are Black women at different career stages and with different entrances into EE. The personal narratives here presented contextualize literature on inclusion and equity in STEM broadly and EE specifically. Central to these individual narratives is the manifestation and impact of effective mentoring and the intersections of identity and academic experiences. Our aim is to illustrate the pitfalls and challenges of EE training and practice for BIPOC while underscoring practices that promote retention.

Opinion/viewpoint

Narrative 1: Institutional commitment

I graduated in 2015 with a PhD in Evolution, Ecology, and Organismal Biology. Only 1% of the people who earned a PhD in ecology that year identified as Black or African American (Hansen et al., 2018). I am currently an Assistant Professor on the tenure track at a liberal arts university in the Northeast US. In reflecting upon my academic journey, an important theme emerges. Institutional commitment to diversity matters, not just in words but in deeds.

As early as 1992, BIPOC retention in STEM has been analogized as a leaky pipeline (Culotta & Gibbons, 1992). When I think of the leaky pipeline, I see a process that may run smoothly at one stage in the academic journey, but whose integrity is determined by institution-dependent factors. My journey is unique in that throughout my undergraduate and graduate STEM training, I had Black, female, research advisors. It was important for me to see who I could be and to see early on, the opportunities and challenges I would face if I pursued a career in academia. My experience is consistent with literature emphasizing the importance of identity and mentoring (e.g. McGee, 2016); diverse mentors matter! Through these women, I learned not only how to achieve academic success but also how to be resilient when faced with institutional challenges.

As a first-generation college student, there was so much I needed to learn as an undergraduate. Having attended a majority Black high school, I was not prepared for the isolation I would feel being one of few who looked like me in my first biology class. My experiences were consistent with the experience of many others with underrepresented

identities; I was shy so I did not speak out in the large classroom of 70 students, and no one acknowledged my presence (e.g. Bhakta, 2019). I felt unseen.

As I advanced through my major, the number of biology students in a single class decreased and I became more visible. I took a class from the only Black professor in the department. This professor was interested in learning students' names and was very engaging in the classroom, and would call on individual students to answer questions, so you always had to be engaged in the classroom! It was nerve-wracking at times, but I was seen, and it felt good to be seen. This professor asked me if I would like to join her microbiology research lab. At the time, I thought that all professors did was teach. I did not know that they conducted research! For the first time I was able to connect what I was learning in the classroom with something practical!

This professor, now my research mentor, and the opportunities she provided were invaluable to my persistence in the STEM pipeline. I had a job in addition to my courses, which limited the time I could dedicate to being in lab. Financial disparities are a frequently overlooked barrier to the success of BIPOC students in STEM, but as in my experience, these can limit the ability to participate in some of the high impact activities (see Chang et al., 2014) that support retention of BIPOC students in STEM (Arif et al., 2021; Estrada et al., 2016). However, my mentor was able to secure funding to pay me to conduct research, and this made all the difference in the world. Resources matter! Without being able to dedicate time doing hands-on research, I may have leaked out of the pipeline. Instead, as is documented (Espinosa, 2011), being in the lab fueled my passion for research and helped me develop my scientific identity, which is also important for STEM persistence (Estrada et al., 2016; Hurtado et al., 2009; Vincent-Ruz & Schunn, 2018). My research advisor was also passionate that her students present their research in formal and informal settings. There were research symposiums at my undergraduate institution where we could present our research to the campus community, which gave us exposure on campus as undergraduate researchers, further solidifying my scientific identity.

Over time, I also presented at national and regional conferences. This was possible because my advisor encouraged me to apply for travel grants offered through our institution and from other invested parties. For example, when I first attended the Annual Biomedical Research Conference for Minority Scientists (ABRCMS), an annual conference that brings together more than 2,000 students from more than 350 colleges and universities, it was due to a travel award that I received from The Federation of American Societies for Experimental Biology (FASEB). This was a career changing experience for me. In addition to increasing my visibility as a scientist, for the first time I had an opportunity to see a critical mass of professors and students of color, who looked like me, conducting research. BIPOC participation is so diffuse throughout STEM disciplines that it takes a conference dedicated to minorities to achieve this experience.

My advisor encouraged me to stay on at the institution to earn a MS degree with her. I agreed, and I acquired the skills I needed to be a competitive candidate for a research assistant position at a major research institution. My journey through the STEM pipeline started out with my being shy and unseen—one of many faces in a classroom, but I left with a BS and MS in Biology. Mentoring matters! Representation Matters! I benefited from many experiences, personal and institutional, that affirmed my scientific identity. We lose so many students who do not have the steadfast support that I had.

A final consideration that is also frequently overlooked is the sense of community at an institution that supports moral well-being beyond STEM training. As an undergraduate, I joined a student-led gospel choir, which provided me with a much-needed cultural outlet. We sang at on and off campus events. The Director of the Office of Minority Affairs would reimburse us for gas when we attended off-campus events while representing the university. The university eventually formed a Gospel Choir class, which allowed us to travel under the auspices of the university. This support created a space where we could bond, and it created a space of safety. We traveled on the University's bus and wore clothing with the University's logo. This type of institutional support, while not directly related to STEM, increased my sense of social belonging (see Freeman et al., 2007; Walton & Cohen, 2011) at the university.

Prior to pursuing a PhD in ecology, my interest in ecology stemmed from having to be outside. I was teaching at a liberal arts college in the Southeast US and the faculty had a goal of teaching our students ecology in a natural environment. Like many underrepresented minorities, my experiences in the natural environment were few. Growing up, I did not hike, go camping, or visit national parks. Consistent with O'Brien et al. (2020), I was never exposed to ecology, and I was not comfortable in outdoor environments. However, I became comfortable in nature because I felt the need to be an effective leader for the students I taught and supported the institution's goal of increasing the field experience of students learning the biology curriculum. My colleagues and I took students to a nearby nature preserve that was a monadnock, an isolated rock hill. The geology and topography of this monadnock allowed plants endemic to the area to survive in the extreme environmental conditions. Observing these plants thrive year after year was something I enjoyed and gave me a sense of belonging to this natural place that was relatively close to my home. Asking questions about the natural environment changed my scientific identity from microbiologist to budding ecologist.

Later in my academic journey, my PhD advisor, an African American woman, accepted me as her graduate student even though I did not have a science background in ecology. Again, I had a lot of catching up to do. Again, effective mentoring and institutional support furthered my movement through the pipeline. Although I was the only African American female graduate student in my department, I had a supportive research advisor and department.

Much of the literature on the value of mentoring focuses on undergraduates, but the success or failure of BIPOC graduate students depends on their mentors (Brunsma et al., 2017). My PhD institution had an active Office of Diversity and Inclusion (ODI) and a Multicultural Center on campus. There were resources and programming in place to help diverse graduate students succeed. Examples included an annual Dissertation Bootcamp, which was a retreat for “ABD” students finishing up their dissertation and their research advisor or writing mentor. There was also an annual Future Faculty Retreat, which helped graduate students to better prepare for applying for faculty positions. Such supports are extremely valuable for Black post-candidacy students, especially Black women to successfully complete their PhD (Johnson & Scott, 2020). I also received a Bell Resource Fellowship, which was an ODI initiative to promote success of minority students. This fellowship sponsored my participation in the retreats listed above.

The community supported by ODI and the Multicultural Center fostered our ability to develop our own support groups. One of these was the Black Women's Retreat, which focused on connecting minority women on campus in support of mental wellness. This initiative was eventually adopted by the university and renamed the Women of Color Retreat. When the university took on this initiative, it relieved graduate students from having to fundraise each year to keep this vital event going. When a graduate student noticed the need for a dissertation writing group, she started a separate group called The Colorful Women of the Academy. When given sufficient structure and support, BIPOC students can clearly articulate what we need and even create it if necessary. Although most of the graduate students I met through ODI were not in STEM disciplines, we were like-minded in our pursuit of education, which Strayhorn (2010) identifies as critical to increasing persistence in STEM. Simply finding a cohort of students who are culturally similar can be vastly important.

My PhD advisor encouraged me to apply for internal and external research grants to fund my research and conference travel. She helped me hone my grant writing skills to make me a more effective candidate for receiving grants. Learning how to write grant proposals gave me confidence that I could remain in STEM regardless of the challenges that might lie ahead, and the validation of a successful proposal increased my confidence as an ecologist. This skill would go on to help me achieve my next step in the pipeline, securing a postdoc position. I applied for and was awarded a Ford Foundation Dissertation Fellowship. This funding afforded me the final step in the pipeline, and the position included important professional development training (see Yadav & Seals, 2019) that supported my persistence in academia.

Narrative 2: Surviving in the field

I came into ecology by happenstance. I often say that my field of study “found” me. I was raised as a vegan in Memphis, TN, a city that some consider to be the BBQ capital. My mom raised us at an early age to appreciate and

respect nature. She was intentional about recycling and composting even though at the time it was often inconvenient and no one else was doing so. If something did not come from the earth directly, we did not eat it, wear it or purchase it. Although my experience is in contradiction to identified barriers for BIPOC participation in EE (see O'Brien et al., 2020), I agree that it is important to teach children to appreciate natural ecosystems and the services they provide. It is also important to recognize that for children of color this might not always happen for various reasons, including that environmental knowledge may not conform to standard expectations (Davis, 2019; Hickcox, 2018; Miriti, 2019; Nxumalo & Ross, 2019).

At the age of 15, I attended Piney Woods School, a small boarding school in Mississippi, which ultimately marked a significant transformation in my career trajectory. It was during that time that I continued to learn about the ways that people are tied to the land and the services it provides. All students were required to work on the school farm, which provided some of the food we ate each day in the cafeteria. The farmers who managed the land were super passionate about what they did and shared their knowledge and passion with us as we worked while also making it fun to be outdoors. At that time, my career goal was to become a chemist or a medical doctor who would utilize natural healing strategies similar to what my mom used for my sisters and me. Growing up, we took no over-the-counter medicine but instead healed our bodies with the foods we ate, such as garlic, echinacea, golden seal, or ginger to name a few. I had never heard of a forester or an ecologist before, so I was not aware of its being a career choice. However, during my senior year we had a visit from a representative from the US Forest Service and she was offering a full scholarship that included a stipend for students interested in forestry or forest ecology.

I was initially hesitant about going into a field I had never heard of but when I told my parents about it, they encouraged me to give it a try. Again, my experience was distinct from studies that find lack of family support as a barrier to BIPOC students in EE (e.g. M. J. Armstrong et al., 2007; Haynes & Jacobson, 2015). The Forest Service (FS) representative/liaison officer that came to recruit was a Black woman and I really connected with her. As a Black woman, she was able to provide mentoring in ways that white mentors generally do not consider (McGee, 2016; Womack et al., 2020). She was very open and honest about the fact that there was very little diversity in forestry but that she would be there to support the students in the program along our journey. I really appreciated her transparency, and I was very excited to have someone that looked like me as a mentor in the program. Studies have shown the importance of representation as it relates to student success and when students are choosing their career/major (Castro & Calzada, 2021; Estrada et al., 2018; Gershenson et al., 2018; Will, 2018).

As part of the scholarship, I was required to work with the Forest Service each summer during my undergraduate

program. I completed my first year and transitioned into my first Forest Service internship where I was exposed to the field of forestry. However, this exposure also resulted in me experiencing racism in the workplace. It was an unpleasant experience that made me initially wonder if this field of study was right for me. Being an 18-year-old Black female in a rural small town in the South (US) where there were no other people of color that I observed was a challenging experience (see Bonfield et al., 2021).

During my first summer internship experience, I made my FS representative aware of some of the challenges I was facing, and she immediately traveled to my field site and addressed these issues with the people supervising me that summer. It is important to address racism and discrimination in a timely manner, especially when it comes to students participating in these nontraditional, predominantly white male environments (Anadu et al., 2020). Field experiences for students of color and women should be an enjoyable learning experience. However, these experiences often involve concerns for safety and inclusion that are impactful for young people who are still deciding on career goals (Anadu et al., 2020; Demery & Pipkin, 2021). My scholarship program lost several students who began with strong interest in pursuing a degree in forest ecology, but after their summer experiences decided that they did not want to persist in a field that demonstrated they were not interested in being inclusive to students of color. Many of these students changed their major after their first summer experience.

While my next few summers working in forestry in rural, southern US towns also included racialized incidents, I continued to pursue my degree in forest ecology. Even though I saw very few people within forestry or the FS agency that looked like me during these experiences, I was able to make good connections with the people I met and worked with each summer.

After completing my undergraduate degree, I transitioned into graduate programs at Duke and North Carolina State University. During my graduate school training there were times I questioned if I would ever be fully welcomed into the fields of forestry or forest ecology. It was quite challenging attending conferences and being in a department that had little to no other people who looked like me. Always being "the only one" was quite exhausting and I unfortunately became accustomed to tokenism, racist and inappropriate comments, and being excluded from social gatherings and academic collaborations such as study groups. Having to persist through some of these nonacademic challenges often places burdens on students of color that their white peers do not suffer (Adams & McBrayer, 2020; Boysen, 2012; Curtis-Boles et al., 2020; Hubain et al., 2016; Maton et al., 2011). These challenges distract, alienate, and deter students from future success in their disciplines.

After finishing my doctoral degree, I transitioned into a position with a company in the forest industry. This work experience started off very rough with my experiencing racism on my very first day of work, which required me to get law enforcement involved. Yet again, I questioned if

this was the field of study I should have chosen. I decided to give it a year to see how things went, and that one year turned into 10 years. I was able to identify some mentors of color within the organization who were beneficial to coaching me through some of the negative experiences that would periodically come up.

Diversity and inclusion in the fields of forestry and conservation sciences lag behind representation in other sciences (O'Brien et al., 2020). Low diversity is very vividly reflected in the workforce. I continue to be indebted to my original mentor from the Forest Service since she has continued to mentor and support me throughout my career.

After working in the forest industry, I transitioned to a faculty position within academia. It was during this transition that I was also asked to lead an undergraduate research program, the Doris Duke Conservation Scholars Program, which fit very well with my interest and passion since I really enjoy students and being able to contribute to their success. An additional goal of the program is to increase diversity and inclusion in the field of conservation. Being able to guide, nurture and mentor students who are navigating the same issues I did has been one of the most rewarding parts of my career. Mentorship has been demonstrated as one of the top reasons for students persisting and succeeding in their academic programs and careers (Eby et al., 2008; Remaker et al., 2021; Sorkness et al., 2017; Womack et al., 2020) and I am thankful to have the opportunity to contribute to that.

In my position as an assistant professor, I also lead several undergraduate research programs. Based on my own summer experiences, I am adamant about sending students to these type of internships in pairs if possible. Studies have shown how beneficial cohort models are when working with first generation students and students of color (Astin, 1997; Eakins & Eakins, 2017). The support of another student, especially a student of color, often can make a substantial difference in how these experiences are processed and managed.

When I was preparing to finalize my position in academia, I requested that my department head allow me to start as a teaching assistant professor since I had seen some of my colleagues of color struggle through the tenure process. These were people that I respected and I knew that they were doing amazing work, yet the metrics used in the tenure process did not always value some of the nontraditional contributions from faculty of color (Fenelon, 2003; Miriti, 2020; Turner et al., 2008). Thankfully, my department head spent time explaining how much the department and the college valued the skills and service I would bring and was very transparent about the fact that my role in the department would likely look very different than that of my colleagues. He was very aware of the unequal burden that faculty of color have as it relates to supporting, encouraging and nurturing students of color in the department (Jimenez et al., 2019). Faculty of color often serve as a mentor/role model/support person for many of the students of color affiliated with the department, even those not enrolled in our courses and lab groups because they often feel comfortable and connected with those of similar backgrounds.

He was so adamantly supportive of this service that he adjusted my Statement of Faculty Responsibilities, the metric used in my department to assess faculty members' success for reappointment, promotion, and tenure, to reflect this service. Based on my understanding, this intervention is not traditionally adjusted in this way. However, I am grateful that the administrators in my college valued this work enough to make these important accommodations.

I am very recently tenured. The tenure process has not always been welcoming and accepting for faculty members that have a portion of their time focused on service and/or diversity efforts. However, as has been stated in this and the previous narrative, retention of faculty of color is important for BIPOC student success. My colleagues and institution have shown consistent and impactful support by acknowledging and rewarding my contributions.

While I have had challenges along my journey and in my position in academia, I am grateful that I continued in EE and can now encourage, mentor, and assist with guiding new students. I look forward to what the future holds and am hopeful that improvements will be made to make for better experiences for students of color in ecology/forestry/natural resources.

Synthesis of narratives

Careers in science and engineering have been recognized as emerging fields in the U.S. and global job markets (National Science Foundation, 2021), partly due to increased awareness of the importance of environmental sustainability and expanding employment opportunities in government and private sectors. However, the fields of ecology, environmental science, and geosciences face an unprecedented educational and demographic challenge because of low ethnic and racial diversity. This lack of representation leaves young people of color unable to see themselves in these types of positions and therefore they often do not seek them out. This cycle keeps ethnic and racial diversity disproportionately lower than other disciplines (Pew Research Center, 2021). The narratives we have presented underscore and personalize many of the issues identified in disciplinary, social science, and educational publications, and they nuance several intervention strategies present in the literature on diversity enhancement in STEM.

Our narratives illustrate that despite similar barriers to retention in EE such as isolation and discomfort in field settings, there is not a singular pathway into the EE academy. Narrative 1 exemplifies how institutional support and mentoring can pair to retain BIPOC throughout the STEM pathway. Not only should institutions recruit faculty who are effective at recruiting and retaining students of color, but those efforts should be rewarded if an institution is serious about recruitment and retention of BIPOC students. By showing how adjusting faculty expectations in a formal contract can be leveraged during faculty recruitment, Narrative 2 underscores the significance of institutional support in retaining faculty committed to diversity enhancement. Finally, our narratives highlight the importance of

mentoring by faculty of color in supporting student retention. Below, we expand on the significance of institutional support and mentorship in attracting and retaining BIPOC students in STEM with an emphasis on ecology, environmental biology, and the geosciences.

Conclusions/recommendations

Institutional support

Administrators must prioritize identifying where and why pipeline leaks occur at their institution and developing interventions to seal gaps as part of their strategic plans. Estrada et al. (2016) posit that demographic data, along with incoming student interests, declared major and department should be made publicly available to identify which institutions have increased BIPOC graduation rates or not. This provides opportunities for mentors to direct students to institutions with fewer leaks and can promote institutional accountability. Further, this strategy can provide successful pathways that support the BIPOC student success and retention.

It is important to acknowledge institutions and programs that have been successful in increasing BIPOC participation in STEM. These include: Meyerhoff Scholars (UMBC), Dozoretz National Institute for Mathematics and Applied Sciences Scholars (Norfolk State University), Biology Undergraduate Scholars Program (UC Davis), and Biology Scholars Program (UC Berkeley). The Meyerhoff Scholars Program has been successfully replicated twice (Smith-Barrow, 2019): 1) the Chancellor's Science Scholarship (UNC-Chapel Hill) and 2) the Millennium Scholars (Penn State University). For these programs, success is defined by an increase in current four-year STEM graduation rates of BIPOC with 72%, 80%, and 67% at UMBC, Penn State, and UNC-Chapel Hill, respectively, and matriculation into graduate or medical school at 48%, 50% and 21%, respectively (Sto. Domingo et al., 2019). Common themes of these programs are mentoring by faculty and peers, research opportunities, community building, and financial support, all factors included in our personal narratives.

We also assert that one and done will not work—change at a single institution is ineffective to increasing diversity because retention of BIPOC students improves with a diverse STEM professoriate. In other words, although undergraduate success is important, students must navigate multiple institutions to complete a PhD. Diversity, equity, and inclusion cannot be a single pillar of a strategic plan but must be woven throughout activities and programs at multiple institutions. Other institution-level interventions include hiring staff who understand the challenges of BIPOC; informing students of financial support for graduate study, including graduate teaching or research appointments; and professional opportunities in EE disciplines, including for PhDs who are not interested in academia. These suggestions are consistent with the narratives presented in this article, which document the importance of role models, cultural peer groups, even if not in STEM, and multiple forms of DEI programing as critical components for persistence in EE.

Mentoring

Our narratives have in common that shared values and beliefs increase BIPOC satisfaction within the mentor/mentee relationship in STEM fields (Hernandez et al., 2017; Pfund et al., 2016). African American undergraduates in STEM take longer to graduate than their peers and leave STEM disciplines in greater numbers, which ultimately requires institutional accountability in effective mentoring to improve (Estrada et al., 2016). Although we've described how mentoring by BIPOC faculty can improve retention (see McGee, 2016; Sealey et al., 2020), substantial increase in BIPOC participation in STEM will never be achieved if mentoring falls primarily on the shoulders of BIPOC faculty. At present, mentoring BIPOC students disproportionately falls to BIPOC faculty (Jimenez et al., 2019), but these activities are frequently not rewarded in institutional structures and can reduce faculty advancement (Corneille et al., 2019; Whittaker et al., 2015). All faculty need to educate themselves regarding barriers to increasing BIPOC participation and retention in STEM (Miriti, 2020) and these efforts should be rewarded. Arif et al. (2021) identify rules for mentors of BIPOC students that embrace diverse experiences and community building. Finally, mentoring networks (e.g. Montgomery, 2018) can be developed to combat the isolation resulting from low diversity in EE.

For disciplines like EE that commonly include field experiences as part of training, mentoring requires special considerations. As included in our second narrative, BIPOC students may face hostilities at remote field sites, especially when these are in regions with racial tensions. Flowers et al. (2021) offer strategies to make field stations more inclusive, while McGill et al. (2021) address inclusion in REU experiences. Field experiences have been identified as solidifying an ecological identity (Bowser & Cid, 2021) that can incentivize BIPOC enrollment in EE graduate programs. Good mentoring can also support this process such as provided by Carson et al. (2021) and advocated by Duc Bo Massey et al. (Duc Bo Massey et al., 2021).

Finally, mentors can play large roles in helping students identify their scientific identity and cultivate a sense of belonging (Sealey et al., 2020). Recent studies suggest that a scientific identity is an important factor in the retention of BIPOC STEM students (e.g. Atkins et al., 2020). This identity can involve supporting student competence, task completion, and recognizing accomplishments (Ero-Toliver et al., 2021). For EE, Bowser and Cid (2021) find that short, cohort, field experiences are critical in the recruitment and retention of underrepresented students. Shorter experiences may also alleviate financial burdens that reduce BIPOC participation in field experiences (Flowers et al., 2021; Jensen et al., 2021), cultivate a sense of belonging and scientific identity in field settings and allow students to work during the summer.

Cultural considerations

Our narratives illustrate the importance of the ways cultural biases influence recruitment and retention in EE. For

example, BIPOC responses to the environment are not always conducive, or aligned with disciplinary norms (Carter et al., 2021; e.g. Haynes & Jacobson, 2015). We emphasize that both narratives and the literature demonstrate that low valuation of the environment (e.g. Bixler et al., 1994) is an exaggerated limitation to BIPOC participation in EE (Mohai, 2003; Pearson et al., 2018; Taylor, 2018). This misperception underscores the importance of recognizing diverse experiences of nature (e.g. Finney, 2014; Mizelle, 2019) in EE programs (see Miriti, 2019). Most dangerously, misperceptions of BIPOC as not being “outdoorsy” can decrease participation in the geosciences broadly (Núñez et al., 2020) and must be redressed in support of BIPOC student retention.

Students perceive disciplinary social cues that can influence performance in academic settings along axes of gender (Cheryan et al., 2009, 2017) and other components of identity (Steele et al., 2002; Walton & Cohen, 2011). Consequently, disciplinary norms that contain cultural biases send signals that can discourage retention. Students should not be made to feel that they must conform to social norms to pursue EE degrees. This pressure is especially true when norms present financial barriers. Abeyta et al. (2021) calculated hidden costs of field supplies such as sturdy boots, clothing, backpacks, etc. that may be cost prohibitive for BIPOC. However, such items may represent a contrived barrier that pressures people to “dress the part” of an ecologist in denial of cultural expression. Name brands of outdoor activity are simply inaccessible to many and have no bearing on the quality of field research.

Finally, Ellison et al. (2021) challenge the scientific community to rethink the way we define the job of ecologist or environmental biologist. EE is not limited to practitioners who conduct field work, and many opportunities exist for those who do not have the capability or inclination to work outside. EE is more diverse than common presentations reveal. As diversity increases in EE, there will be no typical ecologist and cultural expressions will become broader and more inclusive.

Recommendations

Our narratives and supporting literature suggest the following institutional and mentoring recommendations in support of BIPOC student retention in EE and the geosciences:

Institutional

1. Increase cultural points of reference by hiring and retaining diverse faculty and staff.
2. Create spaces for BIPOC to connect outside of the classroom to alleviate isolation, especially at large predominantly white institutions.
3. Prioritize targeted interventions such as implicit bias trainings where institutional attrition rates are high. Putting financial support behind diversity initiatives is more powerful than simply creating aspirational goals. Successful plans will include assessments that

evaluate if a program or initiative is working as intended or needs revision.

4. Incentivize faculty training to learn how to incorporate intercultural pedagogy into their classes so that all students feel welcomed and a part of the classroom space.
5. Create opportunities for students to be viewed as a scientist on campus to provide affirmation and confidence to increase their professional networks beyond their home institution.
6. Include diversity training in orientations of all new hires and admitted students. Sense of belonging is not supported if faculty promotes inclusion, but student peers do not. To be effective, inclusion needs to be broadly embedded in campus culture.
7. To retain and advance diverse faculty and students, adjust departmental responsibilities for faculty actively engaged in supporting BIPOC students.

Mentoring

1. Invite students into research labs who show passion and promise in the classroom to acknowledge that potential to succeed is not always indicated by past achievement in the classroom.
2. Be willing to support students whose research interests do not align with customary disciplinary pathways. Seek support from interdisciplinary colleagues if necessary.
3. Help students to network broadly and stay connected in disciplinary communities.
4. Maintain contact with students once they leave their home institution. They will still need your support while navigating their new institution.
5. To ensure institutional knowledge of the potential risk BIPOC students encounter in the field, develop guidelines such as writing a racial risk assessment (e.g. Anadu et al., 2020) to protect students.
6. Ensure that students are aware of experiences that support EE retention (e.g. Research Experiences for Undergraduate Students (REUs) or short field experiences).
7. Actively recruit BIPOC students into EE programs with the aim to achieve a critical mass of students who feel supported throughout their academic journey.
8. Partner with local BIPOC naturalists who can serve as informal mentors.

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