SSE Workshop on Diverse Careers

Summary

A small and declining percentage of U.S. PhD recipients in the biological sciences go on to attain tenure track faculty positions. While university faculty diligently advise their undergraduates, graduate students, and post-doctoral scholars about how to succeed in academics, many are unaware of the changing landscape and the severity of the current crisis. To address this issue, we frame a three-pronged strategy focusing on faculty, trainees, and stakeholders outside the academy and provide a number of recommendations, mostly involving workshops and training activities at the annual Evolution meeting.

Introduction

Recent reports reveal that a small and declining percentage of U.S. PhD recipients in the biological sciences go on to attain tenure track faculty positions. As academic careers become more difficult to attain, there is increasing interest among students and research trainees in pursuing careers outside the academy. While university faculty diligently advise their undergraduates, graduate students, and post-doctoral scholars about how to succeed in academics, many are unaware of the changing landscape and the severity of the current crisis. Most lack the knowledge and experience needed to help their students explore and attain careers that differ from their own.

The SSE Diverse Careers committee was formed to help fill these gaps. The committee was charged with making recommendations to the SSE regarding this problem. To accomplish that end, we held a workshop on Dec. 4-5, 2014, in Arlington, VA. The workshop attendees included academic faculty, government and NGO employees, and private sector scientists. The goal of the workshop was to frame the issues and provide a set of actions that can be taken by the SSE or by individual faculty aided by the society. We emphasize that the SSE Diverse Careers committee is not attempting to deal with the entirety of the complex problem; rather, we are focusing on issues and the first steps toward solutions within the community of evolutionary biologists.

As students and pre-professional scholars navigate their academic path, they encounter decision points along the way that shape the overall trajectory. The paradigmatic career path is a linear progression from undergraduate, to graduate student, to post-doctoral scholar, to assistant professor at a research institution, to the Holy Grail – tenure. For most in academia this sequence should look familiar. In today's academic hiring climate, there are tenure track opportunities for approximately 15% of PhDs in biology within six years of graduation. For the remaining 85%, there is a critical need to consider a diversity of career options that could provide rewarding alternatives to the tenure track path.

To address this issue, we frame a three-pronged strategic approach the SSE could take. The first prong targets faculty advisors, who are a central focus of our recommendations, because of the critical role they play in shaping and supporting young researchers' lives and in defining the activities of the academy. The second prong directly targets graduate students and post-doctoral scholars, empowering them to navigate career paths effectively. The third prong targets stakeholders outside the academy, encouraging more industry participation in academic venues, as well as collaborations that enhance research efforts, knowledge transfer, and employment opportunities. The knowledge and tools of evolutionary biology are needed to solve many of today's major societal challenges: food, health, technology, and the environment. Ensuring

effective placement will benefit new PhDs and strengthen the American workforce. Therefore, balancing the supply and demand of STEM jobs in a sustainable and consistent manner is a critical national concern.

I. Framing the issues

A) Faculty careers and mentoring

Faculty need to be cognizant of the wide variety and types of careers that are possible, for themselves and for their trainees both inside and outside of academia. How faculty careers are envisaged needs to be reconsidered in light of the current hiring climate and the multitude of exciting and attractive opportunities. The number of faculty positions is much smaller than the number of PhD students produced each year, and that number is even more limited for research-intensive institutions. There are a wide variety of types of institutions where a PhD could be employed even within academia (e.g., primarily undergraduate institutions, community colleges) and types of careers (e.g., non-tenured faculty research positions, teaching-focused positions, managerial positions, administrative positions). Unfortunately, individuals who wish to shift or expand their career focus get few opportunities for career development, mentoring or training, such as a professional development sabbatical that is unrelated to research (e.g., AAAS Science & Technology Policy Fellowships).

There are historical cultural and institutional barriers that shape and hamper the way faculty view careers that do not conform to the traditional paradigm. Students who inform their advisors that they wish to pursue a different career path are often shunted aside and considered a failure to the profession. There are also perverse incentives to not mentor such students because they may not produce as many scientific publications or they may provide less academic prestige.

Such barriers and perverse incentives extend to institutions. Tenure and promotion decisions at comprehensive and research-intensive institutions are primarily based on numbers of publications and grant dollars accumulated, factors that are enhanced by having many graduate students or post-doctoral scholars that are faculty-focused. Successful mentoring and trainee career placement is often not valued for tenure and promotion.

Most faculty could benefit from more information and guidance about the kind of experiences needed to expose and train students and post-doctoral scholars for diverse careers outside of academia. Most faculty are not even aware of the diverse career opportunities open to well-trained scientists who choose not to or fail to enter academic positions. Mechanisms to improve mentoring by faculty are needed to guide students into the complex array of non-academic careers in science, while elevating the level of the student's preparedness from the perspective of the potential employer. Such efforts would be a step toward restoring balances in the supply and demand of newly trained students and post-docotoral scholars and achieving a sustainable, highly qualified scientific workforce. To accomplish these goals, faculty would benefit from training in mentoring beyond the fields in which they were trained, and from acquiring knowledge of diverse career opportunities from partners and stakeholders outside the academy.

B) Careers of students and post-doctoral scholars

Unfortunately, steering off the academic path – whether at the undergraduate, graduate or post-doctoral level – presents some challenges that science professionals seeking diverse employment need to acknowledge.

A first barrier is a general lack of awareness by degree holders of the diversity of careers that exist, both within academia (e.g., laboratory technician, staff scientist, administration) and external to academia (government, NGO, and private sector). Some of this stems from the inertia created by attaining a degree that keeps the tenured faculty position as the preferred professional end point. As noted above, there are inherent cultural and institutional biases that maintain this inertia, but they are not insurmountable and all stakeholders stand to gain by mapping out diverse career paths that lead to financial stability, responsibility, and personal satisfaction.

A second barrier is a degree holder's lack of understanding of the value and marketability of her/his degree. If an undergraduate is told s/he must seek a masters degree to succeed, that person may self-limit his/her career options. Likewise, if a PhD is told s/he must get a traditional post-doctoral position to be competitive for a faculty position, this assumes that a faculty position is the only end goal, and may prevent the PhD from considering other career options. At all levels, degree holders need to realize the flexibility of their career options, and not simply advance in their training because it is the next step in the quest for tenure.

A third barrier is a lack of awareness of the current job market associated with these career opportunities. This requires active partnerships with career development professionals who have the pulse of the workforce. For example, being a chief scientist at a coral reef conservation NGO is a viable career option for someone who holds a PhD in evolutionary biology, but how many coral reef NGOs are hiring chief scientists? Individuals would benefit from information allowing them to align their career aspirations with career availability.

Lastly, degree holders need to know how to market themselves. They need to be able to translate skills, competencies, and experiences to match the criteria of diverse career opportunities. Sometimes this means understanding sector specific terminology, processes, and organizational cultures. Strategic professional development is key to maintaining a wide variety of attractive skills and competencies.

C) Private and government sectors

During graduate school more students lose interest in academic jobs than gain interest, understandably driven by many above-stated factors, including current limits on the number of such faculty jobs. Faculty need to be able to advise students on non-academic careers, especially those in the private sector. Yet, that is an area that evolutionary biologists often know little about.

Effectively communicating with people in the private sector requires being able to reframe the kinds of research one does or one's skill sets. For example, if your research involves the study of mating preferences in fruit flies, this topic would be better reframed as: "I work on how complex traits evolve and are shaped by natural selection." Better still is understanding how this might be pitched to a particular private sector audience: "Grain yield in corn is a complex trait, and I study complex traits…." This ability to hone ones message for different audiences is a skill that can be acquired during graduate training, though often is not due to a lack of opportunity.

Faculty should be comfortable with saying that they are not well informed about such careers, but then need to know whom to reach out to. Individuals are often just one-degree-of-separation from the private sector, although they may not be aware of this. Evolutionary biologists need to

develop contacts in the private sector. They need to learn more about the kinds of skills and knowledge that the private sector values. Faculty need to learn how to advise students in ways that will expand their options while simultaneously facilitating their students' success in their academic pursuits. Both avenues of preparedness might lead to an academic position, while also gaining skills for other careers.

II. Action items

A. Faculty mentoring: Workshops and resources

Diverse career options expand the professional opportunities of scientists beyond the pursuit of tenure. These options can increase the likelihood of a scientist finding a stable and financially secure position that still leads to professional satisfaction in which the skills and knowledge acquired in academia can be applied. Faculty are in the best position to provide some skills while guiding students on where to acquire other skills. Thus, faculty need to expand their own knowledge of diverse careers and the associated skill sets. Among faculty a major shift in the current cultural attitude toward the necessity of including broader skill sets into training is required. The SSE can be a force in driving this cultural change.

Some faculty may acknowledge their limited knowledge of diverse careers and are open to educating themselves about those expanded career paths and skills. However, they lack the time to educate themselves on diverse careers and lack the access to the training necessary to help students to be competitive in these careers. The SSE can assist with both challenges.

Recommendation: Develop a series of workshops at the annual Evolution Meeting focused on aiding faculty in their mentoring of students related to diverse careers, including the following topics:

- How faculty can mentor students who wish to pursue a variety of professional goals.
- How faculty can link with nonacademic partners to introduce internship experiences into postgraduate training and broaden mentorship opportunities early in a training program.
- How to work with students and post-doctoral scholars to develop a thoughtful Individual Development Plan that can accommodate multiple paths from traineeship to career.
- How faculty can improve their career advising to students, encouraging them to be proactive in seeking internship opportunities, and broadening the set of mentors to include those from outside academia.
- How to incorporate high level transferable skills into training programs (e.g., leadership, communication, project management, integrated learning, networking, writing for non-scientific audiences, public engagement in science, business acumen, the role of science in society).

The workshops would include information on how to translate these recommendations into practice for their respective institutions. We suggest that in developing these workshops the SSE tap into the expertise of other scientific societies that have ongoing mentor training programs (e.g., American Society of Cell Biology(ASCB)).

B. Students and post-docs: Broadening their horizons

The annual Evolution Meeting is an excellent venue for redefining and broadening the scope of diverse (academic and non-academic) career opportunities for graduate students and postdoctoral researchers. In an effort to support these expanding career choices, strategies and information from key experts representing diverse careers are required. Workshops and expert panels would be invaluable for the attending trainees. They are beneficial to the SSE itself, as they are likely to become an integral component of the annual meeting and increase and broaden attendance.

We recommend interactive sessions (see below), integrated into the meeting and featured in core programming. Long-term, we hope this will expand to three full days of career sessions, modeled on the career-track programming at the ASCB, SACNAS, and the Annual Biomedical Research Conference for Minority Students (ABCRMS) meetings. An explicit goal is to offer interactive sessions that will help the trainees assess their career goals and then participate in appropriate workshops and panel discussions that further their career development and choices, inside or outside of academia.

Recommendation: Develop and provide sessions integrated into the programming of the annual Evolution Meeting that focus on career advising and career development for graduate students and post-doctoral researchers.

Suggested line-up of interactive sessions for an inaugural Career Development Program:

- Individual Development Plan workshop
- Career diversity workshop
- Communication skills workshop
- Conversations with evolutionary biologists working outside of academia

Promising practices and effective features to consider when developing sessions:

- Include activities that go beyond passive informational sessions to interactive sessions that address concerns and result in actionable items for participants.
- Emphasize interactions with career representatives that facilitate networking and personal connections, such as Q&A sessions in panel conversations.
- Encourage pre-meeting activities that allow individuals to arrive at the workshop with preliminary materials on which to work during the session in order to make the most efficient use of face-to-face meeting time, and/or post-meeting activities to extend the benefit of the workshop into the individual's everyday life.
- Use the SSE website to connect activities at meeting sessions to available resources.
- Post on the SSE website all workshop presentations and informational handouts.

Recommendation: Develop metrics of success for the SSE activities and include regular assessments of the career development programming and outcomes for participants, and use this information to drive SSE's strategic efforts.

Recommendation: Pursue a long-term goal of developing partnerships of the SSE with potential employers to co-develop programming and information presentations.

Recommendation: Provide relevant resources by creating a database/repository of professionals

available for informational talks with trainees interested in learning more about non-academic careers.

Links to example sessions at other meetings:

American Society for Cell Biology provides career development programs that are integrated into the regular meeting programming: http://www.ascb.org/2014meeting/?page_id=8885
ASCB also provides special workshops prior to the regular meeting: http://ascb.org/upenn-mini-course/

SACNAS provides professional and leadership development sessions for minority students, graduate students, and post-docs that address academic career, non-academic careers, mentorship, networking, science policy/ethics, and skills for success: http://bio.sacnas.org/uploads/sessions/table.htm

ABRCMS is designed to encourage underrepresented minority students to pursue advanced training in STEM and provide faculty mentors and advisors with resources for facilitating students' success: http://www.abrcms.org/index.php/abrcms
ABCRMS provides excellent workshops: http://www.abrcms.org/index.php/program/program-at-a-glance

C. Private and government sectors

SSE should help its members make contacts with and understand the needs of the private sector. Doing so will have two benefits. First, it will enable faculty to better meet the mentoring needs of their students and post-doctoral scholars. Second, it will provide possible alternative avenues of funding, an expanded array of research collaborators, or opportunities for translating research into public benefits. While the latter is not the primary focus of our recommendations, it can be an important incentive to faculty action.

Increased contact between evolutionary biologists and those in the private sector can change perceptions in both directions. These connections will need to start with academia and can be facilitated by the SSE. The evolutionary biology community will need to initiate engagement with the private sector because there are currently few clear connections between the outputs of evolutionary biology research and existing business models. SSE also can help the private sector understand the value of evolutionary biology. For example, human resource departments or hiring managers may not understand the alignment between the kinds of work done at their company and the research accomplishments of an applicant.

Many contacts between academia and the private sector already exist; it is a question of how SSE will leverage those connections. Many SSE members have former students or post-docs who are now in the private sector. Some types of biology departments (e.g., agriculture, pharmacy, biomedicine, bioengineering) have long-standing industry ties, but those departments are not where evolutionary biologists are generally housed. Many universities have private sector events on campus, but evolutionary biologists are rarely involved. In other disciplines, academic departments consistently partner with the private sector, NGOs, and government agencies in training students, both with regard to curriculum and internships. We know of no such partnerships with evolutionary biology programs.

Recommendation: Develop workshops at the Evolution Meeting that focus on academic-private sector interactions. Topics can include:

- How do you formalize academic-private sector relationships? What is a patent? What is FTO? What is a trade secret?
- What are the cultural differences between academia and industry, for example with regard to collaboration and ownership? What are the ethics and balance around patents versus open publication of data and results?
- What are the skills in demand by the private sector?
- How can students acquire skills that both let them earn a PhD and succeed as an academic, and also have marketable value outside of academia?

Recommendation: Explore what is required to encourage private sector participation at or sponsorship of the Evolution Meeting.

Recommendation: Explore what is required to encourage regular NGO participation at the Evolution Meeting.

D. Additional SSE actions

The recommendations listed above primarily focus on activities at the annual meetings as that is where SSE has its most extensive interactions with its members and others in the evolutionary biology community. We recommend at least one faculty-focused and one student-focused session be planned for the 2016 meeting. There are additional actions that the SSE can take, some of which are necessary for informing or reinforcing the other recommendations.

Recommendation: Survey the faculty membership of SSE to find out what careers their mentees have pursued. We are hampered by a lack of knowledge of the breadth of successful careers; this survey will tell us about the scope and diversity of careers that are possible for individuals trained in evolutionary biology. Current surveys (e.g., the biannual report by NSF on Science and Engineering Indicators) are aggregated (i.e., all of biology including biomedicine) and therefore are of limited utility for SSE. Suggested survey questions are given in Appendix A. This survey should be administered in 2015 so as to inform the 2016 events.

Recommendation: Create an award for excellence in mentorship. Such an award would provide recognition of faculty who have successfully guided others and/or affected the community beyond their own advisees, and provide best-practice examples.

Recommendation: Diversify the membership of the SSE Board and Council with regard to representation of types of careers and institutions. Currently all board or council members are faculty at research-intensive institutions. While other types of institutions have been represented in the past, they have been rare and non-academic careers have not been represented at all.

Recommendation: Reach out and work with industry-relevant conferences, including possible co-sponsoring of sessions at such conferences.

Recommendation: Publish a position paper in *Evolution* indicating the society's concerns about these issues and highlighting future actions that it will be taken to address them.

Recommendation: Create a taskforce, initially of six to eight people, that represents a diversity of careers to determine responsibility for, and beginning implementation of, these recommendations. Budget $10,000 for the first two years to allow one or more meetings before and possible activities at the 2016 annual meeting.

E. Timeline

2015
First quarter: Establish taskforce.
Second and third quarter: Administer survey.
Fourth quarter: Taskforce meets to discuss survey results and plan for 2016 meeting, including development of two workshops, one faculty-focused and one student-focused.

2016
First and second quarter: Workshop planning and discussion of other meeting activities.
June: Report to Board about current activities and recommendations for future activities.

Committee

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Lex Flagel, Monsanto
Edward Gonzalez, American Association for the Advancement of Science
Claire Hemingway, National Science Foundation
Robert McBride, Sapphire Energy
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Lenny Teytelman, ZappyLab
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Appendix A: Survey

The purpose of this survey is to semi-quantitatively assess career pathways and options for trainees of SSE-member labs. This will serve a dual purpose of informing SSE members and improving the above-recommended workshops for faculty and trainees.

Example of possible types of data output (from ASCB):
http://ascb.org/sample1/wp-content/uploads/2014/04/workforce-infographic-big.jpg

For types of careers, the AAAS website for IDP development is a useful resource.
http://myidp.sciencecareers.org/CareerChoice/Plans

SURVEY:

To the best of your recollection, please answer as many of the questions below as possible, regarding trainees from the past 15 years.

1. For how many people have you been the primary research advisor?
   - Undergraduates
   - Master students
   - PhD students
   - Postdoctoral scholars

2. Of the graduate student trainees, for how many was the highest degree that they ultimately obtained:
   - A Master's degree
   - A PhD degree

3. Of the students who completed a PhD, how many went on for post-doctoral training?

4. Of all of your trainees whose final degree was a Master's, what types of employment are they in now?
   - Faculty position
   - Academic research scientist
   - Government research scientist
   - Nonprofit/NGO research scientist
   - Private sector research scientist
   - Government policy or administration
   - Nonprofit/NGO policy or administration
   - Private sector policy or administration
   - Science writing, publishing and other media
   - Science education
   - Consulting
   - Law/IP

- Other (if possible please specify)
- Unknown

5. Of all of your trainees whose final degree was a PhD, what types of employment are they in now?

- Faculty position
- Academic research scientist
- Government research scientist
- Nonprofit/NGO research scientist
- Private sector research scientist
- Government policy or administration
- Nonprofit/NGO policy or administration
- Private sector policy or administration
- Science writing, publishing and other media
- Science education
- Consulting
- Law/IP
- Other (if possible please specify)
- Unknown

Appendix B: Background material

Baker, B. 2014. The End of the Academy? BioScience 64: 647-652.

National Academy of Sciences. 2014. The Postdoctoral Experience Revisited. National Academies Press, Washington, DC