PRESIDENT'S Column

Selective Pressures on the Evolving Scientist

Earlier this year I had the wonderful experience of spending 10 days touring the Galapagos Islands on a small ship with a dozen distinguished scientists and friends. I was amazed that although each island was formed the same way—undersea volcanic activity has been pushing these islands to the surface for over five million years—the flora and fauna of this archipelago varies immensely from island to island, making each tiny land mass entirely unique. The individual islands have emerged at different times, with different topographies, to different wind patterns and ocean currents, resulting in differing microclimates and differing vegetation, etc. Consequently, the animals on each island (not only the famous Darwin finches, but also mockingbirds, marine iguanas, tortoises, owls, flamingos, penguins, and crabs) have evolved to be ideally suited for their unique situations. Although many of these animals are thriving on their own islands, they would likely not survive on each other's islands.

Sandra Schmid

As our guide informed us of the selective pressures under which different animal and plant species have evolved, I began to consider the environment and selective pressures that an emerging scientist experiences today, compared with those I had experienced three decades ago. An awareness of these changes might help junior scientists to be more proactive in "evolving" into the next, hearty generation of scientists. For senior scientists and mentors, perhaps there is value in considering these changes so that we might better help our students adapt and thrive in a constantly evolving environment. Moreover, as senior scientists and leaders, we have the power to influence the environmental forces confronting our young scientists. We can also change those that we perceive as deleterious to the survival of the species—in this sense, we can *will* the formation of our own archipelago. Yet we must encourage a species of scientist that is more adaptable than our Galapagos friends. They are so tightly bound to the microcosm of their own island that they are dangerously vulnerable to change. Like the once untouched islands of the Galapagos, our scientific climate is changing rapidly—presenting both enormous challenges and exciting opportunities

In thinking about these changes, our adaptations to them, and the consequences of these adaptations, there are many possible examples. These three come first to mind.

Scientists Become Wired

Computers were not a part of my environment as a graduate student. In 1984 I wrote my thesis with pen and paper and then transcribed it on a dedicated word processor the size of a desk. As a student, I would sit for hours at my desk transferring and plotting individual data points, which a scintillation counter (we used to work with radioactivity) had spit out on a long, narrow slip of paper. This slow process gave me time to contemplate the merits of each data point and the implications of the emerging relationships between them. The quiet time allowed me to think about what the next experiment might be. Without PubMed, I would frequently browse the major journals in my field. Invariably I'd stumble across an unrelated article that would capture my interest, exposing me to something new and unexpected. There were no Boolean searches or Google, so to find specific information I sought out and asked colleagues. I went to their labs, I called them on the phone, and I made sure to attend seminars regularly to hear about new research and to make contacts that might be helpful in the future. I wasn't "LinkedIn" to old friends, couldn't follow the latest news events online, and didn't have an iPod. Consequently, I talked to my labmates—all the time. On average, this meant that we discussed what wasn't working and what might work. We shared our successes as well, but these were rarer events.

The American Society for Cell Biology

8120 Woodmont Avenue, Suite 750
Bethesda, MD 20814-2762, USA
Tel: 301-347-9300
Fax: 301-347-9310
ascbinfo@ascb.org, www.ascb.org

Joan R. Goldberg
Executive Director

The *ASCB Newsletter* is published 11 times per year by The American Society for Cell Biology.

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ASCB Newsletter
ISSN 1060-8982
Volume 34, Number 2
March 2011

Postmaster: Send change of address to:
ASCB Newsletter
The American Society for Cell Biology
8120 Woodmont Avenue, Suite 750
Bethesda, MD 20814-2762, USA

Today's students are experiencing an entirely different environment. There is no doubt that the advent of computers and the Internet has made many aspects of scientific survival easier and more efficient. But in adapting to this new environment I wonder if some important survival skills are atrophying. Are our labs as interactive as they once were? Are postdocs and students discussing their results (expected and unexpected, successes and failures), hypotheses, and next experiments? Or are they interfacing with their computers and hence becoming more isolated? Are they inspiring, motivating, and teaching each other as part of a larger scientific community? Are they learning from each other's mistakes and experiences? Are unexpected results and incongruities—the real source of discovery and innovation—going unnoticed by automated data analyses? In adapting to the computer/Internet age of data analysis and information acquisition, scientists have become more efficient in filtering data and focusing on essential information. But are we missing opportunities for serendipitous discovery? How might we adapt to better capture these?

Are unexpected results and incongruities—the real source of discovery and innovation—going unnoticed by automated data analyses?

How can we instill in young scientists the merits of ambition and risk without instilling in them the idea that to survive on this archipelago, you must "go big or go home?"

The Impact of "Impact"

Calculated journal impact factors didn't exist in 1980 when I was a graduate student, or at least I wasn't aware of them. We submitted our papers to the journals most read by our peers based on their content, in my case, either *Journal of Biological Chemistry* or *Journal of Cell Biology* (*Molecular Biology of the Cell* didn't exist). These papers generally consisted of five to seven typically single panel figures. There wasn't room for more because if the figures were too small on the printed page no one could read them: Online supplemental material didn't exist. I published seven such papers in my four years as a graduate student and the frequently repeated experience of writing and publishing gave me self-confidence and motivation. It also taught me how to recognize, complete, and package a "story" and to write a scientific paper effectively: Practice makes perfect.

There's no doubt that the new selective pressures to publish in "high impact" journals and fill pages of online supplementary material with incremental details and/or another paper's worth of experimental data have affected scientists as individuals and as a species. We have become more subjective in peer review. Ego, competitiveness, and/or an unfortunately not-unrealistic view that a paper in *Cell*, *Nature*, or *Science* ("CNS") can open career doors has led us to covet publishing in these journals. I've come to define CNS as a "Career eNding Strategy" for several reasons. First, the one or two years (or more) it takes to publish a single CNS paper often comes at the expense of delaying careers. Second, it can reduce opportunities for discovery in two ways: 1) there are usually better and more important experiments to be doing than the often incremental ones required to fill ballooning supplementals, and 2) it needlessly delays communication of key findings so that others can build on them. Third, it deprives our young trainees of opportunities to practice their writing skills repeatedly and to learn how to "finish" their stories. Finally, it's demotivating to be told that your "work is of high quality, but not of sufficient interest…I call this "rejected without revision." There's no doubt that the attributes required for scientists to thrive under these new selective pressures are different. Some are good: think big, ask important questions, take risks. Some more questionable: political savvy, competitiveness, marketing ability. How can we instill in young scientists the merits of ambition and risk without instilling in them the idea that to survive on this archipelago, you must "go big or go home?"

The Vanishing Independent Scientist

As graduate students in the '80s, our goal was to become "independent scientists." We were assigned largely independent thesis projects (at Stanford it was one enzyme: one thesis) and often published papers alone with our advisors. In a statistically flawed, small sampling of *Cell* papers, there were on average 3.2 authors/paper

in 1975, 5.7 in 1995, and 9.1 in 2010. Clearly, science has gotten bigger and more complex, and hence requires teams with diverse expertise. But, have big labs responded by selecting for specialists and team players? How does this change affect the training of individuals? What skills must evolve to ensure individual recognition and survival in this new era of big, team science? Successful scientists must clearly recognize and seize opportunities to lead. They must acquire strong leadership and communication skills, the ability to motivate and work well with others, and the ability to think strategically and coordinate teams. Are we explicitly teaching these skills to our best scientists? What about the other seven (on average) authors? Can they all be leaders? What are the career paths for the specialist, the team player? How are these critical "followership" skills recognized and retained in the community of scientists?

Successful scientists must… acquire strong leadership and communication skills, the ability to motivate and work well with others, and the ability to think strategically and coordinate teams.

As the Galapagos has done for me, I hope you too are inspired to consider these issues. In particular, as lab heads and mentors, how can we help our trainees to adapt to these environmental changes? Which of the individual characteristics selected for by the current environmental pressures are best suited for advancing knowledge and sustaining the scientific enterprise? Which might be harmful? Can we, as cogent scientists—or as societies—modify or mitigate the less constructive selective pressures? And as trainees, how can we adapt and evolve in the current environment? Perhaps our collective ponderings and future actions will enable us to shape our own archipelago. ■

Comments are welcome and should be sent to president@ascb.org.

Caucus Topics, continued from p. 1

- June 1—"A Genetic Blueprint for the Development of Your Heart," *Eric Olson,* University of Texas Southwestern Medical Center at Dallas
- June 22—"New Therapies for Melanoma," *Keith Flaherty*, Massachusetts General Hospital
- July 6—"Making a Face: The Role of Neural Crest Cells," *Johanna Wysocka*, Stanford University School of Medicine
- September 21—"Regenerative Medicine and Its Role in Improving Recovery from Traumatic Brain Injury (TBI) in Military Service Members," *Regina Armstrong,* Uniformed Services University of the Health Sciences
- September 7—"Sudden Infant Death Syndrome: How Research Is Keeping Babies Safe," *Hannah C. Kinney*, Harvard Medical School

Anyone who is interested in attending should contact CLS National Director Lynn Marquis at lmarquis@jscpp.org. ■