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James P. Collins: Seeking Biology's Growing Points

James P. Collins, Virginia M. Ullman Professor of Natural History and the Environment at Arizona State University, began serving as assistant director for biological sciences at the National Science Foundation (NSF) on 15 October 2005. BioScience editor Tim Beardsley interviewed Collins last November in his office at the NSF headquarters outside Washington, DC.

Beardsley: *Is there a need for biologists to articulate a research and education agenda for the coming decade?*

Collins: Without a doubt. There's a real challenge for this decade, which is clearly the decade of biology. We need to have a very clear sense of, not so much the integration between a research agenda and an education agenda, but what an integrated agenda should look like. You could say that learning is a creative process by which new knowledge is discovered. So the research and the education become one of a piece; the educational part becomes the challenge of getting students to think creatively and to think in a critical inquiry way. That essentially becomes research, and they are becoming researchers in the context of becoming educated.

So yes, I think there is a need, and given the sheer number of discoveries that are being made in the biological sciences, it behooves every citizen to have a much deeper understanding of the process of science.

Beardsley: *Yet biology teaching is being thwarted, to some extent, by creationists. Will NSF be taking active steps to combat creationism, in schools and possibly other places? Do you have thoughts on how you might do that through public education—for example, by developing a unified plan for all the biological sciences?*

Collins: At NSF we have, of course, a whole directorate devoted to education, and we're interested in science educa-



tion within biology. To the extent that things are not scientific, then we would not be interested in supporting them. We're certainly interested in getting a much fuller picture out in front of the public of what counts as science.

Beardsley: *But other than not supporting creationist teaching, no more active campaigns?*

Collins: No more active campaigns.

Beardsley: *Is NSF challenged by non-government actors? I'm thinking of Craig Venter's efforts. He's sailing around the world sampling marine microorganisms and shotgun sequencing the DNA. It's fascinating work to hear about, and it's nice that an enthusiastic individual is supporting it, but shouldn't NSF be supporting it, perhaps by having a ship do this?*

Collins: I am not going to speak to whether NSF should be supporting that particular activity. Should we support

sampling marine microorganisms? Sure, as long as the community takes a look at it through the peer review process and decides that, yes, that's the best way to be investing our resources in order to maximize returns from the funds that you have. In the larger scheme of things, there's room for a variety of different approaches to doing good science. One is the way in which Craig Venter is doing it, and one would hope that it's going to complement and enhance the way other kinds of individuals are doing it. I don't think we want to make the assumption that there's only one way to do science.

Beardsley: *What are your thoughts about funding of research at the molecular and genomic level using nonmodel organisms? The National Institutes of Health [NIH] are concentrating on a restricted number of model organisms, but evolutionary biology is increasing using some high-cost techniques and approaches, some of them discussed at Venter's recent conference. Arguably, the budget for your directorate is not set up to be able to do this kind of research. Will you be able to address that?*

Collins: We're funding a good deal of research that requires high-cost techniques and approaches. Some has to do with microbes that are not those of primary interest to the NIH, and we have some \$100 million invested in the plant genome project. As for other types of research organisms, we're funding work on jellyfish, on *Daphnia*, and on worms (not always the model organisms such as *C. elegans* that the NIH is interested in).

This is a central part of the mission of biology at the NSF: to support individuals who are interested in working with non-model organisms, to be a place where they can come and get their research funded. We're here to support the diversity of life.

Beardsley: *Going from the very small to the very large, what about major infrastructure projects? Can you give me any clues about changes on the horizon for biology? Are there near-term prospects for new infrastructure projects? I should acknowledge AIBS's interest in the National Ecological Observatory Network, NEON.*

Collins: I can tell you that in terms of major infrastructure projects we already have the Long Term Ecological Research project as a long-term investment, but yes, we are funding the initial look at NEON. The community has been in meetings all spring and summer, and AIBS is involved. So on the horizon, that's the big one.

Beardsley: *No others?*

Collins: No others.

Beardsley: *On the criterion 2 requirement for NSF grants [the requirement that grantees address the broader impacts of proposed research]—it's obviously important, but I think that in some quarters there's confusion about how far and in what ways it should be implemented, and what sorts of activities are necessary to ensure compliance. Is there training or coordination in prospect to help PIs [principal investigators] identify ways in which they can increase or broaden the impact of their research? And is that requirement working well, or are there planned improvements you can mention?*

Collins: Yes, I think it's working well, and we continue in our evaluations, such as with the committee of visitors that comes in to evaluate NSF programs. Increasingly there's more attention on the part of the reviewers to the criterion 2 requirement. Criterion 2 has to be some combination of education and outreach. In the best of worlds it's going to come

back to the first question you asked, which has to do with the integration of education and research. Really what we're striving for here is a seamlessness of the research and educational components, to get those wrapped together.

Beardsley: *What does that mean in practical terms for PIs? How should they be wrapping it together? Can you give me some examples of how you would do that?*

Collins: Sure. As far as a PI is concerned, there's the standard approach of involving graduate students in the research, and involving undergraduates in the research. But then there's a possibility of going beyond that, to involving students in K–12 educational situations, and to improving the access of groups traditionally underrepresented in the sciences. That can also be part of criterion 2: including the representation of institutions that are not represented to the degree that we would like. That could involve minority-serving institutions, it could include community colleges, and it could involve small private colleges. To the degree that PIs can take their research program and begin to involve these other groups and also participate in outreach activities, they're satisfying the criterion 2 requirement.

Beardsley: *Do you foresee any changes in the way that's done—will criterion 2 be operating in more or less the same way two years from now?*

Collins: I think it will be operating in an improved way. PIs are coming to what I think is a clearer understanding of what criterion 2 is all about. But secondly, they are increasingly creative in the ways in which they attempt to address it.

The key here is that we're funding some of the best researchers in the world when it comes to scientific discovery. There's every reason in the world to think that those individuals who have a creative approach to doing an experiment at the bench or in the field can also devise creative approaches to involving people other than the researchers themselves.

Beardsley: *On the subject of underrepresented groups, are there any special initiatives planned? Every time I go to a biology conference I find myself thinking, "This is not a diverse group."*

Collins: There's no doubt we have to increase representation of groups traditionally underrepresented within biology. We have a range of programs here within biology that include undergraduate mentoring. Environmental biology is a big one. There are graduate students contributing to K–12 teaching staffs, for example. These are efforts supported by NSF.

We have a new initiative out now for which we just had the very first competition. It's for funding investigators from minority-serving institutions. And going back to your last question, about what we are doing to help PIs understand criterion 2, we're running a series of workshops for investigators from minority institutions.

At those workshops, investigators and NSF program officers come and build teams. I was at one just a week ago in Baltimore. Investigators bring summaries of their proposed research, the abstract. That has criterion 1 and criterion 2 in it. Everybody sits around the table, and the program officers are there, working with these individuals, saying it looks like this could work, maybe you need to think about this, why did you say this in this particular way. They're very hands-on events.

Beardsley: *So is this program you've referred to identified by a name, or an acronym, more likely?*

Collins: There is an acronym. It's CAA/RIG [Career Advancement Award/Research Initiation Grant].

Beardsley: *In general, does feedback from these groups in the community indicate that they are happy that these programs are working effectively, and achieving what you want to achieve?*

Collins: Yes, the feedback is good, but we need more data, we really do, to under-

stand how to make the very best investment in this kind of program.

Beardsley: *Clearly, many of these questions come down to the budget. We've discussed studies of the effectiveness of criterion 2 activities, but fundamental research seems to be getting more expensive, and so devising an agenda that integrates research and education is a challenge. Can I ask you to expand on how you think that can be done? Can you get a small group of people in a room for a weekend to do it? What would be the proper way to devise an integrated agenda?*

Collins: At some point you're going to be involving the larger research community. And that's exactly what is happening in this regard. We're hearing from the ecological community, for example, that NEON is a way to go. We've heard from plant researchers that plant genome research is a way to go. And so we have gotten behind those particular initiatives. When it comes to other initiatives, we depend upon workshops, and we depend on the community, to help us be aware where the growing points are in the biological sciences. We will work to try to understand where the leading examples of research are, and bring each to a fine point. Then we will make those seminal investments that will, at their very best, be transforming, in some sense. That would be the goal—find those key inflection points where, although we don't have an infinite amount of money to invest, we can really begin to transform the science.

Beardsley: *There's a good deal of angst among researchers employing more traditional approaches in biology—I'm thinking of science collections here. It's mentioned in the Office of Science and Technology Policy/Office of Management and Budget annual science and technology budget memo that these are vital components of the national science infrastructure, but it's clear that many of them are struggling with dwindling budgets and grant resources. Is NSF aware of these concerns regarding natural science collections, and do you have a plan to alleviate them?*

Collins: We continue to support the natural history collections. They are a critical piece of the nation's infrastructure, there's no doubt about that. We have to keep providing what support we can, and along with that, support the sorts of research programs that have to do with biodiversity, such as the Tree of Life.

In the long run, we need to support understanding biodiversity at a descriptive level—what the diversity is that's out there. But then we also need understanding at a process level. What are the consequences of extinction in terms of communities and ecosystems, and at the landscape level? These are key elements of the program.

So sure, we need to support that kind of infrastructure as far as research is concerned. And we need to send a very clear message to the wider biological community that biodiversity is a very interesting issue, and an important one that deserves attention and support within the university infrastructure.

The breadth and diversity in biology is something that is critical for young people to understand. Faculty members should know that youngsters have to come to appreciate how diverse this world is and how valuable it is to help them understand that.

Beardsley: *Are there ways that you can imagine that this community could make that case more effectively?*

Collins: Well, I think the museum community, through informal education programs supported by NSF, is always trying to do that. They are bringing to the attention of the larger public what the value of biodiversity is and why we need to defend it.

Beardsley: *What are your thoughts about the effectiveness of biologists as compared to other scientists—are biologists making a good case for their discipline?*

Collins: I think biologists are learning to make their case. In terms of where we are now, we have made terrific strides in understanding biological problems. In many

respects the best is yet to come. I think biology will record, along with other sciences and the social sciences, that some of the most significant advances are probably going to be at the intersection of biology with these other areas of research.

And so I think the key here is an integrative approach. In lots of ways, the key to doing science especially productively is to look at the intersection of biology and the social sciences, the intersection of biology and physics, the intersection of biology and mathematics, biology and the geological sciences, biology and education, biology and engineering, biology and the humanities. The point is to see where those intersections are and make the case for biology along with these other disciplines.

Beardsley: *You've only just started your work here at NSF, and so it's ridiculously early to ask you a question about your legacy. But I am going to ask it anyway. When people look back on the Collins years, when you were head of the biology directorate, what do you hope they will say about what you've done that's important?*

Collins: A big part of my agenda will be what I mentioned in my answer to your last questions: fostering an integration between biology and some of these other areas of research. We really need to push forward on the edges, in some of these interdisciplinary areas: biology and society, biology and the social sciences, biology and mathematics, biology and the physical sciences. The key is funding the very best science and the very best scientists. That along with broadening access.

Beardsley: *Any more comments for BioScience readers?*

Collins: Just that I am incredibly honored to be here and humbled and gratified that Dr. Bement [NSF director Arden Bement] should choose me to lead biology for the foundation. I'll do the very best I can to advance the biological sciences while I'm here.

Biodiversity: The Interplay of Science, Valuation, and Policy

Photograph: National Park Service.

**ANNUAL MEETING of the
American Institute of Biological Sciences
24–25 May 2006
Washington, DC**

Register online and submit posters at www.aibs.org

“Biodiversity: The Interplay of Science, Valuation, and Policy” is the theme of the 2006 AIBS annual meeting. Plenary speakers and discussion groups will approach that topic from several interwoven perspectives. In recent years, policymakers have increasingly recognized the economic values associated with biodiversity, economists have increasingly found ways to incorporate values associated with biodiversity into economic thinking, and scientists have increasingly documented the variety of services that diverse ecosystems provide. Participants will have the opportunity to explore the many and diverse linkages among these fields.

The early registration fee for individual AIBS members is \$100; for nonmembers, \$150 (which includes membership in AIBS and a subscription to *BioScience* for one year); for government employees, \$90; for educators, \$80; for students, \$75.

**Register now!
Early registration ends 2 May,
and attendance is limited to 200!**

Special note: The annual meeting will be preceded on 23–24 May by an AIBS business meeting for the general membership, combined with a meeting of the AIBS Council of member societies and organizations, to discuss AIBS activities, plans, and priorities.

PLENARY SPEAKERS

AIBS is pleased to announce that the following distinguished scholars will speak at the annual meeting. Additional speakers are in the process of being added to the program.

- **Stephen Bocking**, Environmental and Resource Studies Program, Trent University, Canada
- **Shahid Naeem**, Department of Ecology, Evolution, and Environmental Biology, Columbia University, New York
- **Richard B. Norgaard**, Energy and Resources Group, University of California, Berkeley
- **Stephen Polasky**, Department of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul

PANELS AND DISCUSSION GROUPS

In addition to the plenary sessions, panels and discussion groups will convene throughout the day on 25 May, led by plenary speakers, invited guests, and AIBS board and committee members and staff.