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Source: BioScience, 56(6) : 470-474

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/0006-3568(2006)56[470:KKSITL]2.0.CO;2

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# Kathleen K. Smith: Integrating the Levels of Evolution

*Kathleen K. Smith, professor in the Department of Biology at Duke University, took over the directorship of the National Evolutionary Synthesis Center (NESCent) from Clifford Cunningham this past January. NESCent is now hosting conferences, postdoctoral students, and sabbatical faculty, and has made impressive steps toward establishing a cyberinfrastructure. AIBS is providing education and outreach services to NESCent under the center's grant from the National Science Foundation; last March, at NESCent's spacious new accommodations in a converted cotton mill in Durham, North Carolina,* BioScience *editor Timothy M. Beardsley interviewed Smith about the center's plans.*



**Beardsley:** *What have you spent most of your time doing since becoming director?*

**Smith:** First, coming to grips with many of the details. I have additionally spent a lot of time with Todd [Vision, associate director of informatics], working on what the informatics program will be—not only the intellectual program, but the structure. Our both coming on board at about the same time enabled us to change the way we think and talk about NESCent.

We were able to invite a new round of proposals for groups and postdoctoral students to be evaluated and funded, so we have taken the next step in terms of our scientific activities. And we were able to really start hosting meetings here. These offices opened up only in November, and we weren't able to host big gatherings previously. We have been able to work with several international projects that are very natural partners, including Cyberinfrastructure for Phylogenetic Research, the group creating globally unique identifiers for biodiversity, and others.

**Beardsley:** *To what extent will the activities here be focused on making available information, as opposed to conceptual work needed to solidify evolutionary science?*

**Smith:** There are the two parallel strands. One focus is developing databases and providing cyberinfrastructure, which will make information available. We have an internal bioinformatics team that will work on that either directly or with the help of partners.

On the other side, we are facilitators of a whole range of community activities to develop new conceptual approaches. That's our largest national service. I think some of the partnerships and informatics initiatives will grow out of needs expressed by some of the working groups.

The groups we've funded so far are representative of the diversity in evolutionary biology. One is evolution in contemporary human population considered from medical, genetic, and behavioral perspectives. And we've had integrative groups studying adaptive radiation in different groups of organisms, one on the evolution of biodiversity in Madagascar, and two looking at rates of evolution in fossil and molecular time. These groups will provide the conceptual breakthroughs. We are talking about 200 to 300 scientists in just the latest group of proposals, all of them interacting with NESCent, and we fund two groups each year. So that's a large part of our mission.

**Beardsley:** *Is NESCent's deliverable research or education?*

**Smith:** From the perspective of the National Science Foundation, the overall deliverable is research. Researchers have been conducting modern evolutionary studies for essentially 50 years, from the time of the modern synthesis. The question is whether we now have enough data and enough new techniques for analysis to change our understanding significantly. We are not an evolutionary data–generating center; there are many other centers that offer such opportunities. What's unique about NESCent is that



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we hope to provide a home for synthetic work, although that means different things to different people.

**Beardsley:** *You probably can't know in advance where the productive interactions will be.*

**Smith:** There are no specific expectations of deliverables. It's not like a research program where you say: I am going to answer questions A, B, and C, and five papers will come out of this. What we hope is that we can show, five years down the road, that we are identified as a place where the community has made a difference in the understanding of evolutionary biology. That's a slippery concept; we are having a lot of discussions about how we are going to assess that. It's very important that our community knows about our efforts and our results.

I think our impact in terms of education is important, but education was not the purpose of the grant. Candidly, that's difficult, because evolution is not only a scientific and an educational issue. It's a political issue. It's very awkward for an organization funded entirely by the NSF to take a political position. We have to do educational activities that will be interpreted only as scientific and educational, not as political. We come up against that wall very quickly.

**Beardsley:** *What mechanisms do you have in place for the evolutionary biology community to provide feedback about what you do?*

**Smith:** The main mechanism that we have now is a senior advisory board, which is a group of 10 or so evolutionary biologists from a wide range of disciplines. We think of them as representatives of the community. They should know if we're having an impact and help us assess it. For example, we will ask if a certain direction is the direction we should be going, what we should be concerned about, and so on.

We also have a science review board that's widely representative of the evolutionary biology community. It evaluates the proposals we receive and makes recommendations on which ones should be funded. As part of that discussion, we ask whether we are getting the right array of proposals, whether there are obvious gaps, and whether there are other groups who should be participating. In addition, NESCent's directors attend a wide variety of scientific meetings. We are planning to have a short symposium at the Evolution 2006 meeting.

We haven't had many groups come through NESCent yet, but we will ask all our working groups to have a postmeeting census about the services that were available. We'll ask participants if they can think of other things we need to do, and in general communicate with as many people as we can.

**Beardsley:** *Can you tell me about any feedback or reactions you've had so far?*

**Smith:** There's a major NSF initiative called "Assembling a Tree of Life." Independently of NESCent, they were having a meeting at Duke recently, which involved all their principal investigators. There was a reception here for them, and many people commented on how important NESCent is, how glad they were that NESCent has stabilized, and how much they wanted to continue the partnership. That group has a pretty strong profile. Colleagues who have been to scientific meetings recently have told me that many people see whether NESCent has stabilized as an important question. So we are getting the word out, and we are only a year into the grant.

The National Center for Ecological Analysis and Synthesis has paved the way for us. Because NCEAS has been so successful for the ecological community, there's some idea of what a synthesis center can contribute. I believe evolutionary biologists see they can use that model, and they understand what we might do when we're fully operational. The other side of that is that NCEAS has been in operation for 10 years, and I have some apprehension that we in our second year are expected to be functioning like NCEAS in its tenth year. We're still growing.

**Beardsley:** *What are the main lessons you would draw from NCEAS's success?*

**Smith:** I had a long talk with [NCEAS director] Jim Reichman about that. I think the number one lesson is to be responsive to the community and be very flexible about the kinds of programs and the activities that you support. We have a set of models for that, but I want us to make sure that we look at anything that comes up and seems important.

It may be that a big synthetic breakthrough will come not from one of the formal working groups, but from just two or three people working here who have a great idea for a new analysis. We should be able to take a risk and support that. And we must have a strong enough profile so that when people have a good idea they will come to us. The worst thing would be if we became very mechanical in the way that we evaluated things and very channeled in the activities we support.

**Beardsley:** *Given all that you've said, isn't the education and outreach group going to be a difficult operation to direct?*

**Smith:** Yes and no. It's one of the challenges. We initially tried having that group interact with all our scientific activities, but many of the activities that we support don't lend themselves to that sort of dissemination. So I've talked to our education and outreach staff about the need to target a subset of our activities. When we identify one of the groups working here as a good case study, we can go wild with it. So we might decide that the group studying evolution in contemporary human populations would make a good case study because it has tremendous contemporary relevance and will resonate with people. We should be able to have stories saying, "This is coming out of NESCent, this is how you can use it as educators, and this is how the public can understand evolution and our activities better." There are other examples.

**Beardsley:** *I've read the opinion that very little is actually known about how students learn about evolution. Will NESCent be able to sponsor studies of education techniques?*


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**Smith:** I don't think so. We don't have the expertise to evaluate what is a good study. Education per se, as an activity, is outside the purview of evolutionary science. One of the sabbatical people we're sponsoring focuses on education and effectiveness of the curriculum, however. He has developed a curriculum to study ecological concepts in elementary school and wants to take the opportunity to develop curriculum to study evolutionary concepts. So we are facilitating that, and we are facilitating a working group that is involved in education. Then the education group itself has a couple of activities. So I think we're sponsoring groups that should have things to say about how students learn.

**Beardsley:** *Have you identified any common misunderstandings about evolution that it would be important for the education and outreach group to be aware of and to address?*

**Smith:** My answer will be based just on my experience as an evolutionary biologist. I think the obvious misunderstandings are what a theory means and what corroboration and proof of a theory mean. Broadly, what science means. That's clearly misunderstood by the majority of Americans. A second major misunderstanding is confusing the theory of evolution with a theory of the origin of life. One may have a scientific or materialistic view of both of those, but the theory of evolution has nothing to do with a theory of the origin of life. A third major misunderstanding is about phylogeny and how to interpret a phylogenetic tree. I see this even in advanced biology students; they don't really know what a phylogenetic tree means. This might explain some of the simple-minded things we hear about humans being descended from apes or monkeys. Unless those three misunderstandings are cleared up, it's very hard to discuss the modern understanding of evolution.

**Beardsley:** *Are there misunderstandings about evolution that are prevalent at a much more specialized level?*

**Smith:** The things that one might be tempted to characterize as misunderstandings are probably miscommunications among biologists. But there are a number of issues, and again, this is coming from my particular experience as a biologist. We still have within science different views on microevolution and macroevolution. Many people don't believe there is such a thing as macroevolution. They believe that when we talk about macroevolution, we are not actually talking about evolution, and that when we're talking about evolution, it is sufficient to talk about changes in gene frequencies. But many other people think there are other kinds of questions to be answered. I would say that's one of the fundamental issues among professional evolutionary biologists: What is the proper realm of questions that are evolutionary biology? Are microevolution and macroevolution two different things, and if so, how do we reconcile their patterns and processes?

**Beardsley:** *Do you think they are two different things?*

**Smith:** I think that though they have different definitions, they are reconcilable. But that's a belief, not a fact.

**Beardsley:** *Do you hope NESCent might be able to do some of that reconciling?*

**Smith:** I would be disappointed if some of the people that came to us didn't include that in their projects. But I'm not convinced that it's NESCent's role to generate the research questions. I do think we should evaluate, with our advisory board, whether we are getting proposals that address the most important and meaty issues in evolution. If we are not, we must examine how we can get more of them.

**Beardsley:** *Do you want to comment on how the intelligent design challenge should be met? It seems to me that there is a big divide between those who think you should engage, challenge, and refute, and those who think the best thing is to say nothing at all about it.*

**Smith:** Again, this is a personal answer. If we believed that the ID discussion was one based on its merits and on principles, then I think we as scientists should engage it. I don't say that NESCent should engage it. But by and large my experience is that the ID discussion is carried out using political and courtroom tactics rather than intellectual tactics—the sort of thing you see on the evening news, applied to all kinds of issues. That's not a level at which you can have an intellectual discussion. Not only are we not trained to do it, it's not very profitable.

Regarding "teach the controversy," it depends on the rules. If there were to be an intellectual, scientific assessment, you could teach the different approaches. But I don't think you could teach the yelling match we have now.

**Beardsley:** *What advice would you give to biologists who want to make use of NESCent's services? How should people prepare themselves to be credible candidates?*

**Smith:** First of all, the project needs to be truly synthetic. That is, it should bring together diverse ideas, diverse data, and diverse sets of individuals. The combination of these diverse elements should have a chance of achieving some kind of breakthrough. We look for things that have some risk intellectually and might not be easily funded through other mechanisms. We hope the argument can be made that pulling together a particular set of information will lead to something new, whether it be a new insight, a new research program, a new way of analyzing data, or a new accumulation of data that others may then use. There is a whole range of possibilities.

**Beardsley:** *Have the numbers of people coming forward and making proposals been satisfactory?*

**Smith:** Absolutely. After our second call for proposals, we jumped to 50 or 60 total, including postdocs, sabbatarians and meeting proposals. I think that's comparable to what NCEAS gets in a round. We funded about 20 across the board.

**Beardsley:** *So it's still a competitive business?*


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**Smith:** It is still a competitive business. My greatest fear, when we get that degree of competition, is that you begin to look for reasons not to fund things, rather than reasons to fund them. I don't know how we avoid that.

**Beardsley:** *How many people did you fund in the first round?*

**Smith:** I think we had about seven postdocs and seven sabbatarians, and then about six meetings. So last year we funded almost the same number as we funded this year, but there were probably about half the number of applications.

**Beardsley:** *What about people from overseas? I realize NESCent is funded by the NSF, but I saw that some categories of grants appeared to be open to people from overseas.*

**Smith:** It's dicey. We need to justify funding people who are not US citizens. We're still working through that. We're committed to finding alternative sources to fund those people. Evolutionary biology is an international activity, and we want to fund the best science. So we are not limiting applications to US citizens. We'd hope that if activities involve foreign applicants we could have a partnership with their countries to help support the travel, and we'll support the activities themselves. That's our hope and that's NSF's hope. It's not as if we are just funding research activities of individuals. When you're funding synthetic programs, you can't say in all cases that you're going to fund the best opportunity for synthesis and then limit it to the citizens of one country.

**Beardsley:** *I'm not trying to put you on the spot here, but I am interested in your thoughts on AIBS's continuing role in education and outreach for NESCent.*

**Smith:** I am very interested in it. AIBS's general role is so important that we want to continue to be involved at some level. We certainly support AIBS's general positions in Washington, and its constituent societies and their role in the biological sciences. In the long run, NESCent should participate more in outreach and policy issues. Broader participation in the activities of AIBS is something that I don't want to minimize and that I am very interested in pursuing. But I need to feel very comfortable with what we're doing here before I am going to be able to initiate anything new.

**Beardsley:** *What are your thoughts about the continuing lack of racial diversity in biology? Everybody acknowledges it's a problem, but nobody wants to talk about it.*

**Smith:** I think it's a bigger problem in academic biology than in the applied fields. I am not sure if it's a bigger problem in evolutionary biology than in other academic specialties. Certainly there are always relatively small pools of minority applicants in undergraduate population biology majors. I think that for minorities, issues of upward socioeconomic mobility are important, and that tends to lead to a more professional path. The minority undergraduates that I see aim more toward professional degrees than toward academic degrees. For those that are interested in academic careers, we need to make it clear that evolutionary biology is one of many good avenues.

**Beardsley:** *NESCent seems like such an obviously good idea that I wonder, why didn't it start sooner?*

**Smith:** I really don't know. There's always a tension at the NSF between funding centers and individual grants. Certainly, with the success of NCEAS one would think that they might have started this a little sooner. As for what finally brought us to the tipping point: I suppose changing priorities at the NSF. There had been several task forces about evolutionary biology, and a center for evolutionary synthesis was a recommendation of one of those.

**Beardsley:** *Are there any specific techniques now becoming available to evolutionary biology that you think will be particularly important, ones where NESCent will have to be active? To prime the pump: I've heard that controlled vocabularies is one that's going to be important to know more about.*

**Smith:** That is one of the first things I would have talked about. On the bioinformatics side, we are increasingly getting, for a number of organisms, very good information on many levels, from genetic through organismal and developmental, behavioral, and ecological, to phylogeny and near relatives and, in some cases, biogeographical patterns and the fossil record. So there may be many hierarchical levels of information about individual organisms, groups of organisms, or related organisms. Levels don't automatically integrate themselves. There are very few scientists who are working at more than a few of those levels, or who can do so.

Real insights into understanding evolution will come about precisely by integrating all of those levels. That is the ideal for NESCent, because we can bring those individuals together, with support from informatics initiatives such as controlled vocabularies and common sets of questions. Without trying to control the vocabularies and the databases, it is hard to make them accessible to common portals or informatics avenues, or to Web-based applications. As a central location where researchers work intensively on a few steps, we can facilitate that process. We already have scientists working intensively on a couple of different organisms in a way that nears that. We can set up models for that process and for the various types of data, and approach integration without each group having to reinvent everything. Once we can show the community that we can integrate levels of analysis for a couple of situations or organisms, then I think more and more people will see the utility of doing so.

One of the most interesting working groups is with Paula Mabee and Monte Westerfield. They are bringing together the community that works on the developmental genetics of zebrafish, which has done a great deal to control its informatics, with a group that has done work on the comparative phylogenetics of fish. So people studying characters and character changes can use a vocab-


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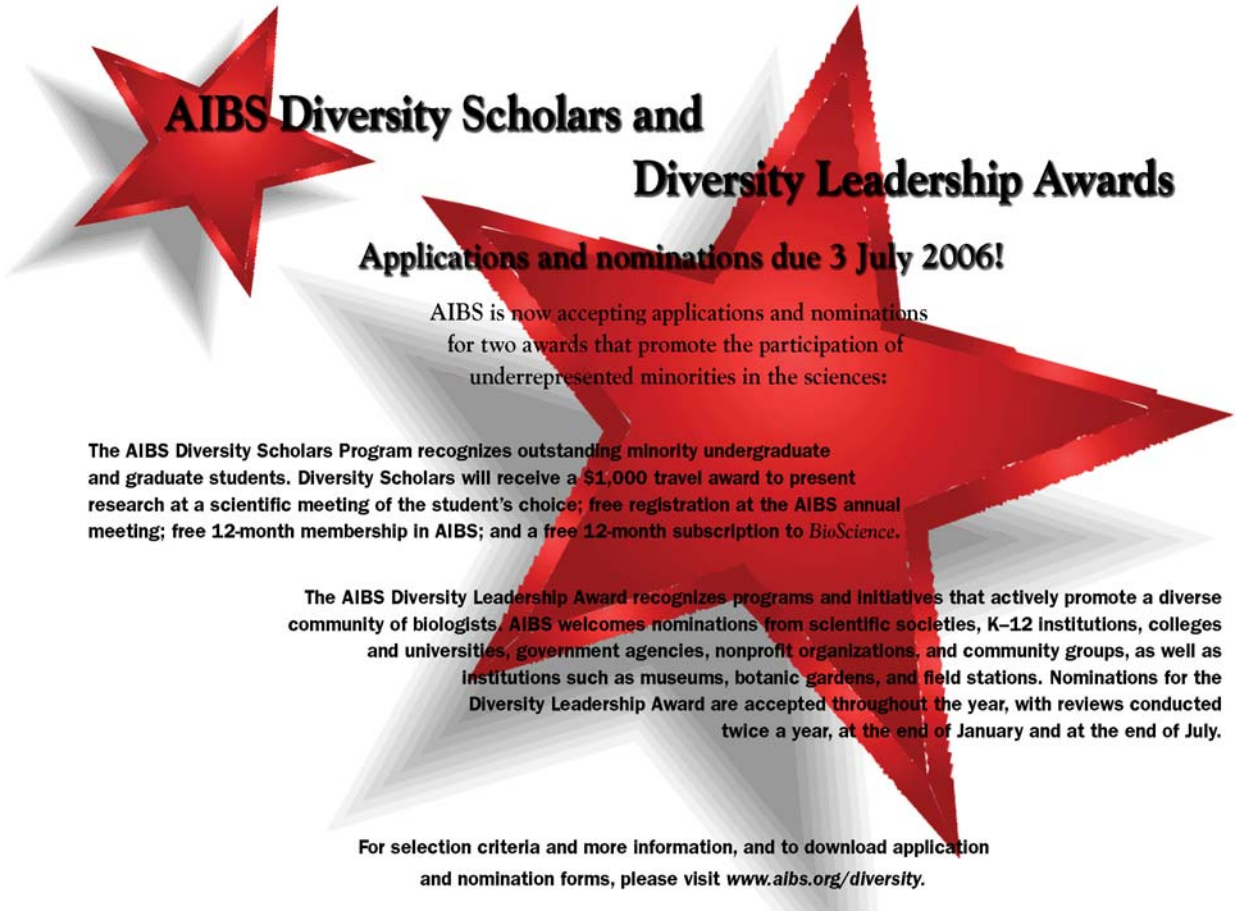
ulary that meshes with that used by people looking at zebrafish genetics. That's a prime example, and we're hoping it will become a model. *[Editor's note: An Overview article on this work, by Paula Mabee, was published in* BioScience *in April.]*

**Beardsley:** *Would you agree with the view that comparative genomics is something that every biologist is going to have to learn something about, because whatever organism you're working on, there will soon be a genome sequence available? And will you provide appropriate instruction?*

**Smith:** Even I am starting to learn something about comparative genomics, but NESCent can't be the place for that. There are other places that do such work, and it's a big project. Much of this research is coming out in the biomedical literature, and the amount of money that the National Institutes of Health are spending on it is a mint compared to our minuscule amount. Our role is to make resources that are designed for the specialist more accessible to the evolutionary biologist, who may be a bit intimidated by them.

**Beardsley:** *Ten or 20 years ago, people might have guessed that by now progress in communications technologies would mean that wherever you were in the world, you'd be able to have a conversation in ultrahigh-definition video and sound with anyone you wanted. Yet we apparently still need centers where people meet. Why is that?*

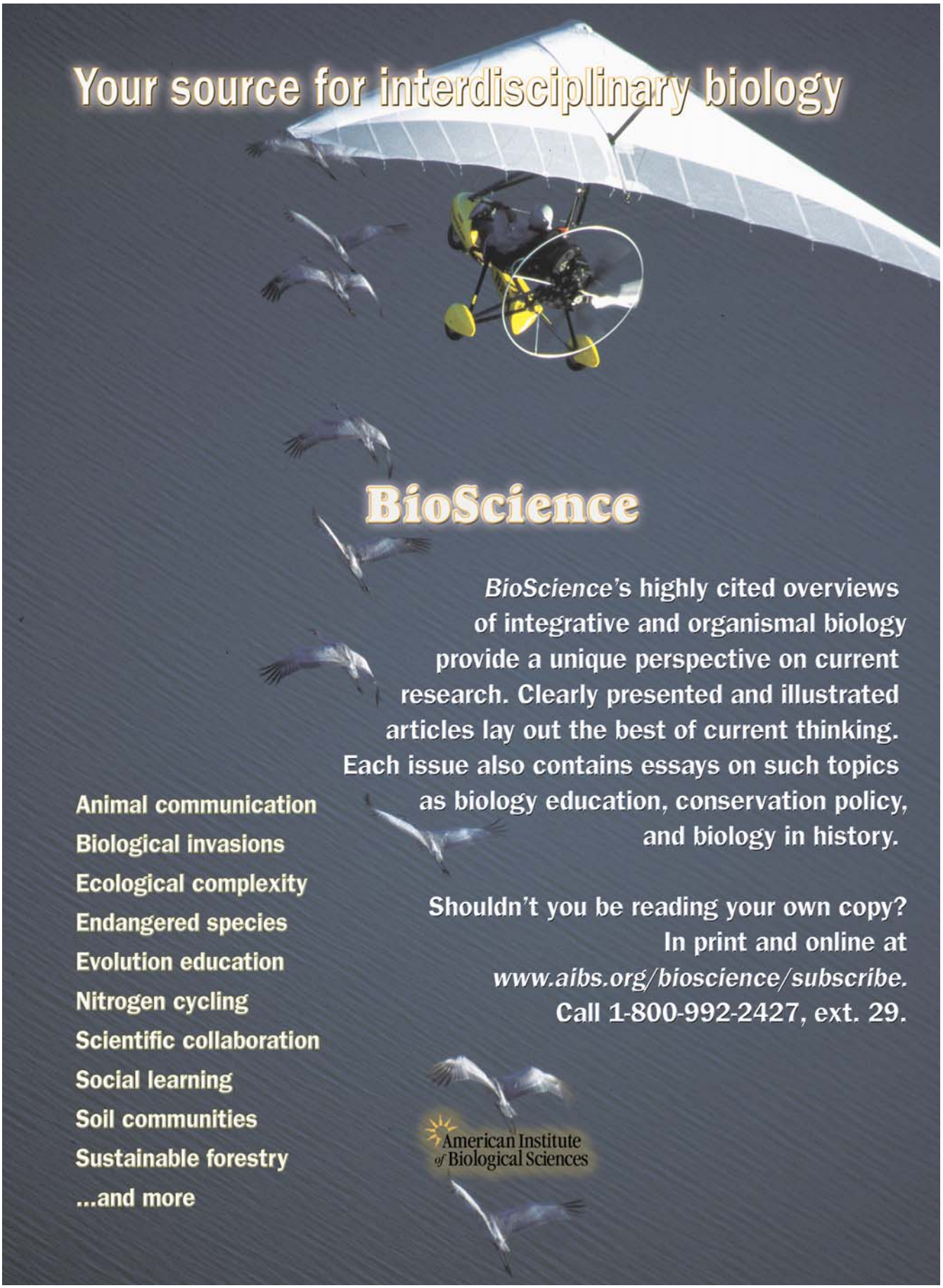
**Smith:** Even with banks of televisions, I don't think you can get the same kind of give and play that you can get in a face-to-face meeting. If it's a full day, you can go out to lunch together; you can break up into various small groups; you can say, tonight we'll think about this; then you might get together over breakfast to argue about one small point you've identified. There are certain kinds of communication that work well by teleconference, but in the sort of intense endeavor where people are really trying to come together to work out problems, I think the face-to-face contact makes a difference. There's a lot to be said for a venue where you can do all that.





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