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SPECIAL INVITED PAPER—YEAR OF SCIENCE

SYMPOSIUM ON SCIENTIFIC LITERACY: INTRODUCTION[1]

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Society needs science, and scientists need an informed, thoughtful, and open-minded citizenry. Thus, the obvious dependence of American society on science is strikingly inconsistent with the low level of scientific literacy among U. S. citizens. A recent poll conducted by the Pew Research Center for the People and the Press (2009) shows that 70% of the public thinks that science and scientists contribute "a lot" to the well-being of society, yet only 28% of American adults currently qualify as scientifically literate. The general public understands what science does, but not how it is done. There is also a disconnect between what the public and practicing scientists think of U. S. science. According to the 2009 Pew Center poll, whereas only 17% of the public think that U. S. science is the best in the world, 49% of scientists surveyed considered U. S. science to be superior to that in other countries. Most scientists (85%) also consider that one of the major problems for science is that the public does not know very much about science. By establishing 2009 as the "Year of Science," professional scientific organizations and grassroots, citizens-for-science groups hope to bring a renewed and invigorated focus on the importance of science now and in the future. As knowledge experts and educators, practicing scientists are key players in advancing the scientific literacy agenda.

The Botanical Society of America (BSA) has been involved consistently in helping to educate new generations of scientists and citizens. The "Teaching Section" has been a prominent element of BSA activities at national meetings and throughout the year. Through this section, the BSA has developed and promoted important initiatives, made awards to educators, and sponsored symposia. A primary education focus of the BSA in recent years has been the PlantingScience program (http://www.PlantingScience.org). The spark that initiated this program was struck at the 2003 annual meeting in Mobile, Alabama, when Bruce Alberts, then President of the National Academy of Sciences, presented the keynote address at the Educational Forum and challenged the society to develop a tradition of cooperation between scientists, science educators, and teachers and to incorporate inquiry-based activities into student laboratories. Originally in association with the Acme Animation project, developed by teacher and professional animator Dave Master, Alberts' challenge integrated three different constituencies. Schoolteachers provide the disciplinary standards, principles, and processes to design appropriate discipline-based challenges. Student research teams take on the challenges and design investigations to meet them. Scientists are the expert mentors who interact with schoolteachers and student teams as they develop and meet their challenges. In the classroom, student teams and their teacher reflect on and revise each team's work, which is then posted online for interaction with a larger group of students and expert mentors.

With strong encouragement from the Education Committee, the BSA council approved funding in 2004 to develop and implement a pilot study. The successful implementation at all levels was encouraging as we moved into the pilot study in the fall of 2005, which involved more than 400 students in 10 schools and nearly 40 scientist mentors. Subsequent strategic planning addressed two major themes: (1) continued development and evolution of the fledgling program and (2) building sustainability. On the development side, the American Society of Plant Biologists' (ASPB) "Principles of Plant Biology" (www.aspb.org/education/foundation/principles.cfm) became the focus for developing further modules, and a goal was set to introduce two new modules annually. Implementation of the strategic plan was evident by the fall of 2006. ASPB became a formal partner in the program and the first Master Plant Science Team was formed and trained.

In the spring of 2007, an extensive assessment was completed and was supported by a grant from The Monsanto Fund. The Monsanto grant was followed by two grants from the National Science Foundation, both of which were implemented in the summer of 2008. The NSF grants brought teachers from around the country to Texas A&M University for a 9-day intensive training program on implementing inquiry. In addition to BSA and ASPB, eight other societies now partner in the program. All indications are that vigorous growth lies ahead for the PlantingScience seedling that was sown in Mobile in 2003.

Although PlantingScience involves numerous botanists directly with meeting the challenge of helping the public become more scientifically literate, most practicing scientists remain uninformed about the scope of the problem and the possible solutions to it. To help BSA members focus on the public understanding of science, a symposium was organized as part of the annual meeting of the BSA in July 2008. This symposium sought to inform attendees about the issues involved in scientific literacy as well as the progress achieved toward the goal of obtaining a public that is better informed and more accepting of scientific achievements and science in general. There were five presentations during the symposium: Marshall Sundberg discussed the PlantingScience initiative developed by the BSA (just summarized in this introduction), Gordon Uno showed how developing botanical literacy among our students can contribute to scientific literacy, Judith Scotchmoor illustrated how

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she and her colleagues have developed educational outreach and resources for helping teachers teach the process of science to their students, and Matthew Nisbet and Dietram Scheufele each discussed different aspects of science communication and the public.

This introduction and the following three papers bring these presentations into print. All the papers show how both passive and active forces have led to current concerns about scientific literacy. Gordon Uno (2009) summarizes why it is important for scientists in general and botanists in particular to invigorate science teaching with inquiry methods. He illustrates the challenges we face because students lack critical thinking skills, are generally uninformed about plants, and many are actually hostile toward learning about plant biology. To improve this situation, Uno provides seven principles of learning that make recommendations about how botanists should teach, including using themes and "thinking botanically" to illustrate all biological concepts. Judith Scotchmoor and her colleagues Anastasia Thanukos and Sheri Potter discuss efforts targeted at raising public awareness of science (via COPUS, the Coalition on the Public Understanding of Science) and provide resources that are available to teachers who seek to weave the "process of science" into courses to inform students about how science works (Scotchmoor et al., 2009). By developing a public that is more actively aware of science as part of their lives, both citizens in general and students in particular are more likely to be interested in learning about science. Scotchmoor et al. also discuss the web-based project called "Understanding Science" that aims to improve teacher understanding of the nature of the scientific enterprise, provide resources that encourage and enable K-16 teachers to reinforce the nature of science throughout their teaching, and serve as a clear and accessible reference that accurately portrays the scientific endeavor. Matthew Nisbet and Dietram Scheufele decided that instead of writing separate papers based on their symposium presentations, they would combine forces and generate a single communication that captures the messages they wanted to convey (Nisbet and Scheufele, 2009). As researchers into communication about science, these authors illustrate that building a public that is more receptive to science requires more than enhancing scientific literacy, and they emphasize that any science communication efforts need to be based on a systematic empirical understanding of the intended audience's existing values, knowledge, and attitudes, their interpersonal and social contexts, and their preferred media sources and communication channels.

Taken together, this set of papers captures current issues about the public understanding of science, illustrates why greater emphasis on helping students understand and appreciate the process of science is so important, and provides insights and perspectives on what we as practicing plant biologists can do to build a more receptive audience for our work, as well as a public that is more informed about plants and their contributions to science and human affairs. It appears that in some respects academic scientists are contributing to the problem because we tend to teach content (facts about plants) rather than process (how to learn about plant biology), we do not help our students understand how scientists actually do our work, and we are not sufficiently aware of the social dynamics involved with scientific communication. Each of the papers presents different elements of making us more aware of the challenges we face, better prepared to help our students appreciate and learn about science and plants, and in general enhancing our capacity to change the future. We should be active participants in making sure that botanical literacy improves for new generations of students.

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