from the start. One effort of SPARC in this regard is BioOne[5] - an electronic aggregation of bioscience journals.

References

[1] ARL Statistics, 1997-98, Washington, DC, Association of Research Libraries, 1999, p. 9. Relevant chart is available at www.arl.org/stats/arlstat/1999t2.html.

[2] "Measuring the Cost Effectiveness of Journals: The Wisconsin Experience," ARL Bimonthly Report, 205 (August 1999), pp. 1-6. Also available at www.library.wisc.edu/projects/glsdo/cost.html.

[3] "Journal Price Study of Core Agricultural and Biological Journals," Faculty Taskforce, College of Agriculture and Life Sciences, Division of Biological Sciences, Albert R. Mann Library, Cornell University, November 1998. Available at http://jan.mannlib.cornell.edu/jps/jps.htm.

[4] The SPARC web site is located at www.arl.org/sparc.

[5] The BioOne web site is located at www.BioOne.org

THE PEER-REVIEW SYSTEM

The peer-review process is critically important and often an under appreciated portion of scientific publishing. A number of leading editors and experienced reviewers have recently started an open exchange of opinions in the Theme Section of the journal *Marine Ecology Progress Series* (MEPS): "The peer-review system: time for re-assessment?" (Idea and Coordination: Hans Ulrik Riisgård; MEPS, Volume 192, page 305-313, 2000, see also http://www.int-res.com/forum/peer_review.html.) The MEPS Discussion Forum expands issues raised by previous contributors.

The "publish or perish syndrome," identified as a core problem challenging the peer-review system, should be replaced with a "contribute or perish philosophy." Submission of manuscripts to the peer-review system is a professional request for colleagues to donate their time. But some authors expect their manuscripts to be "cleaned-up" by the peer-review process. There is a substantial imbalance between positive and negative consequences of submitting a manuscript. For authors, manuscript submission and re-submission always have the potential for improvement and publication and relatively little risk of negative consequences. If manuscripts of low quality carried a greater risk of negative consequences for the authors, it would discourage re-submission and yield a considerable savings in time with little cost in lost value to the scientific community.

Referees are the backbone of quality control. **Acting as a referee and serving on editorial boards should be recognized as essential contributions, and appropriate professional advancement should be given.** You are invited to express your opinion. Please send your text (as brief and concise as possible) to the MEPS Forum Editor, Hans Ulrik Riisgård, Odense University, Hindsholmsvej 11, DK-5300 Kerteminde, Denmark, Fax: +45 6532 1433, E-mail: hur@biology.ou.dk.

EDUCATION

PERSPECTIVES ON GRADUATE EDUCATION EXPERIENCES IN AQUATIC SCIENCE

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Introduction: The Dissertations Initiative for the Advancement of Limnology and Oceanography (DIALOG) Program was initiated to foster interdisciplinary understanding and collegial interactions across the aquatic sciences (http://www.aslo.org/dialog.html). The program includes collection of Ph.D. dissertation abstracts to showcase the work of the most recent generation of aquatic science researchers, collection of demographic information from these new graduates for human resource purposes, and a symposium to bring together a group of recent aquatic science Ph.D. recipients with the goal of fostering interdisciplinary understanding and collaborations.

The third DIALOG symposium (DIALOG III) was held October 18-22, 1999, at the Bermuda Biological Station for Research. The 42 participants received their Ph.D.s from 34 institutions in 10 countries (Canada, Chile, Germany, Greece, Japan, the Netherlands, Russia, Sweden, United Kingdom, and the U.S.) Many sub-disciplines of aquatic sciences (mostly biological) were represented, ranging from molecular biology to community ecology and biogeochemical cycles.

As part of this symposium, participants divided into four working groups for discussion of their graduate school experiences. Each working group included both limnologists and oceanographers graduating from different-sized institutions and representatives from at least three countries including the U.S. Each working group was asked to collect some data to structure the discussions (faculty size and number of students entering in the same year). Other than that, discussions were open. After the breakout sessions, participants met together to exchange information. A survey was sent out after the symposium to gather additional data. Finally, drafts of this article were circulated for comment. Overall recommendations from these four groups, collected by topic, are summarized below.

Academic Program Size: Students compared faculty and student cohort sizes based on memories from their time as

graduate students at the 34 institutions where their Ph.D.s were completed. The size of graduate programs in limnology, indicated by the number of hard-money faculty positions and number of aquatic science students beginning the same year, differed from that of oceanography programs. The median number of aquatic-science faculty at institutions graduating limnology participants was 6.5 (range 4-25), compared with 20 (range 2-82) for oceanography. The largest limnology program represented was Lomonosov Moscow State University (Russia) and the largest oceanography program represented was Scripps Institution of Oceanography (U.S.). Median and ranges for limnology and oceanography faculty at U.S. schools were 5.5 (4-13) and 20.5 (2-82), respectively.

Participants compared cohort size, defined as the number of aquatic scientists entering graduate school the same year. The median number for cohort size was 3.5 for the limnologists (range 1 - 14) and 5.5 for the oceanographers (range 1-30).

The group noted the differences in faculty size and student cohort size between limnologists and oceanographers but did not get into a discussion of reasons or impacts, and no recommendations were made. (A discussion of size based on the above numbers may be misleading because many limnologists are from large biology departments, which might have only a few limnologists.) In contrast, the biological oceanographers were in interdisciplinary departments or institutions where they interacted with physical, chemical, and geological oceanographers through joint courses, seminars, cruises and the like.

Coursework and Exams: Graduate programs and requirements varied across institutions. The major difference between limnologists and oceanographers was in the amount of coursework required during the first year or two of graduate school. Oceanographers tended to have more physical science requirements (for example, physical, chemical, and geological oceanography) in addition to biology courses. They agreed these courses were necessary because oceanography is too interdisciplinary to ignore a basic understanding of all four disciplines. The broader course requirements in oceanography programs provide additional opportunities to connect with peers from other disciplines.

Overall Recommendations

- No more than one year of courses should be required. Coursework and plans should be designed to fit individual needs. A committee should meet with the student at the beginning of the program to consider the student's background and plans. It should identify weaknesses and suggest courses that would be pertinent to the proposed thesis topic and improve the quality of the thesis program.
- While graduate students in oceanography need a broad spectrum of core courses due to the interdisciplinary nature of the field, departments should establish guidelines that allow students to be exempted from the core courses if they have taken them elsewhere.
- Some courses in ethics and philosophy of science should be offered.
- A comprehensive exam should not be required after the first year of coursework. Such exams place undue stress on the first year and are particularly difficult for those who are non-native speakers. More importantly, the faculty committee should monitor and advise the student's progress on an ongoing basis.
- An exam that involves broad-scale questions regarding the thesis area and a thesis proposal defense should be held during the first two years.

Student Support: Wages for graduate students varied dramatically ($100 to $43,000 per year), and almost all DIALOG III participants utilized more than one source of support during their graduate years. Participants received support from the following sources while graduate students: research assistant (RA; 76%); teaching assistant (TA; 64%); external fellowships (42%); institutional support (36%); and "other" (18%). Nine percent received no support for one or two years.The "other" support included a spouse, the military, a full- time technical position, a university position, a nine-month position as a visiting professor, and a full-time position as PI on a grant.

For U.S. participants, the median wage earned during the final year was $14,000 (range $5,000 - $32,000). The two highest were for a nine-month teaching position at a near-by institution and for a situation in which the student was allowed to develop and serve as PI on a grant. Among participants studying outside the U.S. the median wage was $10,600 with a range of $100 - $30,000. The highest was for a full-time technical position that allowed degree work. The wages at the lower end demonstrate the difficulty many scientists face in developing countries and the former Soviet Union. With wages of $100 per year, even student membership in a professional society such as ASLO is out of reach.

Among the RAs, some were paid to work on their thesis research while others were expected to work on a different project. Each system had advantages. Working on a different project provided a more diverse research experience, but concentrating on one's own research generally resulted in a faster time to completion. Among those who worked as RAs, 59% reported they had spent time working on a project other than their dissertation topic (median was 15 hours on a non-thesis topic). Time was definitely an issue for this group; the median time spent as graduate students was six years (range 4-12), and participants were around 31.5 years old when they completed their degree (range 25.5 - 42.0). At the time of the symposium most were still in postdoctoral positions with uncertain futures.

Overall Recommendations

- Funding should be stable so students do not lose valuable time hunting for support each year.
- At some point, all graduate students should be required to develop proposals for research funding to the National Science Foundation, the European Commission, or its equivalent to gain familiarity with the process.
- Some work as a TA should be required.
- The department should provide funds for students to attend at least one meeting during their tenure as students. Some participants thought that students should have funds to attend one meeting per year once they begin work on their thesis research.

Teaching Assistantship (TA) & Training: Overall 60% had TAed at least one course during their graduate-student years. Among participants graduating from U.S. universities, 66% TAed at least one course (median two courses per participant, range 1-5). Of these, 79% TAed at the undergraduate level, 42% at the graduate level, and 21% at both levels. In terms of advisor support for teaching, 57% were encouraged to TA, and 30% were discouraged from doing so; the rest were neutral. Among those receiving degrees outside the U.S., just one-third had TA or equivalent experience. Given the fact that academic positions even at major research institutions include a teaching component, many participants felt that teacher training was not a strong enough part of their graduate training. Only 47% considered the amount of teacher training received as adequate.

Two excellent models are mentioned here. Brian Helmuth described the Pew Foundation's Preparing Future Faculty Program (http://www.preparing-faculty.org/). The components vary from site to site, but in general the goal is to prepare graduate students for academic positions and create better college-level teachers. At the University of Washington, the program included a one-quarter class in which students developed course syllabi and exams, role-played student-instructor interactions and, perhaps most importantly, gave lectures in front of a video camera. After completing the course, these scholars were given opportunities to present guest lectures in large university classrooms and at smaller colleges in the area.

Anke Mueller-Solger outlined programs coordinated through the University of California at Davis' Teaching Resources Center (http://trc.ucdavis.edu/trc/). A Program in College Teaching fosters close teaching collaborations between graduate students and faculty mentors. Depending on their interests, students can pair up with mentors at the University or at local two-year or four-year colleges. Participants also can carry out teaching-related projects, often in teams. Among other things there is also a peer-advising TA consultant program that offers workshops, consulting, videotaping, and course evaluations. The TA consultants (usually a group of eight to 10 experienced graduate students) are responsible for all parts of this service. They receive further training themselves in the form of weekly seminars/group meetings.

Overall recommendations:

- Training in teaching skills should be part of the graduate experience.
- It is not sufficient to TA a course with no additional training. Opportunities such as those outlined above should be provided.

Ph.D. Advisors: Advisor roles varied considerably, representing the diversity of programs and individual styles, strengths and personalities. Given the number of years spent in study and the important role the advisor plays in a student's experience, all felt it was important to establish a good working relationship with the advisor. Among this group, 40% felt they had an excellent relationship with their advisor. Another 21% considered theirs to be very good, 14% good, 9% fair and 5% poor. Discussions indicated the tension between the student's need for freedom to develop his or her own research, and the desire for encouragement and some guidance along the way. Professors have various styles and strengths, and students have very individual needs.

Overall Recommendations: While there is no one formula for good advising, the advisor should at least

- Act as a mentor and nurturer;
- Be available to students when needed, and ready to offer advice and constructive criticism;
- Provide training in the review and writing of manuscripts;
- Provide training in the review and development of research proposals; and
- Ensure that students receive financial support during their student tenure.

After Graduate School: A large proportion (76%) of the symposium participants held postdoctoral positions at the time of the symposium, and 44% indicated that this was of necessity rather than choice. During one evening session, participants with tenure-track positions gave their perspectives on interviewing and negotiating. Jobs (or the lack thereof) were a frequent topic of conversation, but the overall mood was positive, and participants were optimistic about finding positions.

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SHIPBOARD RESEARCH EXPERIENCE FOR UNDERGRADUATES: BUILDING SKILLS, SELF-CONFIDENCE, AND LEADERSHIP POTENTIAL

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Talented, aspiring young scientists in the prime of their undergraduate education continuum apply to summer research experience programs in order to get a grip on the reality of scientific careers. In limnology and oceanography, that reality must include significant field-oriented research. In our business, the information of the Information Age must still come in significant part from actual analysis, and students must understand what is involved in collecting the data used in local, regional, and global models.

Funded by the National Science Foundation, Research Experience for Undergraduates (REU) programs in aquatic sciences combine group participation with a planned, science-driven research agenda. Students gain a contributory, fulfilling, and real oceanographic experience using UNOLS* ships. Cruises of several days' duration permit exploration of a range of physical, chemical, and biological habitat conditions as well