SUNBURNT ORGANIC MATTER: BIOGEOCHEMISTRY OF LIGHT-ALTERED SUBSTRATES

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Limnologists and oceanographers have long recognized the importance of light as a fundamental factor that provides energy for primary production. Over decades, biologists have come to recognize many related subtleties: e.g., there can be too much light (saturation, photodamage), color matters (action spectra), even if it’s unseen (UV effects). This fairly mature body of knowledge about light and photosynthesis has varied applications, such as sophisticated in situ pump-probe methods to study the state and potential of the photosynthetic apparatus, refined remote sensing algorithms that account for light saturation effects on chlorophyll-productivity relationships, and the study of UV interactions with phytoplankton (and land plants) to evaluate the effects of the ozone-hole and ultraviolet light in general. Many functional roles of light in living systems also have received attention historically; for example, its roles in numerous sensory and behavioral modalities - phototaxis, vision, light–entrained rhythms, bioluminescence, etc.

Indirect roles of light relevant to biology and biogeochemistry have also been noted, such as its possible roles in pre-biotic evolution, in forming banded iron formations, and in creating the ozone layer. However, until quite recently the indirect (abiotic) biological effects of photochemical processes in aquatic environments have not been well recognized. This article focuses on the role of such indirect photochemical effects, since studies of the surprising and subtle roles of light in remineralization - the other half of carbon and energy cycling in aquatic ecosystems - have become ever more prominent. (Remineralization is known in some circles as the “dark side” of the carbon/energy cycle, reflecting an appreciation of the role of sinking, but ignoring that of light). However, these studies are still at a very early stage.

What directions are emerging in studying the couplings of aquatic photochemistry to biology? The theme of this essay is that a central trend will be towards elucidating the abiotic photoalteration of organic matter, the resultant changes in its biological properties, and the biological responses. Multi-disciplinary studies will develop this rich, challenging theme. This short essay:

· predicts that these connections define a very promising research direction
· presents ideas about sunlight-driven processes and how product pools couple to biology
· focuses this synthesis on the dissolved (DOM/colloids) and particulate (POM) pools
· suggests that inter-disciplinary “cracks” may hinder studies of senescent cells.

Far from being comprehensive, a short essay can hardly cite all relevant work. “Photochem*” shows 1332 post-’90 hits in Aquatic Sciences and Fisheries Abstracts and 466 in Oceanic Abstracts; many are relevant. The few references below may provide useful leads. Two recent books include chapters reviewing and synthesizing several aspects (DeMora et al. 2000; Hansell and Carlson 2001).

Below the intuitive term “sunburn” is used to denote the photoalteration of non-living (non-viable) aquatic organic matter and the prefix S- to designate sunburnt chemical pools. Although the focus is on one major class of sunburn effects - the alteration of organic matter’s substrate quality for oxic heterotrophy - examples of other important biological aspects that deserve recognition in passing include the photobleaching of colored dissolved organic matter (CDOM) that alters water-column optical properties (e.g., Vodacek et al. 1997), as well as alterations of micronutrient cycling (e.g., iron availability; Barbeau et al. 2001).

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Sunlight modifies the bioavailability and the bioenergetics of DOM, and likely those of POM. In the mixed layer (ML), sunburning effects are intertwined with concurrent photobiology (photoinhibition and damage). Although often it is unclear whether the light-dependent step is obligatory – can the substrate be remineralized in the “dark zone?” – sunburning effects matter whenever they change the rate or course of remineralization from that which it would otherwise take. As substrates, both DOM and POM are notoriously complex mixtures with components that are metabolized on timescales varying from geological to seasonal, but rarely fast enough to turn over entirely while confined to the euphotic realms of freshwater bodies or oceans. While differentiating DOM from POM is obviously operational – here, 0.2 µm filtration – the crucial factor is that the separation method must remove enough living biomass that the effect of light on the sample’s nonliving molecules can be measured without being seriously affected by microbial metabolism. This need arises because we lack “perfect” poisons, and the photobiological effects of light on heterotrophic rates are likely so non-linear that subtracting them is impractical.

SUNBURNT DISSOLVED ORGANIC MATTER (S-DOM)

The sunburning of DOM – particularly of CDOM – has been the subject of intensifying study in the freshwater and marine communities for over a decade (for early papers, see Geller 1986; Kieber et al. 1990). Cartoon 1 is intended to encapsulate two key aspects of DOM, and some aspects of POM by analogy, as substrates for respiratory metabolism. This cartoon also shows some of the ways that the sunburning of DOM may modify the two substrate qualities depicted. Chemists may visualize the vertical axis as representing thermodynamics (free energy, redox equivalents) and the horizontal axis as kinetics (bioreaction rate constant). “Food quality” (vertical) and “bioavailability” (horizontal) are biological synonyms for these properties. Dots along the vertical axis symbolize the eight formal oxidation states of carbon, from methane to carbon dioxide (CO₂ is non-respirable, so “out of the box”). In this plane depicting energy-rate space, or nutrition-availability space, ellipses surround potential substrate pools. While their relative vertical positions are

Cartoon 1. Sunburnt DOM: food availability and quality. This plot depicts some possible roles of light in altering the energy content (vertical axis) and bioavailability (horizontal axis) of CDOM molecules commonly found in aquatic environments. Purple: biomacromolecules; dark brown: fresh CDOM; light brown: S-CDOM (partially photooxidized and bleached); hatched: S-CDOM of lowered reactivity (not a well-established pool); white: low molecular weight (LMW) photoproduction molecules of low or no photoreactivity, but of high biogeochemical significance. (Methane and hydrogen are also shown to exemplify the range of the energy scale). Dotted or dashed boundaries surround molecular classes of low or no photoreactivity, but high biological significance. The yellow arrows indicate likely or known phototransformations. The indirect photodegradation of lipids to unknown materials is included (arrow leading to a question mark).
phenomenon of "regression to the mean." Effects may exemplify the familiar but under-appreciated to treat the global DOM pool as a statistical population, these decreases it (Obernosterer et al. 2001; Tranvik and Bertilsson 2001). To the extent that it is valid to deordered S-CDOM pool, but rather are altered biomolecules, bioavailability, while altering a "juicy" one probably often decreases it (Obernosterer et al. 2001; Tranvik and Bertilsson 2001, Williamson et al. 2001). To the extent that it is valid to treat the global DOM pool as a statistical population, these effects may exemplify the familiar but under-appreciated phenomenon of "regression to the mean."

The class of photochemical changes that stimulates heterotrophic activity thus seems most likely to be that which involves the colored, biorefractory, light-sensitive CDOM pool rather than the major biopolymers, since evolution seems to ensure that the ubiquitous biomolecules are nearly photo inert (or easily repaired). What are the broader implications of this idea? First, the CDOM pool is sensitive to a much broader range of wavelengths, penetrating much deeper into the water column, than are the biomolecules. Second, for molecules that are not truly bioinert (relative to their residence times in the ML or environment of choice), a paradox arises: while one major effect of sunburning of the CDOM pool increases the rates of coupled heterotrophic metabolism (as measured in short-term post-irradiation incubations of S-CDOM), sunburning probably decreases the larger systems' total bioavailable energy by partially photooxidizing molecules that otherwise might be totally respired with a higher potential biological energy yield. Certainly the major trend of recent work (see book chapters and recent references) has been to show that alteration of CDOM liberates an array of smaller molecules (Cartoon 1, white ellipses) that are quite light stable (LMW acids, carbon monoxide (CO)). These are all readily bioavailable to heterotrophs. All of the known fragments to date are also more oxidized (less nutritious) than the starting materials. At the heart of this paradox lies the plausible but yet-unproven paradigm that, like heterotrophic bioprocesses, many environmental photoreactions are net oxidative (Zafiriou 1977; Andrews et al. 2000). Thus, in this view the two processes compete in a zero-sum game for redox equivalents. However, they cooperate kinetically in the stepwise oxidation of many molecules; coupled chemical–biological oxidations are often faster than is either process alone.

What are some bounds on stepwise, coupled processing? Biologically, DOM processed entirely within a cell likely avoids photochemistry; "leaky" intermediates that are processed by consortia may encounter it. Abiotically, a key recent finding is that CO$_2$ is a very major photoproduct. In freshwaters, Miller and Zepp (1995) recently rediscovered, and accurately quantified for the first time, the carbon dioxide (CO$_2$) yield from CDOM photolysis (a process demonstrated by Miles and Brezonik in 1981). CO$_2$ forms with the highest quantum yield of any known carbon-bearing photoproduct at ~10-15 times the efficiency of the next most abundant one, carbon monoxide. Miller's group has now extended these studies to the sea (Johannessen 2000; Johannessen et al. 2000), where initial data imply an annual production globally of 12 Gt CO$_2$ C yr$^{-1}$!

The most abundant known product of DOM photooxidation is thus a molecule of no bioenergetic value. However, to understand the overall effect of CO$_2$-forming photoprocesses, we also need to know the bioavailability and nutritional quality of any co-produced S-CDOM pools (Cartoon 1). A final large-scale issue for sunburnt DOM is the question, "To what extent are the biological properties of the refractory but colorless DOM pool - many times larger than the CDOM pool - also subject to sunburn through sensitized processes or attack by reactive species?" Issues such as these
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two ensure that the prediction that sunburnt DOM studies will remain a vigorous research theme for some to come is a safe, even obvious one. The case for POM seems ultimately more promising, but less certain.

**SUNBURNABLE PARTICULATE ORGANIC MATTER (S-POM)**

The POM pool’s photoreactivity and S-POM’s biological properties are much less well elucidated than is DOM; the literature is relatively sparse, especially for organic detritus as opposed to clays, soot, and artificial substrates. Also, applying the kind of energy-availability plot of Cartoon 1 to POM as a prediction of turnover rates and paths seems simplistic: molecular structure is likely to be a much weaker determinant of POM processing rates and paths than it is for DOM.

CDOM photochemistry seems quantitatively more active than that of POM in the few cases studied, such as CO and HOOH, since filtered waters form these products at similar rates to unfiltered samples. Biogeochemically, however, this result merely means that the reactive flux of escaping particles does not equal that generated in the far larger DOM pool. It is very plausible that on a per-molecule basis many non-viable particles, including aggregates with non-viable major constituents, will be more photoreactive than CDOM. Because of the intense localization of reactive intermediates formed on the surfaces and in the interiors of particles, it is conceivable, even likely, that intermediates formed there modify particles significantly, and that these changes lead to different, weightier biogeochemical consequences than in the dissolved phase.

Some factors favoring a rich POM photochemistry are: (1) particles adsorb organic molecules at their surfaces (Their surface photochemistry likely resembles, in part, the CDOM photochemistry above. In particular, estuarine flocculation coats particles heavily with riverine humic/fulvic acid flocs); (2) particles harbor such potentially photoreactive metals as Fe, Cu, and Mn at high local concentrations, and/or in more reactive forms, such as MnO$_2$ (Sunda and Huntsman 1994); and (3) particle dynamics critically determine much of the complexity and structure in aquatic ecosystems. Finally, the extreme proximity of these ingredients and the very high local rates they imply likely enhance synergistic couplings amongst them, increasing their impacts. Overall, particles thus likely harbor diverse microenvironments of unusually intense reactivity adjacent to targets of enhanced biogeochemical relevance.

Another powerful prime cause of POM photochemistry lies in a major exception to the general transparency of major classes of biomolecules. Primary producers are, obviously, committed at all levels (biochemical, physiological, ecological) to harboring an array of highly evolved, organized, and colored machinery such as chlorophylls and accessory pigments (Cartoon 2, top). Viable living cells efficiently channel reactive intermediates within this factory, avoiding or repairing photodestruction. When cells become moribund or die (by grazing, viral lysis, starvation, excessive photodamage, thermal or salinity shocks, old age) their redox factories seem unlikely to be dismantled neatly by enzymatic and dark chemical reactions alone. Rather, cells processed in the euphotic zone in daylight are likely subjected to a flood of misdirected, reactive redox equivalents as their machinery continues producing intermediates that their production line no longer translocates appropriately. Damage - S-POM - results as transients react more randomly than in viable cells. With this background, the forecast is that euphotic zone photochemistry is likely to prove ultimately responsible for many changes that critically affect aquatic particle biogeochemistry and the biota, especially for autochthonous and hybrid organic particles, including aggregates. Cartoon 2 sketches out some of the innumerable possibilities.

The photopigment degradation concept in the prior paragraph has a long history. Perhaps SooHoo and Kiefer (1982, and references therein) first posed it forcefully, with enough evidence to bring it into the
mainstream. Very recently, impressive progress has been made on a broad front in quantifying the photooxidation in situ of the side-chain of chlorophyll. Cuny et al (2002) recently proposed a “Chlorophyll Phytyl side-chain Photodegradation Index” (CPPI) - the ratio of modified to unmodified moieties. Applying it over an annual cycle in the upper 160 m at a moderately oligotrophic site off Nice, France (65m euphotic zone depth), they found that the water-column’s CPPI ranged from 0.8% to 46.1% (n=34), median ~ 4% (Cuny et al. 2002, and references therein). They conclude that “...the bulk of the detrital chlorophylls...undergo(es) photodegradation before sinking out of the euphotic zone.” This statement applies to the entire pigment molecule, not just the side-chain, but quantification hangs on the CPPI calibration and other assumptions. The authors are undoubtedly correct that this landmark study is a beginning, not an ending. The prospects are exciting.

However, for POM as a whole compared to DOM, progress has been miniscule. The critical experimental methods are very difficult (especially solid, quantitative ones). It is hard to sample representatively, hard to select credible model systems, hard to ensure sample integrity during processing, very hard to account for or eliminate the effects of co-occurring photosynthesis or microbial metabolism, and hard to irradiate particles knowing how much light was absorbed by which molecules. Aggregates pose all of these problems in an especially severe form. However, advances in ultrafiltration, field-flow fractionation, flow-cytometry sorting, as well as in organic and whole-element inorganic microanalyses and other useful techniques, are continually being made, so the power of available methods to tackle this problem is growing. Where is it adequate for pioneering experiments?

There are also non-methodological barriers in this area of research. The significance of rates often cannot be put in context on requisite scales because competing particle-processing rates are also poorly known. Moreover, to date few burning “fundable” issues point clearly to non-living particle photochemistry as a key process. The multi-disciplinary nature of the coupled phenomena may also impede progress; what are the fates of cells senescent enough to bore most biologists, yet not officially pronounced dead? Are they all too often omitted from “process studies” because chemists hesitate to include them in samples?

A final fortune-cookie forecast: a future focus on photons as a factor for feeding flora and fauna furnishes fertile, fascinating fun, a funding flood, and fresh frustrations for a few fervent photochemists and fellow photobiologists fixating furiously on the forefront of this fertile field.

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ON THE USE OF $^{14}$C MEASUREMENTS OF PRIMARY PRODUCTION

Banse’s letter in the ASLO Bulletin is correct as far as it goes. However, it does not include the value of $^{14}$C measurements for measuring P, the ‘assimilation number’ or ‘index.’ This is a measure of the rate of photosynthesis, not the amount. The units for this value are derived from dividing the $^{14}$C measurement by the standing stock of chlorophyll and Pmax values in units of mg C (mg Chl a hr$^{-1}$) generally range from < 1.0 to ca. 10 (Parsons et al. 1990).

Providing the chlorophyll a is measured on the same sample as the $^{14}$C uptake, the value is independent of grazing. This is a valid measure of the physiological state of the phytoplankton and will reflect light and nutrient conditions. For modeling purposes, it can be used in conjunction with assumed values of chlorophyll a to create scenarios of geographical differences in primary production.

REFERENCES


Sincerely,

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WHY WE WILL CONTINUE TO MEASURE PHYTOPLANKTON PHOTOSYNTHESIS DURING THE NEXT 50 YEARS

The Oceanographer’s Lament: ‘O Neptune, the sea is so large, and my grant is so small!’

Karl Banse challenged the oceanographic community to justify continued estimation of regional rates of phytoplankton productivity, specifically via rates of $^{14}$C-uptake by phytoplankton in a profile of the euphotic zone. His argument is that measuring the rate of photosynthesis during 24-hour incubations yields data with low predictive value, mainly because loss terms (grazing, sinking) are not constrained at the same time. (To these loss terms we could add total system respiration, but that’s a topic for future discussion.) We only partially agree with Banse’s assessment. He is correct that studies of phytoplankton mortality processes (and respiratory losses) have greatly lagged studies of the rate of phytoplankton production in the world ocean. But, there are other issues beyond day-to-day predictability of phytoplankton production. We are confident that over the coming decades oceanographers will continue to measure rates of photosynthesis in order to estimate marine productivity. Here’s why:

1) In 50 years, it won’t be the same ocean. There is high probability of major shifts in ocean systems due to global climate change in this century. Ocean currents, particularly in the North Atlantic, are poised to shift dramatically over a short time scale if the Arctic ice cap and Greenland glaciers continue to melt. Warmer temperatures in the sea surface, more frequent El Niño events, and expansion of hypoxic zones in coastal regions are also predicted. Time series measurements will provide a continuity of data from the pre-warming state of the ocean into the period when global change effects become increasingly apparent. We will want to compare the patterns of phytoplankton photosynthesis in the world ocean in the 1980’s with the patterns of photosynthesis in the 2030’s. Using the same methodology ($^{14}$C uptake) would facilitate direct comparison.

2) The ocean remains woefully under-sampled (yes, even for photosynthesis! See Lament, above). Biological oceanographers are just beginning to grapple with the spatial and temporal variability in phytoplankton biomass and rates of production in the world ocean. The results of the BATS and HOTS time series projects show clearly that there is intra-annual, inter-annual, even inter-decadal variability in phytoplankton stocks, in the composition of the phytoplankton community, in rates of production, in organic matter stocks, and in sinking fluxes (e.g. DuRand et al. 2001, Karl et al. 2001). And, these data sets are from the boringly uniform, warm oligotrophic regions of the world ocean! What about the other half of oceanic productivity, upwelling systems and shelf regions? There are currently no decadal data sets, analogous to BATS and HOTS, for these very important components of ocean production. The GLOBEC Long-Term-Observation Program (if six years can be considered long term!) in the California Current system has recently documented a dramatic year-to-year increase in the concentration of inorganic nutrients in upwelled water, which fueled very dense phytoplankton blooms (Wheeler 2002). Sinking of these blooms in turn resulted in the first-ever documented subsurface hypoxia event and massive die-off of benthic fauna, including rockfish, for the Pacific Northwest coast (Grantham et al. 2001, Karl et al. 2002). It is clear that time-series studies of mesotrophic and eutrophic ocean systems are needed to properly evaluate their intrinsic variability, and their response to global change processes. Such monitoring should include measurements of phytoplankton productivity.

3) We are still discovering major pieces of the oceanic productivity puzzle. Major groups of light-harvesting organisms (e.g., prochlorophytes, pico-phytoflagellates, and photoheterotrophic bacteria) are fairly new to us. We are also still in the early stages of elucidating the importance of atmospheric nitrogen inputs and nitrogen fixation as sources of new nitrogen to open ocean phytoplankton. Research is needed to evaluate the quantitative importance of these findings (and undoubtedly others as yet unknown) in the context of oceanic productivity.
Phytoplankton production is a basic process in marine ecosystems. We have far to go to understand the underlying physical, chemical, and biological factors that determine the rates and fates of primary production in various regions of the world ocean. New methodology (e.g., fast repetition rate (FFR) fluorescence instruments) may allow greater temporal and spatial resolution of phytoplankton photosynthetic activity, but bottle incubations with isotopically-labeled (13C or 14C, 15N) substrates will continue to be a standard protocol for rate quantification.

We answer Banse’s challenge by stating: more research is needed, both on marine photosynthesis and on phytoplankton loss processes. The next 50 years should be as interesting and important in this effort as were the previous 50.

REFERENCES

Sincerely,
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REPLY BY KARL BANSE...
The comments by my colleagues are correct as far as they go. However, perhaps misled by the intentionally provocative headline, T.R. Parsons and E.B. and B.F. Sherr seem to have overlooked my premise stated in the very first sentence: “A principal goal of ecology and, hence, biological oceanography and limnology, is to understand and be able to predict the abundance of organisms and the rate of temporal change.” Photosynthetic rate measurements were not the actual subject (see also the end of my first paragraph).

I’d also like everyone to note that there was a typo in the 6th line of the right-hand column of the first page; it was to be (Banse 1992), not 1994. Also, Hydrobiologia 480: 15-28 is the complete reference to (Banse 2002).

Regards,
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Sincerely,
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MESSAGE FROM THE PRESIDENT

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I am quickly learning how busy Bill Lewis really was. ASLO has changed immensely since I sat on the board ex-officio as editor-in-chief of L&O from 1986-1992. Our flagship journal has nearly doubled in the volume of manuscripts arriving since then; moreover, they are leaving on schedule. This Bulletin has resurfaced as a vehicle for more diverse contributions. We have just launched a new electronic-only journal, and the manuscripts are already streaming in to L&O: Methods. The electronic medium lends itself very well to methods “papers” in particular because improvements can be linked as methods evolve. The flagship has an armada and convoy that promise to be joined in the near future by one or more new journals in the intensifying battle between for-profit and societal journals for authors and library resources. Our early and robust web presence has been key in keeping ASLO and its journals at the fore of information dissemination in aquatic sciences.

ASLO is also getting busier in science policy and rewardingly so. The Public Policy Committee ably took on the charge of responding to a request of ASLO by the U.S. Ocean Commission to contribute issues for their consideration. I had the privilege to deliver their summary in Boston in July and have reason to believe that the words and issues that they chose were effective. Since then, ASLO has contributed in very timely fashion, with Greg Cutter’s able help, to advising the U.S. National Science Foundation (NSF) on evolution of their fledging Biogeochemistry Program.

I have been concerned for some time about the health of limnology as a basic-research discipline, in the U.S. in particular, but elsewhere as well (Jumars 1990). These concerns have been shared, emphasized and re-emphasized by scientists much more qualified than I am (e.g., Naiman et al. 1995). The applied issues are certainly challenging, with water threatening to replace oil in this century as the controversial liquid in limiting supply, and U.S. privatization of water supplies is projected to reach 65% by 2015. It is inconceivable that the applied challenges will be met successfully without an aggressive portfolio of basic research.

The ASLO board under Bill Lewis’ direction judged the situation to be critical, and charged the Education and Human Resources Committee to act. Simultaneously, ASLO’s representatives to the Council of Scientific Society Presidents (CSSP) were taking up the same cause, in conjunction with agronomists from several societies and with our colleagues at the American Institute of Biological Sciences, the Estuarine Research Federation, and the Ecological Society of America. On the road to an initiative from the entire CSSP, representing over 1.4 million scientists and science educators, we caught the attention of NSF which was in the process of developing its decadal plans for research in the environment. By the time you read this message, ASLO will have organized and held an NSF-sponsored symposium to articulate the basic research issues in limnology for the next decade – that may well be a significant stimulus for formation of a limnology program at NSF. Please join us in Salt Lake City this February to hear a summary and update. Whatever the eventual outcome, I am gratified that ASLO understands the benefits of combining top-down and bottom-up controls and is finding mechanisms to exert them. I am even more excited by the Education and Human Resources Committee’s next focus on K-16 education and our prospects for engaging minds at all educational levels in the fascinating problems that fall within and extend from the watery components of the environment.

Not everything that we have tried has succeeded. Catalyzed by problems experienced by the Ocean Sciences Program Committee, ASLO attempted to negotiate a new agreement with the American Geophysical Union (AGU) for the Ocean Sciences Meetings. We failed to achieve one in time for the 2004 winter meetings. We retain high hopes for reaching an agreement in time for a reunion in winter ’06 because we value the integrative role that these meetings play across disciplines that are unequally represented in AGU versus ASLO. To retain an integrative, interdisciplinary benefit for our members in ’04, and to try out some new variety in meeting styles, we have reached an agreement with The Oceanographic Society (TOS) to meet jointly with them in Hawaii for an Ocean Research Conference, and we hope that the ’06 meeting can include the members and goals of each of the three societies while being even more integrative than Ocean Sciences Meetings of the past.

Overall with meetings, ASLO is experiencing growing pleasures and pains. As our meetings continue to grow, so do the diversity and depth of subjects available to attendees, but fewer and fewer facilities can accommodate us. We filled the Victoria, B.C., conference center in June to overflowing, and the meeting was a pleasure for those who could attend. We recognize, however, that meeting attendance at convention centers is in general less affordable than the old ASLO standard of meeting on college campuses. Not only have we grown in meeting size, but also college campuses have grown in commitments to year-round activities. The Meetings Committee has identified affordability and accessibility as high priorities for some upcoming meetings choices. As Carlos Duarte writes in an upcoming piece for the Bulletin, however, we have also become a truly global society, so no one site can satisfy us all at every meeting, and we are looking forward to our second European meeting in ’05. Keeping a diversity of
sites and aquatic topics in the mix is essential to ASLO’s mission of integration in the aquatic sciences.

REFERENCES


Peter A. Jumars, Darling Marine Center

MESSAGE FROM THE BUSINESS OFFICE

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It’s now time to make sure that you have renewed your membership in ASLO! Your current membership will end on December 31, 2002, so be sure to get your membership renewal in before then. Remember, you can renew on-line through the ASLO website (www.aslo.org), or you can use the printed form that you have received in the mail. If your renewal form has not reached you, contact me at business@aslo.org and we will mail or fax a form to you so you can renew. 2003 will be an exciting year for ASLO members, and we don’t want you to miss out on any of your membership benefits including six months free access to L&O: Methods, the society’s new all-electronic journal debuting in January 2003.

The business office is also getting ready for the Aquatic Sciences Meeting in Salt Lake City, Utah, February 9-14, 2003. We will be putting up the new ASLO display booth so be sure to come by and introduce yourself if you are attending the conference. We will be in the exhibit area as well as at the conference registration desk throughout the meeting.

In addition, mark your calendars for these upcoming ASLO meetings:

Ocean Research Meeting (with The Oceanography Society) February 15–20, 2004, Honolulu, Hawaii

ASLO Summer Meeting June 13–18, 2004, Savannah, Georgia

Please let us know if there is anything that we can do to serve you better!

Helen Schneider Lemay, ASLO Business Office

THE ROLE OF SCIENTIFIC SOCIETIES IN BRIDGING THE GAP BETWEEN SCIENCE AND POLICY

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Scientific societies represent the nation’s best-trained researchers, many of whom conduct research on areas of significant public interest such as the role of non-point source pollution in water quality of coastal areas or impacts of global climate change on commercial fisheries. While some of these researchers may wish to make their knowledge available to policy-makers, it is often not practical for them to do so due to the limited time available for policy activities, the lack of a “reward” system in academia for such work, and the lack of political “know-how” to effectively communicate with policy-makers.

Since it is often difficult for individual researchers to engage in policy debates, many scientific societies, including ASLO, have recently taken on the responsibility of engaging scientists in the policy arena. Inevitably, however, the governing boards of those societies wonder which activities are “proper” for the society to engage in as an entity, and which issues are best left to the membership for individual action. A common question asked by governing boards is: if the society were to address an issue on behalf of its members, how can the society be sure that its view is representative of that of the membership? If the society doesn’t take positions on issues as a whole, what can the society do to facilitate the participation of individual members in the policy world?

Participation in public policy debates must be a partnership between the scientific society and its membership. Both have a role to play, be it a lead or supporting role. To better understand how the two players can work together, it is useful to divide policy issues into two categories. Public policy issues that are of interest to researchers typically fall into one of two categories – “science policy” and “science in policy.” Conveniently enough, these two categories can also serve as a guideline for division of labor between the society and the membership.

SCIENCE POLICY VS. SCIENCE IN POLICY

Science policy is the area of public policy that pertains to activities that affect how scientists do their work, such as regulation of research activities, funding for research activities, or education policies that affect the future workforce for scientific research. Some recent examples of science policy issues include the NSF Doubling Act, the proposed transfer of Sea Grant to NSF, attempts to limit the teaching of biological evolution, and federal data quality guidelines for researchers.

Science in policy refers to the application of scientific knowledge to natural resource management issues and policies. The majority of environmental policy issues fall into this category: determining appropriate levels of discharge from dams, designating critical habitat for endangered species,
whether or not drilling in the Arctic plain will result in a loss of biological diversity, and setting standards for wetland mitigation banking.

Many policy experts suggest that scientific societies should take primary responsibility for science policy issues, such as the NSF budget level, with individual members playing a supporting role. One of the roles of consortia such as the American Institute of Biological Sciences (AIBS), American Association for the Advancement of Science (AAAS), and Council of Scientific Society Presidents (CSSP) is to make voices on these issues even more coherent. A society's policy professionals based in Washington, D.C., are able to continually track developments and can mount a rapid response. It is unrealistic for most individual researchers to develop the legislative know-how to follow the federal budget process or the understanding of the intricacies of congressional procedure, which are required to be an effective player in this activity. Just as an academic researcher may study a particular habitat or organism, policy professionals study and monitor Congress, the White House, and federal agencies. Additionally, the policy professional is well placed in Washington to interact with representatives from other scientific organizations to coordinate strategies for working on these topics. These types of issues often have to be dealt with immediately, so having policy professionals with the authority to address them is in the best interest of the society. Usually, the “position” to take on science policy issues is not terribly controversial. (I have yet to meet a scientist who does not think we need more funding for research.)

Still, individual scientists also have an important role to play in science policy issues. Acknowledging the time limitations of scientists, scientific societies hope to maximize participation in science policy issues by making it as painless as possible. Policy representatives for scientific societies track developments on research funding and regulations and often share these developments with the membership through regular policy updates and occasional “Action Alerts.” It is up to the scientific community to read and respond to this information, often through phone calls or letters to their representatives. A golden rule in Washington, D.C., is “the more voices, the better.” When visiting congressional offices, we still hear that individual scientists aren’t weighing in on important issues such as funding levels for oceanography. Even the most eloquent plea from a Washington-based policy professional won’t get noticed if the sentiment is not echoed by scientists in the field.

For science in policy issues, the situation is reversed: the lead on these issues should be individual members, with the societies playing supporting roles. Individual members of the society are the experts on these issues and as such, it is most appropriate for them to respond to and participate in science policy activities. Also, these issues can often be controversial and societies with several thousand members face difficulty reaching consensus on position statements.

The society’s role, through a Washington, D.C.-based public policy office, is to educate the membership about how best to communicate science to policy-makers – i.e., the policy office would not tell individual researchers what to say (after all, you are the experts), but to whom, when, and how to say it. At ASLO, we have made progress in helping the membership engage in the policy arena through activities such as hands-on workshops at ASLO meetings, monthly updates on aquatic policy issues, and maintenance of a web site which contains background and “how to” information on participating in public policy (www.aslo.org/policy). If there are other things that we could be doing here in D.C. to help you, please drop me a line (afroelich@aslo.org) and let me know. Feedback from the membership is extremely valuable to us as we reconfigure the Washington, D.C., office.

MEETING HIGHLIGHTS

2003 ASLO AQUATIC SCIENCES MEETING: THE EARTH’S EYES: AQUATIC SCIENCES THROUGH SPACE AND TIME

Co-Chairs of ASLO 2003: Mandy Joye, Dept. of Marine Sciences, University of Georgia, Athens, GA 30602-3636 USA, mjoye@arches.uga.edu; and Jim Cotner, Dept. of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, MN 55108 USA, cotne002@umn.edu

The ASLO Aquatic Sciences Meeting will be held February 9-14, 2003, in Salt Lake City, Utah. We are very excited about the meeting theme, which emphasizes some aspects of limnology and oceanography that are not typically highlighted at ASLO meetings. The four meeting sub-themes, Historical Issues, Paleo-oceanographic and Paleo-limnological Studies, Spatial Patterns and Trends, and Extreme Environments, will be the focus of special sessions. Around 1000 papers have been contributed for this meeting, and we expect it to be one of the most exciting ASLO meetings ever!

The meeting will feature several new and stimulating events. The meeting will begin Sunday with a special opening address presented by Dr. David Des Marais (NASA-AMES) entitled, “Astrobiology Extends Biology into Deep Time and Space.” A welcome reception will follow Dr. Des Marais’ presentation on Sunday evening. Each day, Monday through Thursday, will begin with a plenary lecture by Dr. Sherilyn Fritz (University of Nebraska), Dr. Donald Canfield (University of Southern Denmark), Dr. James Elser (Arizona State University), and Dr. Colleen Cavanaugh (Harvard University). On Tuesday morning, a special “town meeting” will include a panel of attendees from NSF’s Limnology Workshop. This workshop will present results of the NSF presentation on Sunday evening. Each day, Monday through Thursday, will begin with a plenary lecture by Dr. Sherilyn Fritz (University of Nebraska), Dr. Donald Canfield (University of Southern Denmark), Dr. James Elser (Arizona State University), and Dr. Colleen Cavanaugh (Harvard University). On Tuesday morning, a special “town meeting” will include a panel of attendees from NSF’s Limnology Workshop. This workshop will present results of the NSF workshop and solicit input from the audience in a question and answer fashion. Finally, the meeting will include a very special three-day session focusing on “The History and Current Status of Eutrophication in Freshwater and Marine Ecosystems.” On top of all this, you have the beauty and wonderful climate of Salt Lake City—which features a few extreme environments of its own. DON’T MISS IT!! See the ASLO website for more details: http://www.aslo.org/slc2003/
Fish Nutrition
THIRD EDITION
Edited by
John E. Halver
Ronald W. Hardy
This third edition of Fish Nutrition is a comprehensive treatise on nutrient requirements and metabolism in major species of fish used in aquaculture or scientific experiments. The authors have focused on selected demonstrations of nutrient requirements and metabolism which summarize the basis and applied principles of fish nutrition.

KEY FEATURES
✦ Nutrient requirements for dietary formulations for fish farming
✦ Digestive physiology
✦ Comparative nutritional requirements of different species

April 2002, Casebound 824 pp, $199.95/£139.95/ISBN: 0-12-319652-3

Aquatic Ecosystems: Interactivity of Dissolved Organic Matter
A New Volume in the Aquatic Ecology Series
Edited by
Stuart E.G. Findlay
Robert L. Sinsabaugh
Aquatic Ecosystems explains the interplay between various movements of matter and energy through ecosystems mediated by Dissolved Organic Matter (DOM). This book provides information on how much DOM there is in a particular aquatic ecosystem and where it originates. The book further details how DOM becomes incorporated into microbial food webs, and gives a better, clarifying, understanding to its significance of DOM.

September 2002, Casebound 528 pp, $99.95/£65.00/ISBN: 0-12-256371-9

Freshwater Ecology
Concepts and Environmental Applications
Walter K. Dodds
Freshwater Ecology is a general text covering both basic and applied aspects of freshwater ecology and serves as an introduction to the study of lakes and streams. The book provides an extensive background on freshwater ecosystems that will be useful both to those pursuing advanced coursework and to those whose work involves freshwater ecosystems. It explicitly recognizes that understanding aquatic systems requires a holistic approach that includes watersheds, groundwaters, streams, wetlands, and lakes.

KEY FEATURES
✦ Contains broad coverage on a variety of aquatic systems, including ground waters, streams, wetlands, and lakes
✦ Provides background for basic scientific concepts and environmental applications
✦ Featuring small chapters that mainly stand alone, this book can be read in the order most suited to the specific application.

March 2002, Casebound 592 pp, $79.95/£55.00/ISBN: 0-12-219135-8

Freshwater Algae of North America
Ecology and Classification
Edited by
John D. Wehr
Robert G. Sheath
Freshwater algae are among the most diverse and ubiquitous organisms on earth. They occupy an enormous range of ecological conditions from lakes and rivers to acidic peat swamps, inland saline lakes, snow and ice, damp soils, wetlands, desert soils, wastewater treatment plants, and are symbionts in and on many plants, fungi, and animals. This book provides in one volume a practical and comprehensive guide to the genera of freshwater algae known from North America.

KEY FEATURES
✦ The first complete account of North America’s freshwater algal genera in more than 50 years
✦ High-quality photographs and drawings of more than 770 genera
✦ Contributions from 27 experts in all areas of freshwater algae

October 2002, Casebound 880 pp, $129.95/£65.00/ISBN: 0-12-741550-5

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Limnology
Lake and River Ecosystems
Third Edition
Robert G. Wetzel
Limnology is the study of the structural and functional interrelationships of organisms of inland waters as they are affected by their dynamic physical, chemical, and biotic environments. Limnology: Lake and River Ecosystems, 3rd Edition, is a new edition of this established classic text. The coverage remains rigorous and uncompromising and has been thoroughly reviewed and updated with evolving recent research results and theoretical understanding. In addition, the author has expanded coverage of lakes to reservoir and river ecosystems in comparative functional analyses.
$74.95/£36.95/ISBN:0-12-744760-1

Ecology and Classification of North American Freshwater Invertebrates
Second Edition
Edited by
James H. Thorp
Alan P. Covich
The First Edition of Ecology and Classification of North American Freshwater Invertebrates has been immensely popular with students and researchers interested in freshwater biology and ecology, limnology, environmental science, invertebrate zoology, and related fields. The First Edition has been widely used as a textbook and this Second Edition should continue to serve students in advanced classes. This title features expanded and updated chapters, especially with respect to the cited references and the classification of North American freshwater invertebrates. Chapters include those on freshwater ecosystems, snails, aquatic spiders, aquatic insects, and crustaceans.
$79.95/£53.95/ISBN:0-12-690647-5

Streams
Their Ecology and Life
Colbert E. Cushing
J. David Allan
Streams is a handbook that combines a discussion of the ecology of streams and rivers, in layperson language, with an illustrated field guide of the plants and animals found in running waters of North America. Various illustrations and maps accompany the text. The authors are extremely well known and in four parts, they explain stream ecology to the general reader.
$49.95/£33.95/ISBN:0-12-050340-9

Groundwater Science
Charles R. Fitts
$79.95/£39.95/0-12-257855-4
OUTSTANDING L&O REVIEWERS

Peer review is a crucial component of modern science. The fact that L&O is able to utilize the services of the best scientists as reviewers allows it to be a leading journal in the aquatic sciences. However, these individuals seldom get the recognition they deserve for this selfless work. Therefore, each issue of the Bulletin will cite two outstanding reviewers that Everett Fee, L&O Editor, feels deserve special recognition for their overall reviewing efforts. The ASLO membership extends its sincerest appreciation and thanks to these two outstanding scientists.

WEI-JUN CAI

Wei-Jun Cai is an associate professor in the Department of Marine Sciences at the University of Georgia. His research includes the development of pH and pCO2 micro-sensors, proton and electron transfer reactions in marine and freshwater sediments, the surface binding properties of humic substances, mechanisms of carbonate dissolution, carbon cycling in continental shelf waters, and air-exchange of CO2. His recent fieldwork is primarily in the U.S. South Atlantic Bight and the South China Sea, where he studies the role of salt marshes and the continental shelf in oceanic carbon cycles, and in the Gulf of Mexico where he studies carbonate and redox chemistry in sediments around gas hydrate seeps.

CHARLES RAMCHARAN

Charles Ramcharan is a research professor in the Department of Oceanography and Coastal Studies at Louisiana State University in Baton Rouge. His primary research focus is the role of predators in structuring the food webs of freshwater lakes. He hopes to soon return to Canada (Laurentian University) where the list of top aquatic predators does not include alligators!

GETTING TO KNOW YOUR L&O ASSOCIATE EDITORS

Everett Fee, Limnology & Oceanography Editorial Office, 343 Lady MacDonald Crescent, Canmore, AB T1W 1H5, Canada; lo-editor@aslo.org

The next time that you pick up an issue of L&O, I hope that you will take a moment to peruse the list of Associate Editors (AE) on the inside of the front cover. These are the people who decide what is published in L&O. ASLO acknowledges the important work that these people do for the society; two AEs are featured in each issue of the Bulletin.

The role of the AE is that of an impartial judge — to fairly assess the reviewers’ comments and guide the author’s next steps. About every two weeks an AE is assigned a new manuscript. His or her first task is to select reviewers. This delicate job requires profound knowledge of both science and politics (the often conflicting relationships among people in a society). When the reviews are received, the AE digests that input along with his or her own assessment of the manuscript to arrive at a decision. It is unfortunately quite common for reviewers to recommend very different fates for a paper, which puts the AE in the uncomfortable position of having to make at least one of the reviewers and perhaps the author unhappy. If a paper is accepted, the AE’s final job is to edit the manuscript, suggesting wording and organizational changes to improve clarity.

L&O AE’s work at the highest level of our profession. Being an AE is a very demanding job, and we are extremely fortunate that these people devote so much time to the ongoing challenge of making L&O the leading journal in the aquatic sciences.

MARKUS HUETTEL

Markus Huettel is head of the Research Group for Flux Studies at the Max-Planck-Institute for Marine Microbiology in Bremen, Germany, and his research and expertise are in the fields of sedimentology, geochemistry and benthic biology. The work in his research group focuses on the mechanisms that link water column and sedimentary processes and includes benthic lander deployments, field measurements in coastal zones, laboratory flume studies and modeling of the transport processes. Within the last 10 years his work has addressed various aspects of transport processes in marine sediments with emphasis on advective transport in permeable shelf sands and its impact on geochemical and microbial processes in the seabed. He also teaches at the University of Bremen and among other work related responsibilities is co-chair of the SCOR Group “Transport and reaction in permeable marine sediments” and member of the board of directors of the International Association of Sediment and Water Science. As an AE, he handles manuscripts addressing geochemical and biological processes in the benthic environment. In the past this included papers that addressed boundary layer and microscale transport processes, nutrient and carbon cycling, benthic photosynthesis and bioturbation.

ED McCauley

Ed McCauley is a Canada research chair in population ecology and professor of biological sciences at the University of Calgary, Calgary, Alberta, Canada. Dr. McCauley’s research interests include dynamics of freshwater plankton communities, species outbreaks, and algal-zooplankton interactions. In his work, he uses aquatic systems to develop and test general theory for the dynamics of
ecological systems. Dr. McCauley’s most recent work examines mechanisms producing alternative dynamics in predator-prey systems including both freshwater and terrestrial systems. As an AE, Dr. McCauley handles manuscripts on zooplankton, phytoplankton, population processes, and food-web dynamics.

INTRODUCING THE ASSOCIATE EDITORS OF LIMNOLOGY AND OCEANOGRAPHY: METHODS

Paul F. Kemp, Editor-in-Chief, Marine Science Research Center, State University of New York, Stony Brook, NY 11794-5000 USA; lomethods-editor@aslo.org

The associate editors of Limnology and Oceanography: Methods listed below represent disciplinary specialties ranging from microbial ecology to open-ocean physics, from benthic ecology to ecosystem modeling, and from marine geochemistry to paleoceanography. They were chosen after a months-long process of winnowing dozens of suggestions down to a handful of individuals. They have the experience, breadth of knowledge, enthusiasm, and commitment to high standards needed to deal with the expected diversity of manuscripts submitted to L&O: Methods. We encourage you to talk with any of the associate editors about your ideas for manuscripts.

CRAIG CARY, ASSOCIATE PROFESSOR
Director, Center for Marine Genomics
College of Marine Studies, University of Delaware
Molecular techniques applied to: microbial community structure analysis, especially interactions among bacterial communities in extreme environments; comparative physiology, biochemistry and ecology of marine invertebrate/bacterial symbioses; biological indices of condition and levels of adaptation of marine bacteria in extreme environments; diagnostic tools to detect and enumerate harmful algal species.

GREG CUTTER, PROFESSOR
Department of Ocean, Earth, and Atmospheric Sciences
Old Dominion University
Trace element speciation and distributions in natural waters and sediments; air-sea transport and exchange of gases and trace elements; paleoceanographic tracers; analytical methods for aquatic chemistry; computer modeling of geochemical processes.

TOMMY D. DICKEY, PROFESSOR
Ocean Physics Laboratory
University of California at Santa Barbara
Air-sea interaction; turbulence and internal waves; mesoscale features; equatorial waves and ENSO; bottom boundary layers and sediment resuspension; bio-optics; upper ocean ecology, primary productivity, biogeochemistry, and physical-chemical-biological interactions; time series and spatial measurements from moorings and autonomous underwater vehicles; design and development of near real-time regional and global observational systems.

GERHARD J.HERNDL, PROFESSOR
Head of Department of Biological Oceanography
Netherlands Institute for Sea Research
Microbial ecology; dissolved organic matter in marine and freshwater systems; phylogenetic diversity and link between phylogeny and function of prokaryotes; role of ultraviolet radiation on the transformation of dissolved organic matter by prokaryotes.

JULES S. JAFFE, RESEARCH OCEANOGRAPHER
Scripps Institution of Oceanography
University of California, San Diego
Development of in-situ optical and acoustical sensors; image and signal processing science; biomedical engineering; public outreach.

JAMES R. KARR, PROFESSOR
Aquatic Sciences and Zoology
Adjunct Professor of Civil Engineering, Environmental Health, and Public Affairs
University of Washington
Biological monitoring and assessment; water quality and land use; environmental policy; conservation biology; fish and benthic invertebrate ecology in streams; detecting and understanding the biological consequences of human activities; measuring what matters.

MARLON LEWIS, PROFESSOR
Department of Oceanography
Dalhousie University
Phytoplankton ecology; bio-optical oceanography; upper ocean physics.

SALLY MACINTYRE, RESEARCH LIMNOLOGIST AND OCEANOGRAPHER
Marine Science Institute and Institute for Computational Earth System Science
University of California at Santa Barbara
Turbulence in the upper mixed layer, thermocline, and benthic boundary layer; internal wave dynamics, surface energy budgets, and convective circulation; physical, biological and chemical coupling, including rates of nutrient and light supply to phytoplankton and resulting primary productivity; fine scale distributions of plankton and marine/lake snow; dispersion of pollutants; gas exchange.

LARS PETER NIELSEN, ASSOCIATE PROFESSOR
Department of Microbial Ecolog, Institute of Biology
University of Aarhus
Nitrogen cycling and other microbial processes studied with stable isotopes; microsensors and flux measurements.
CLARE E. REIMERS, PROFESSOR
Director, Cooperative Institute for Marine Resources Studies
Hatfield Marine Science Center
Oregon State University

Sediment biogeochemistry; in situ monitoring of aquatic systems; chemical sensor development and application.

JOHN P. SMOL, PROFESSOR
Paleoecological Environmental Assessment and Research Lab
Queen's University, Kingston, Ontario

Paleolimnological techniques to track long-term environmental change; development and application of biomonitoring approaches; water quality issues such as acidification, eutrophication, and climatic change.

HEIDI M. SOSIK, ASSOCIATE SCIENTIST
Biology Department
Woods Hole Oceanographic Institution

Phytoplankton ecology and photophysiology; bio–optical oceanography and remote sensing of ocean color; regulation of distribution, abundance, and community structure of marine phytoplankton; modeling of marine primary production; optical methods for studying phytoplankton.

GORDON T. TAYLOR, ASSOCIATE PROFESSOR
Marine Sciences Research Center
Stony Brook University

Microbial mediation of biogeochemical processes (particularly carbon cycling); trophic interactions among microorganisms; microbial biofouling; microbiological and chemical exchange processes at interfaces.

DAVID THISTLE, PROFESSOR
Department Chair
Department of Oceanography
Florida State University

Soft-bottom benthic ecology including the deep sea with emphases in the ecology of meiofauna and disturbance ecology.

ROB WHEATCROFT, ASSOCIATE PROFESSOR
Oceanic & Atmospheric Sciences
Oregon State University

Interdependence between sedimentological and benthic biological processes in marine environments; the role of episodic sediment transport events on continental margins; organism effects on sediment transport and bottom boundary layer mechanics.

STEVEN W. WILHELM, ASSISTANT PROFESSOR
Department of Microbiology
University of Tennessee, Knoxville

Interactions of viruses and microorganisms in marine and freshwater environments; development of molecular methods for characterizing microbial and viral community composition as well as nutrient bioavailability; the role of iron and other trace elements as limiting agents in aquatic systems.

RICHARD ZEPP, SENIOR RESEARCH SCIENTIST
Ecosystems Research Division
U.S. EPA, Athens

Interactions of solar UV radiation with biogeochemical cycles; optics for underwater UV measurements; fluorescence and absorption properties of colored dissolved organic matter (CDOM); interactions of UV with CDOM and particles, including humic substances.

MEMBER HIGHLIGHTS

STEPHEN BRANDT SELECTED FOR PRESIDENTIAL RANK AWARD
Contributed by Jonathan Phinney, Office of Oceanic and Atmospheric Research, NOAA, SSMC 3, Room 11525 R/OSS, 1315 East West Highway, Silver Spring, MD 20910 USA; jonathan.phinney@noaa.gov

Dr. Stephen B. Brandt, director of the OAR Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan, was recently selected to receive one of the 2002 Presidential Rank Awards. This is the most prestigious recognition bestowed on career senior executives. Each year just five percent of executives are selected for the “meritorious” category. He was cited for his excellent organizational leadership, engaging staff at all levels in decision-making and problem-solving, fostering recruitment, retention and training of next-generation scientists, and generating strong partnerships with universities, state, and federal agencies. His initiatives created new multidisciplinary programs critical to science-based decision making. He will be recognized personally along with 10 other recipients by President Bush and Department of Commerce Secretary Evans.

FROM THE EDITOR’S IN-BOX

CALL FOR PAPERS: NINTH INTERNATIONAL CONFERENCE ON RIVER RESEARCH AND APPLICATIONS
Contributed by Martin Thoms, Applied Ecology Research Group, University of Canberra, ACT 2601, Australia; thoms@scides.canberra.edu.au

The Ninth International Conference on River Research and Applications will be held on the banks of the River Murray at Albury, New South Wales, Australia, from Sunday, July 6, to Friday, July 11, 2003. It will be an opportunity for environmental scientists, managers and students from throughout the world to share their discoveries and ideas about river ecosystems. The theme for the meeting is: The Nature of Variability in River Environments.
By their nature, rivers extend over large areas and persist for long periods of time, and to understand them we need to relate observations made at many different scales of space and time. The ways that patterns and processes are distributed across scales, from days to centuries and reaches to catchments, may be what most distinguish the big rivers of the world. Yet, we know little of the nature of this variability, its environmental and evolutionary consequences and its significance for resource management. Nevertheless, the theme is not exclusive, as papers on all aspects of river regulation will be considered.

Papers submitted for presentation may be considered for publication in the international journal River Research & Applications, published by John Wiley and Sons. For more general information, see the Internet at http://www.conlog.com.au/#NISORS. Registration details and other logistic information should be directed to Ms. Elizabeth Medley (conference@conlog.com.au). Inquiries about the scientific program should be directed to A/Professor Martin Thoms (thoms@scides.canberra.edu.au). The deadline for abstracts is 31 January 2003.

DIALOG DISSERTATION REGISTRY:
CONGRATULATIONS
RECENT PH.D. RECIPIENTS!

**C. Susan Weiler**, Biology Department, Whitman College, Walla Walla, WA 99362 USA; 509-527-5948; weiler@whitman.edu

On behalf of the DIALOG Program and the ASLO membership, congratulations and best wishes to the following new Ph.D. recipients! The graduates listed below registered their dissertation abstracts with the DIALOG Program between July 1, 2002, and September 30, 2002.

The DIALOG Dissertation Registry provides a unique overview of emerging aquatic science research and researchers from around the world. All aquatic science Ph.D.s are encouraged to register as soon as they complete their Ph.D. dissertation requirements. The dissertation registration form is posted at http://aslo.org/phd.html. Dissertation abstracts are available at http://aslo.org/dialog/dcite.html in a fully searchable format.

Please send job and other announcements to phd@whitman.edu for distribution to this network of recent grads. Once registered with the program, participants receive a weekly electronic newsletter with job and other announcements of interest to recent grads. Participants also receive symposium updates and other program information.

**DIALOG V Symposium:** I am pleased to report that funding has been received from NASA, NOAA, ONR, and NSF, and the DIALOG V symposium is scheduled for October 19 – 24, 2003, at the Bermuda Biological Station for Research. Support from the European Commission is pending. The symposium offers an opportunity for recent grads to meet their counterparts from around the world in a collegial format designed to foster interdisciplinary understanding and peer networking. Forty participants will be selected by application. Travel subsidies are provided by the sponsoring agencies. See http://aslo.org/phd.html for details.

**Arzayus, Krisa M.** 2002. Fate of organic compounds associated with extractable and bound phases of estuarine sediments deposited under varying depositional regimes. College of William and Mary (USA), 236 pp. (arzayus@skio.peachnet.edu)

**Bahamon, Nixon** 2002. Dynamics of oligotrophic pelagic environments: Northwestern Mediterranean Sea and subtropical North Atlantic. Polytechnic University of Catalonia (Spain), 172 pp. (bahamon@ceab.csic.es)

**Barber, Valerie A.** 2002. Millennial to annual scale paleoecologic change in central Alaska during the late Quaternary interpreted from lake sediments and tree rings. University of Alaska at Fairbanks (USA), 132 pp. (barber@ims.ufaf.edu)

**Benoy, Glenn A.** 2002. Community consequences of indirect interactions between waterfowl and tiger salamanders in prairie potholes. University of Guelph (Canada), 247 pp. (gbenoy@uoguelph.ca)

**Biber, Patrick D.** 2002. The effects of environmental stressors on the dynamics of three functional groups of algae in seagrass habitats of Biscayne Bay, Florida: A modeling approach. University of Miami (USA), 367 pp. (pbiber@email.unc.edu)

**Camargo, William N.** 2002. Characterization of Artemia populations from Colombia for use in aquaculture. Ghent University (Belgium), 184 pp. (wcamargo@siu.edu)

**Cheng, Bin** 2002. On the modelling of sea ice thermodynamics and air-ice coupling in the Bohai Sea and the Baltic Sea. University of Helsinki (Finland), 38 pp. (bin@fimr.fi)

**Christian, Alan D.** 2002. Spatial and temporal analysis of freshwater mussel assemblage size structure, distribution, trophic status, and nutrient recycling in low-order streams. Miami University (USA), 270 pp. (achristian@astate.edu)

**Clarke, Annemarie L.** 2002. A diatom-based transfer function to infer historical changes in total nitrogen concentration from coastal sediments: A case study from Roskilde Fjord, Denmark. University of Newcastle upon Tyne (UK), 385 pp. (a.l.clarke@ncl.ac.uk)

**Colin, Sean P.** 2002. Determination and characterization of resistance by populations of the copepod Acartia hudsonica to the toxic dinoflagellate Alexandrium sp. University of Connecticut (USA), 168 pp. (scolin@rwu.edu)

**Cottenie, Karl** 2002. Local and regional processes in a zooplankton metacommunity. Katholieke Universiteit Leuven (Belgium), 187 pp. (karl.cottenie@bio.kuleuven.ac.be)

**De Mol, Ben** 2002. Development of coral banks in Porcupine Seabight (SW Ireland): A Multidisciplinary approach. Ghent University (Belgium), 363 pp. (bdemol@yahoo.com)

**Dowling, Carolyn B.** 2002. Submarine groundwater discharge to the Gulf of Mexico and the Bay of Bengal: Elemental flux estimates and sediment-groundwater interactions. University of Rochester (USA), 211 pp. (dowling,37@osu.edu)
Fisher, Karen E. 2002. Intermittency of spatial and temporal plankton patterns. Cornell University (USA), 265 pp. (kfisher@sfsu.edu)

Franck, Valerie M. 2002. Iron and zinc effects on silicon and nitrate uptake in high-nutrient, low-chlorophyll regions off central California, the Southern Ocean and the eastern tropical Pacific. University of California at Santa Barbara (USA), 210 pp. (franck@lifesci.ucsb.edu)

Greenfield, Dianne I. 2002. The influence of variability in plankton community composition on the growth of juvenile hard clams Mercenaria mercenaria (L.). Stony Brook University (USA), 189 pp. (dgreenfi@ic.sunysb.edu)

Haque, Shahroz M. 2002. Physiological regulation of toxin production in harmful raphidophytes. Kagoshima University (Japan), 88 pp. (mahean@rocketmail.com)

Kochzius, Marc 2002. Ecology, genetic population structure, and molecular phylogeny of fishes on coral reefs in the Gulf of Aqaba and northern Red Sea. University of Bremen (Germany), 148 pp. (kochzius@uni-bremen.de)

Koeniger, Paul 2002. Tracer hydrological investigations of groundwater recharge at a forest meteorological test site in southwest Germany. Albert-Ludwigs-Universität Freiburg (Germany), 87 pp. (paul.koeniger@hydrology.uni-freiburg.de)

McKinley, Galen A. 2002. Interannual variability of air-sea fluxes of carbon dioxide and oxygen. Massachusetts Institute of Technology (USA), 169 pp. (gallen@alum.mit.edu)

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Graduate Student Fellowships
Integrated Graduate Training and Research in Biogeochemistry and Environmental Biocomplexity

The Cornell University Program in Biogeochemistry and Environmental Biocomplexity is seeking to award several research fellowships to new graduate students beginning in Fall, 2003. This interdisciplinary endeavor, funded by NSF, focuses on research in several broad areas: 1) Elemental sources and cycling; nutrients and metals; 2) Biogeochemistry and biocomplexity: the microbial connection; 3) Nitrogen in terrestrial environments; 4) Ecosystem functioning: effects of variation in genotype and phenotype; and 5) Complex behavior from coupling simple mechanisms.

For more detailed information and application guidelines, visit our website: www.biogeo.cornell.edu. Review of applications will begin January 15, 2003.
DIALOG V

Dissertations Initiative for the Advancement of Limnology and Oceanography

Program for Recent Ph.D. Recipients across the Aquatic Sciences and Related Disciplines

The DIALOG goal is to catalyze interactions and understanding across the aquatic sciences. Recent PhDs are targeted to introduce new graduates to the community, forge lasting collegial bonds across peer groups and foster early career development.

Ph.D. DISSERTATION REGISTRY

The registry encompasses all aquatic science disciplines. Dissertation abstracts are posted on line in a fully searchable format, providing a concise overview of the field and highlighting individual accomplishments.

Graduates completing PhD requirements after January 1, 2001 are invited to register. Citations submitted within 3 months of PhD will be published in the L&O Bulletin. Participants will receive an abstract book, peer directory and a demographic report on their 2-year cohort.

ELECTRONIC COMMUNICATION

Once registered with DIALOG, graduates are placed on an e-mail list to foster cross-institutional communication and distribute job and other information. Anyone may submit job and other announcements for posting. Submissions should be sent to dialog@whitman.edu. Brief summaries are encouraged, with web addresses for details. Please do not send attachments.

SYMPOSIUM

"I suspect that, in years to come, the familiarity with distant specialties and connection to the top young scientists in diverse fields will greatly impact my own research and teaching."  
Past DIALOG participant

The DIALOG symposia catalyze early career development with a focus on interdisciplinary understanding and peer networking across the full spectrum of aquatic sciences.

DIALOG V will bring together 40 recent grads from around the world. Both oral and poster sessions will be used to relate each participant's dissertation research and current interests. Working groups will discuss emerging aquatic-science research, education, career and societal issues. Agency representatives will describe interdisciplinary and international aquatic science research opportunities. While the format is intense, there will be time for informal as well as formal interactions. Past participants agree this opportunity for information exchange and developing an international peer network should not be missed:

"I am positive that my perspective of science was changed by this meeting. It has already proven to be a milestone in my career."

"This is exactly the sort of thing we need to bring the newest generation of aquatic scientists together."

Symposium Eligibility

DIALOG V is open to PhDs completed January 1, 2001 - March 31, 2003 in any subject within or relevant to the biologically oriented aquatic sciences. Selection will favor applicants who plan to engage in interdisciplinary aquatic science research. Graduates from all nations are eligible. A committee will select 40 participants based on the application materials submitted. Travel subsidies are available.

SYMPOSIUM Dates & Location

October 19 - 24, 2003
Bermuda Biol. Station for Research

Application Deadline

May 1, 2003

HOW TO PARTICIPATE

Abstract Registration Forms
Symposium Application Instructions
PhD Dissertation Registry

http://aslo.org/phd.html

Questions
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