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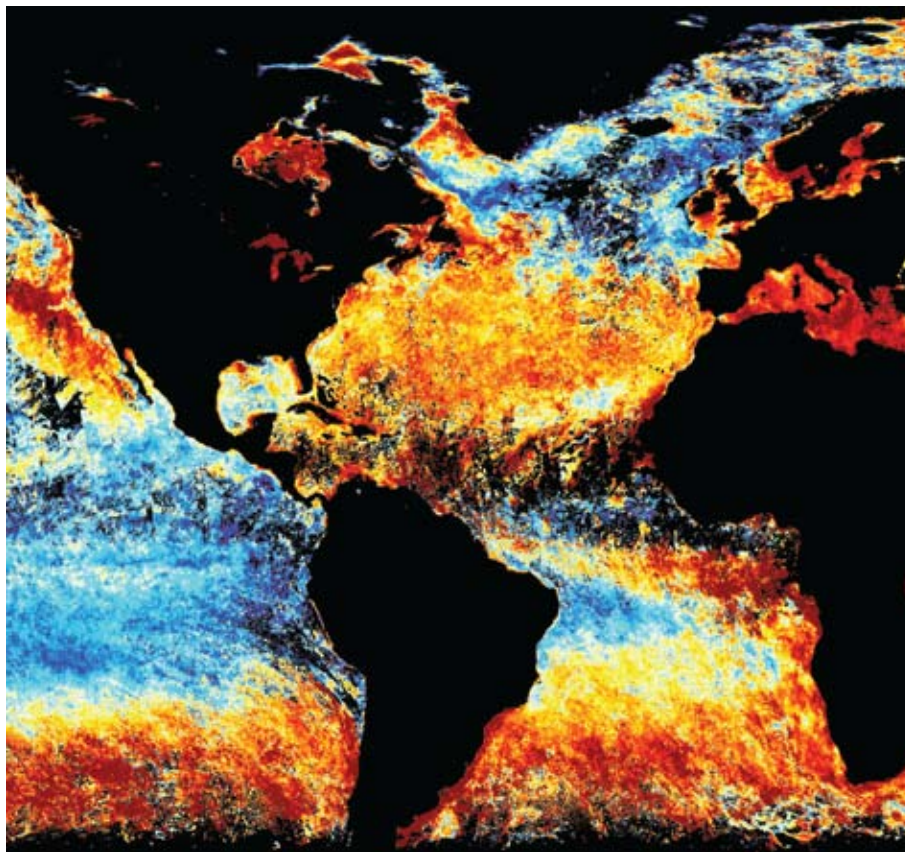
# LIMNOLOGY AND OCEANOGRAPHY BULLETIN

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**Anomalies of the absorption by non-algal colored matter** for June 2006, which is mostly composed of colored dissolved organic matter (CDOM) originating mainly from degraded vegetal matter. Warmer colors indicate higher values and cooler colors lower values relative to the mean oceanic value for the respective trophic status of the area as estimated by the chlorophyll concentration. Black pixels are either where no data is available or land. Image by Catherine Brown.

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# The Limnology and Oceanography Bulletin

The American Society of Limnology and Oceanography is a membership-driven scientific society (501(c)(3)) that promotes the interests of limnology (the study of inland waters), oceanography and related aquatic science disciplines by fostering the exchange of information and furthering investigations through research and education. ASLO also strives to link knowledge in the aquatic sciences to the identification and solution of problems generated by human interactions with the environment.

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## RESPONSE TO A SKEPTIC ON SATELLITE OCEAN COLOR

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**Editors' Note:** *The broader its intended audience, the harder it is to write an article of general interest describing scientific concepts. This new series highlights researchers who take up just that challenge for our multidisciplinary readership. Any volunteers?*

*This is that ancient doctrine of nemesis who keeps watch in the universe, and lets no offense go unchastised.*  
—Ralph Waldo Emerson

### PREVIOUSLY...

The diverse scientific community at our oceanographic institute gathers once a year for a full day of in-house talks. Ecologists rub shoulders with physical oceanographers, and some otherwise unlikely interdisciplinary exchanges occur. This year, a graduate student from the Satellite Ocean Color group was just finishing her talk at the podium when a voice rang out, "I didn't understand a word you said! Each year your group presents these optics equations and jargon, and I don't understand any of it. I have no idea what you people actually do!"

The provocation came from an esteemed senior scientist in a well-respected field of oceanography. I cautiously visited his office soon afterwards carrying a final version of my thesis under one arm. I came face-to-face with a full-on Skeptic. An otherwise friendly fellow, "Professor Nemesis" with his signature sandaled socks propped up on his desk challenged me to defend my research field. Through sharp questioning and a willingness to antagonize he sought honest scientific discourse above collegial harmony. By the time I left his office I felt off balance; the Skeptic had tried to puncture my scientific expertise just as I was on the eve of my doctoral defense. My recollection of our conversation has been transcribed below:

**Skeptic:** Hey! We don't see your kind around here too often! Coming to redeem your colleague?

**Student:** No, just coming for a chat.

**Skeptic:** I like that! Sit down. Want a coffee?

*An opacified coffee pot was simmering in the corner of his office, probably there since the day of his recruitment. I accepted the coffee, sat down and nonchalantly placed my thesis on the corner of his desk. He pounced on it and looked half amused flipping through its pages.*

**Skeptic:** A one-trick pony! Don't satellite oceanographers produce anything other than maps of chlorophyll (Figure 1A)? Anyways, weren't those published some 30 years ago?

**Student:** There's more in there than algal biomass distributions! I've come to show you...

**Skeptic:** Hold your horses! First, explain how this stuff works. No equations or jargon, please.

**Student:** Well, a satellite ocean color sensor measures light leaving the atmosphere in a few wavebands...

**Skeptic:** Wavebands?

**Student:** Colors, if you prefer. For example, SeaWiFS (Sea-viewing Wide Field-of-view Sensor), one of the current ocean color satellites, has 6 wavebands in the visible range of the electromagnetic spectrum and 2 in the near infra-red. The objective of ocean color science is to interpret the spectrum of light leaving the ocean. Since the sensor measures light above the atmosphere, the standard processing of satellite data requires the removal of atmospheric light, other environmental effects and observational biases. After these steps, we are left with the "normalized water-leaving radiance" or "nLw" at 6 wavebands.

**Skeptic:** That already sounds more scientific than "ocean color"!

**Student:** Yes, and we're a bit image conscious about being called "ocean color" scientists. To sound more scientific, our coordinating body the International Ocean-Colour Coordinating

Group has suggested we talk about “Ocean Color Radiometry” instead of just “ocean color”.

*A sort of amused grunt came from his grizzly beard. Surely it had last been trimmed the same day his coffee pot had been cleaned. Nevertheless, it gave him the air of an intrepid Robinson Crusoe. Or, the contemporary version played by Tom Hanks in the movie Cast Away...*

**Skeptic:** Anyway, I suppose you mean this nLw is the light leaving the ocean surface? I’ve been looking at the ocean for a while and have come to realize that it’s essentially the color of the sky. When the sky is gray the ocean is gray, and when the sky is blue so is the ocean.

**Student:** That’s because you’re looking at the reflection of the sky on the ocean’s surface. The “ocean color” quantity called nLw is the light leaving the ocean but “normalized” in such a way that it’s not affected by observational conditions. The sky reflection has been removed and we are looking only at the light originating from just below the sea surface. Theoretically, nLw is only dependent on *the amount and composition of in-water constituents that absorb and backscatter light*.

**Skeptic:** Uh-huh...

**Student:** This nLw is now an operational “ocean color product” which is provided by space agencies for different satellites. For example, NASA (National Aeronautics and Space Administration) provides these products several hours after the passage of their satellites. Other Space Agencies are somewhat slower, to say the least. Afterwards, equations or “algorithms” that use the shape as well as the amplitude of nLw are applied to convert ocean color to other optical – as well as biogeochemical – values, such as the chlorophyll concentration.

**Skeptic:** Let’s start with chlorophyll then. How good is it? Do I need to take measurements of chlorophyll if I go out on a cruise or could I just rely on your satellite ocean color thingy?

*Taking a second to collect my thoughts, I raised the mug of coffee to my lips, and the coffee maker made a bubbling noise... perhaps warning me...*

**Student:** It’s estimated that in the open ocean, where the chlorophyll concentration ranges over three orders of magnitude, that the accuracy is about 50%. In coastal waters the error is greater.

**Skeptic:** How much greater?

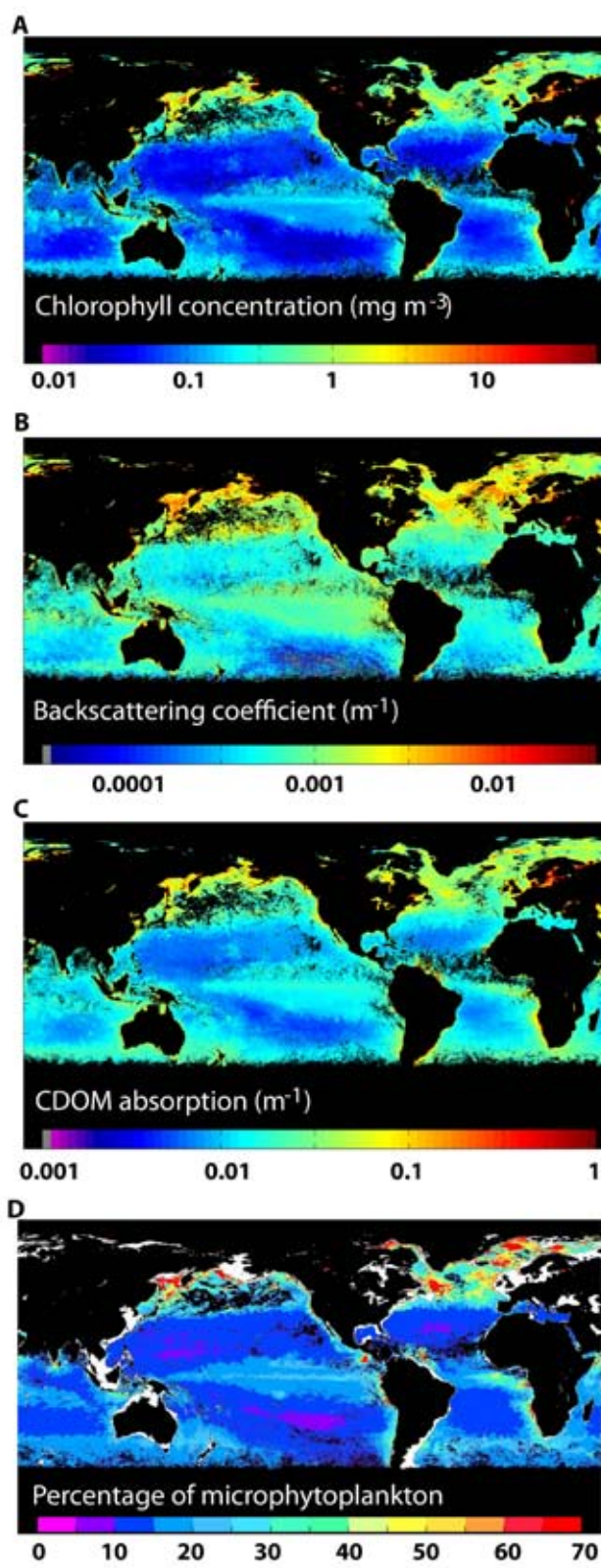
**Student:** I don’t really know. Quite a bit more... Well, it’s not very good.

**Skeptic:** You mean that your best “product” has 50% error in the best-case scenario and doesn’t work in coastal waters? Plus, from the little I got out of those talks it only measures the chlorophyll near the surface. You do realize that this is not exactly stunning?

*Think quickly! I couldn’t let him destroy more than 30 years of fine research right there!*

**Student:** If you had to choose the best method to measure chlorophyll in the ocean what would you pick?

Figure 1. Some of the figures the Skeptic was looking at while flipping through my thesis. A) Chlorophyll concentration from the operational OC3M empirical algorithm (June 2006). B) Backscattering coefficient of particles at 551 nm (June 2006) from Brown et al. (2008). C) CDOM absorption coefficient at 412 nm (June 2006) from Brown et al. (2008). D) Distribution of microphytoplankton size class (June 2000) from Uitz et al. (2006).



**Skeptic:** HPLC (High-Performance Liquid Chromatography), surely.

**Student:** Then consider this. If you were to ask several labs to measure chlorophyll-*a* on the same sample the average error will be around 7 to 10%, but as high as 20%. That's for samples from the same sampling bottle. You'd probably get higher variability with fluorometric chlorophyll. With this in mind, that 50% doesn't seem so bad especially if you consider that you get a measurement *over the whole globe every few days!*

**Skeptic:** Every few days?

**Student:** If there are no clouds, roughly every two to three days depending on the sensor and latitude. Ocean color satellites don't see through clouds. Also, keep in mind the resolution of satellite images. A pixel represents roughly 1 km<sup>2</sup>, and therefore the chlorophyll estimate is the average over that pixel.

**Skeptic:** This is obviously not a substitute for my measurements of chlorophyll at a precise location and time, which accompany my other discrete measurements. And, it definitely isn't a replacement for my measurements in coastal waters.

**Student:** Let's be fair! It's an incredible tool to support a cruise, and cost-effective compared to ship time. For example, it can be used for understanding how representative the area you sampled is of a wider one. Or, even for positioning your sampling efforts over interesting features. Aside from this, don't dismiss the impact of these images on the public perception of the "living ocean". Satellite observations provide global estimates of ocean productivity, and how it varies geographically and seasonally. I would say these powerful images still have lots of potential to inspire public interest in oceanography, if perhaps they (and we!) knew more about them...

**Skeptic:** I guess so.

**Student:** You really need to grasp what is physically occurring. Sunlight penetrates the water surface, interacts (through scattering and absorption) with the water body and a small part, much less than 1%, is returned upwards to the sensor a few hundred kilometers up in space. When it reaches the sensor this light forms less than around 5% of the total light measured by the satellite as the rest comes from the atmosphere. Furthermore, in the water multiple optical interactions occur with a variety of constituents. Despite all these physically complicated processes, we manage to get nLw, and from that the concentrations of phytoplankton pigments and absorption by colored dissolved organic matter (CDOM). To me, that's a pretty major achievement!

**Skeptic:** It is pretty good that you can manage that.

*I thought I had perhaps convinced him that our work had some value!*

**Student:** Well, I didn't do any of it... this was all worked out years ago.

**Skeptic:** But, why does it work at all?

**Student:** For phytoplankton, it's easily explained.

Phytoplankton pigments absorb light much more strongly in the blue than in the green. As the phytoplankton concentration increases the water-leaving radiance in the blue decreases. Because phytoplankton are accompanied by all kinds of particles which scatter light, the amount of light in the green increases slightly. Therefore, by taking a ratio of nLw in the blue and green wavelengths we can derive quantitative estimates of pigment concentration. These estimates are then used in calculations to determine primary productivity for the ocean. CDOM, which comes from river runoff and phytoplankton degradation, reduces the water-leaving radiance as it causes significant absorption in the ultraviolet and blue wavelengths relative to those in the red.

**Skeptic:** And the accuracy of your CDOM estimates?

**Student:** Hard to say exactly... probably not as good as for chlorophyll.

**Skeptic:** And primary productivity?

**Student:** Well... the good thing about errors in ocean color is that they are randomly distributed about a mean value. So, for global estimates of primary productivity these errors tend to cancel out. However, the largest error in primary productivity estimates comes from the parameterization of phytoplankton physiology in these models. That's a topic for another day!

*All the while, he was browsing through my thesis. He had an uncanny knack for hitting the problem right on the head...*

**Skeptic:** The suspicious thing is that you've got maps in here of a host of other variables: absorption anomalies, backscattering (Figure 1B), CDOM absorption (Figure 1C), CDOM to phytoplankton ratios... Not exactly what biogeochemical conclusions are made of! If I count all of these variables, that's at least 20 different "data products". If there are only 6 wavebands on a sensor, how can so many quantities be derived? And, what do you use such exotic variables for anyways?

**Student:** Perhaps I was not clear about something. There's no magic in ocean color. The measurement can tell us directly about only two basic physical quantities: the total absorption coefficient and the backscattering coefficient. I'm pretty sure that you're familiar with the first. The second is simply the fraction of light per unit distance traveled in the water going in one direction that is redirected backwards (through angles of more than 90 degrees) through its interaction with water molecules and particles in the water per unit length traveled in a water body.

**Skeptic:** You're telling me that you have only two measurements, but can provide me with 20 or so products?

**Student:** Yes. It's possible to partly decompose the estimated total absorption into different components, usually phytoplankton absorption and CDOM absorption. The backscattering coefficient of particles is kept as one measurement.

**Skeptic:** That's only... 1, 2, 3 variables!

**Student:** As you know, in the open ocean phytoplankton form the base of the food web and thus dictate the ecosystem structure. Everything follows suit and, as such, most variables covary with algal biomass (for historical reasons, optical oceanographers call these conditions Case 1 waters). The blue to green ratio is thus a good predictor of almost everything! Indeed, chlorophyll-*a* is one of these variables. Satellite algorithms for most of the ocean do not utilize wavebands that are influenced by chlorophyll absorption. Instead they utilize bands that observe the absorption of other phytoplankton or "accessory" pigments. Thus, they rely implicitly on the good correlation between chlorophyll-*a* and phytoplankton absorption.

**Skeptic:** You mean the other variables covary with the principal driver, which is phytoplankton biomass?

**Student:** Yes, but only in the open ocean and only approximately. There are two ways to obtain the other variables. Sometimes a regression is made directly with the blue to green nLw ratio. Otherwise, the relationship between the variable of interest is made with *in situ* chlorophyll and then applied on the chlorophyll obtained from a satellite sensor. Of course, we can extract some of the variability around the mean trends with chlorophyll: this is what is done for CDOM and backscattering.

**Skeptic:** Can anything else be retrieved without using regressions with chlorophyll?

**Student:** One of the best examples is probably the large anomalies of backscattering in the open ocean that can generally be attributed to the presence of coccolithophores. These organisms strongly backscatter due to their calcite liths.... Basically, they are like chalk particles in the water.

**Skeptic:** That's pretty cool.

*Feeling a bit more at ease, I took a sip from my coffee mug without thinking. My taste buds were immediately assaulted. This coffee was what Cheese Whiz is to Camembert...*

**Skeptic:** I recently saw global satellite maps of different phytoplankton types obtained from ocean color. How were these obtained?

**Student:** Apart from coccolithophores, which have a strong and unique optical signature, most other phytoplankton do not. However, because global biogeochemical models now incorporate more than one phytoplankton type, and because there is no easy way to validate these models, there is a lot of interest in developing algorithms for the distribution of other phytoplankton groups. This is one of the hot topics in our field. Different approaches based on anomalies and correlations have been proposed.

**Skeptic:** But, if your chlorophyll estimates have 50% error how wrong could these be?

**Student:** Well, I can't say for sure. The most compelling

study, in my opinion, uses correlations between phytoplankton biomass and species composition (Figure 1D). You know, Yentsch and Phinney (1989) style, a rather constant background of small cells with larger cells becoming more abundant. It's just the modern version with a large dataset of HPLC pigments. Of course, you could sometimes be completely wrong with this approach, but it will be correct on average and it provides realistic distributions.

**Skeptic:** What else is hot in ocean color these days?

**Student:** Certainly, much effort is going into improving estimates of all the variables that are not chlorophyll. Perhaps the most interesting transition occurring at the moment is that scientists seem to be sufficiently satisfied with the quality of ocean color data to use them to make inferences. This comes at a time when continuous time series have celebrated their 10th year. Recently, several studies examine these trends in an attempt to relate them to climate change, local or global. Attempts to use and interpret 30 years of ocean color data (including using data from the first ocean color sensor, Coastal Zone Color Scanner, deployed in 1978) with the help of global models are also underway. This may well foster a much better understanding of the fundamental forcings on the ocean as well as the way to model them. Then, there are the classic but always timely questions such as the origin of backscattering or the causes for the distribution of CDOM in the ocean.

**Skeptic:** You don't even know what causes backscattering?

**Student:** We have best guesses, but the answer is no, not exactly. It's likely very small particles, smaller than most phytoplankton cells, probably detritus of organic origin; however, there is no consensus because we cannot measure these particles.

**Skeptic:** What else?

**Student:** There are exciting new directions such as the future launch of geostationary satellites, which will provide high temporal resolution images, generally in coastal areas. Another possibility is acquiring more highly resolved spectra (we call them hyperspectral), which may help us to tune algorithms or to obtain new variables. Furthermore, there is still information in the existing ocean color data that remains to be exploited, such as sun-induced chlorophyll fluorescence or the polarization of the signal.

**Skeptic:** The what?

**Student:** Satellites can observe the fluorescence of chlorophyll-*a* when excited by sunlight. It contains information about algal physiology. The main problem is that presently we don't know how to interpret it.

**Skeptic:** And polarization?

**Student:** Sunlight is backscattered, and through its interaction with different types of particles in the water it can be polarized to different extents. Perhaps it can provide information about the type of particles present, in particular the ratio of mineral to organic content.

**Skeptic:** More of these unusual variables I see! Who uses them anyway?

**Student:** There are probably three main users. There are scientists interested in specific processes and for whom estimates of these different parameters are useful. And then, some global biogeochemical modelers are interested in validating their estimates of phytoplankton biomass in the world ocean or want to assimilate chlorophyll fields to improve their models. Phytoplankton species, as I mentioned before, is another variable modelers are very interested in. Finally, the military is certainly a large source of funding for ocean color research. This goes back to the very origin of remote sensing with aerial reconnaissance, which was followed by satellite reconnaissance. Parameters of interest to them also include visibility, basically how far you can see in the water, and bottom depth and type in waters shallow enough for the bottom to be seen from above the surface. Climatologist and physicists are also becoming more and more interested in the measurement of ocean color. Indeed, while they are heavily using another remote sensing product, the sea-surface temperature, this product only provides them with information about less than a millimeter at the surface of the ocean. Ocean color can often provide them with supplementary information about physical features because in the open ocean it typically “sees” down to a few tens of meters.

**Skeptic:** Now, what do you do exactly?

*Confident that I had piqued his natural curiosity, I picked up my thesis and rose to leave.*

**Student:** I hope you’ll come to my thesis defense to find out!

*He smiled. Perhaps my arguments had placated him... Or, was “Professor Nemesis” satisfied with having delivered a strong dose of humility? I felt uneasy leaving his office. Could other scientific colleagues harbor similar doubts? How could we best inform and collaborate with them?*

#### ACKNOWLEDGEMENTS

This fictional account was inspired by true encounters at the Laboratoire d’Océanographie de Villefranche, France. The resemblance of the skeptic to a Bulletin editor may not be purely coincidental. Thanks to Julia Uitz for providing the microphytoplankton distribution figure.

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## BEYOND THE IVORY TOWER: BOULDER VALLEY BOARD OF EDUCATION’S LESLEY SMITH

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Photo by Anton Trainer

While the number of scientists communicating with policy-makers has been steadily increasing in recent years, becoming a politician remains low on the “to do” list of most researchers. This month’s “Beyond the Ivory Tower” column features ASLO member Lesley Smith, who was elected to the Boulder Valley

Board of Education (BOE) in Colorado in 2005. She currently serves as Vice-President of the BOE. Lesley received her B.A. in Aquatic Biology from the University of California at Santa Barbara, and Ph.D. in Marine Environmental and Estuarine Sciences from the University of Maryland. Lesley spent 15 years as a research scientist prior to joining the University of Colorado’s Cooperative Institute for Research in Environmental Sciences (CIRES). At CIRES, Lesley has been facilitating partnerships, developing educational programs, and writing grants in the CIRES Science Education and Outreach Program.

Despite her background as a scientist, science was actually a secondary reason for deciding to run for office. In 2003, Smith’s children’s school was caught up in a series of school closures that resulted in the school being moved to another neighborhood and into the same building as another school. As Vice President of the School Leadership Team at the time, Smith spent a lot of time with the principals, parents, and district leadership to try and find a better solution to the situation. Smith was later asked to be on a newly created district task force on destratification of schools. It was during a meeting of this task force that “a light bulb went off” and Smith first considered running for office. “I realized I could offer the district some expertise as a board member with regard to this issue.” Smith

began to research running for her district's board position, which was going to be up for election that year.

Running for office entails fundraising and campaigning, two activities many scientists are loathe to engage in. Smith, however, says running for office was an amazing experience. "I would say I gained the most amount of personal growth in a short period of time, ever!" Smith says fundraising "is definitely not the funnest part of a campaign – nobody likes to ask for money but that's what you have to do as a candidate." Smith's friends hosted events, during which she'd speak and there were donation envelopes. She also received the endorsement of the teacher's association, which came with a \$1500 check. Fortunately, the election cycle for the BOE is "short and sweet" and doesn't require a lot of money. Smith raised a total of \$5500 in two months, and her campaign lasted from August to election day in November.

While campaigning, Smith met with people throughout the district, listened to their concerns and ideas, formulated her values and honed them down to a short and understandable message (excellent practice for scientists, she notes), marched in parades, and helped design her yard signs. One of Smith's favorite aspects of running for office was debating the other candidates in a variety of venues, including on the radio and on television. The debates were a different – and challenging – experience for Smith. "It's really different hearing a question, formulating a response within seconds, taking 60-90 seconds to answer and remain poised! These are skills that I can use forever."

Beyond the skills acquired during the campaign, Smith has found that serving on the BOE has been an extremely valuable experience and feels that her training and background as a scientist has helped improve education in her district. "I have made a difference both locally and on the state level and being a scientist has lent me a high degree of credibility." On the local level, she often mentions a science related issue during the televised board meetings. As a result of those meetings, science teachers see her as an advocate; teachers and the district science coordinator often approach her with concerns or ideas. For instance, Smith meets frequently with the director of learning services to discuss her concerns about science education. These conversations have led to significant changes for the school district. Smith was particularly pleased following a lunch when the director said "I'm starting to understand what Scientific Inquiry means, and I can't expect teachers to use the same old text books and for the kids to get what Inquiry is." The director pushed the teachers to adopt a new type of curriculum and receive professional development to help them implement more inquiry-based learning.

On a state-wide level, Smith was on a panel to review the Scientific Inquiry science standards. Smith was the only scientist on the panel. She says the teachers found it "invaluable to have my input on what Inquiry really is, and I was happy to have their input on questions about age-appropriateness. Together we made a good team." When the state board of education was voting on the standards, Smith had expressed some concerns about the width and narrowness of the standards so they called her to testify at the board meeting. Smith feels a scientist has a certain credibility that the community will listen to.

Smith says she benefited personally from her experiences as well. She has learned how to work with the press, has made "tons of great connections" including knowing all the state delegates from her district, and has become more skilled in budgeting and finances of major institutions (the district's budget is \$200 million). Smith says now that she is an Outreach Scientist rather than a Research Scientist, "all of these skills and connections help me tremendously in my job, and my institute recognizes this."

Smith's campaign and work on the board has been time-consuming, however. The campaign was very intense, so she took a leave of absence for two months. The time commitment for serving on the board varies widely, ranging from "fairly minimal to overwhelming." Typical duties include bimonthly board meetings, monthly work sessions, and answering emails, totaling approximately 20 hours a month. During times of controversy, however, the duties can become overwhelming and could easily become a half-time job. Usually, however, the time commitment is lower. While most active researchers would not have the time availability required for such a position, Smith says she would counsel every member of ASLO to seriously consider running for school board. "If they feel they don't have the time now, then they should consider it when they retire. It's interesting, they'll learn lots, and most importantly they'll make a difference in science education at the local and possibly the state level." Smith says she would be happy to talk to any members who might consider running for school board. She can be reached via email at [Lesley.Smith@colorado.edu](mailto:Lesley.Smith@colorado.edu).

## THE ETHICS FORUM: THE ETHICS OF ENVIRONMENTAL MANIPULATIONS

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Large environmental manipulations have a long history in limnology and oceanography. For example, an entire watershed in the Hubbard Brook Experimental Forest was deforested in 1965 to study the effects of the treatment on nutrient budgets (Likens et al. 1970) and succession (Reiners 1992). Fertilizers were added to lakes to study eutrophication (Schindler 1974). More recently, large quantities of iron have been added to the ocean to study phytoplankton blooms and carbon sequestration (e.g. Coale et al. 1996, Boyd et al. 2000), and non-native oysters may be introduced into Chesapeake Bay to revive the oyster industry and restore ecosystem functions lost with the decline of the native oyster (NRC 2004).

These studies bring up some important ethical issues. How do we balance the pursuit of knowledge against damage to the environment? How do we guard against unintended consequences of large-scale manipulations? At what scale

should we be concerned about impacts? According to the ASLO code of conduct, members have the responsibility to “promote environmental integrity and conduct research in a responsible and humane manner.” How can this be achieved?

Before performing large-scale environmental manipulations, we should ask ourselves if we can answer our questions using models and laboratory studies. Oftentimes, however, field studies provide more realistic tests of our hypotheses. Scientists should use laboratory and modeling approaches first, however, to gain insight into possible adverse effects of a larger-scale field study.

Assuming a field study is to be conducted, at what scale should we be concerned about adverse impacts? Certainly large-scale studies will have greater impacts than small-scale studies. For example, deforesting the watershed surrounding a small tributary will have a lesser impact than deforesting the watershed surrounding a 3rd order stream. If a small-scale study can be used in place of a larger-scale study to answer the questions at hand, then the small-scale study is preferable because of its lesser impacts.

If a large-scale field study is deemed necessary to answer a particular scientific question, scientists should weigh the benefits of the knowledge to be gained against potential harmful effects of the proposed manipulation. Modeling efforts and laboratory experiments conducted beforehand should be used to identify and quantify possible adverse effects. Once possible adverse effects are identified, precautions must be taken to avoid them, or at least minimize them. For example, if a species introduction is planned, can we hypothesize what effects the introduced species would have on the ecosystem outside the study area? With whom would it compete? What would it eat? What effects would it have on the abiotic environment? What can be done to prevent the species from dispersing outside the study area? Is there any way to sterilize the introduced individuals so that they don't reproduce? The study conducted for the introduction of Asian oysters to Chesapeake Bay (NRC 2004) provides a good example of a risk assessment for a species introduction. In addition to considering the ecological impacts of the introduction of non-native oysters, the NRC study examined possible effects on human health, the economy, and social and cultural systems.

CLIMOS, a company examining the use of iron fertilization to remove carbon dioxide from the atmosphere, has developed a code of conduct for iron fertilization projects (CLIMOS 2008). The three primary sections of their code relate to “(1) protection of the marine environment; (2) methodological rigor in accounting for carbon credits; and (3) transparency and openness.” The standards CLIMOS proposes for environmental protection include obtaining permits from all relevant authorities, conducting an environmental impact assessment, avoiding sensitive ecosystems, and ensuring that the iron compound used in the fertilization has a particular level

of purity. Although the benefits and drawbacks of large-scale iron fertilization are still being debated, the CLIMOS code's requirement for an environmental impact assessment suggests that work should not proceed without careful consideration of possible negative effects.

In summary, scientific research should be conducted with approaches least likely to damage the environment. If environmental manipulation is required to answer a question, care should be taken to identify all possible harmful impacts to the environment as well as human well-being. These impacts should then be weighed against the anticipated benefits of the research. If the researchers decide to proceed with the manipulation, then all precautions necessary to minimize adverse effects should be taken.

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## MESSAGE FROM THE PRESIDENT: IS ASLO INTERNATIONAL ENOUGH?

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### AN INTERNATIONAL COMMUNITY

At a time when globalization seems to bring nothing but bad news (e.g. terrorism, climate change, domino effects on the global economy), ASLO is about to celebrate its global dimension by holding one more meeting, the third in ASLO's

history, outside North America. Going "global" has been a positive for the society; ASLO's finances remain healthy and resilient due to sound targets and policies.

The call for abstracts for our 2009 Aquatic Sciences meeting in Nice, France (January 25-30, 2009), closed a few weeks ago, with just under 2,000 abstracts submitted to the 118 sessions. The meeting co-chairs, Jean-Pierre Gattuso (France), Peter Bossard (Switzerland), and Markus Weinbauer (France), along with the dedicated and enthusiastic help of their international planning committee and the competent guidance of ASLO's business office, lead by Helen Schneider, have done a superb job in assembling an exciting program, with plenty of hot scientific topics for discussion, promising plenary lectures with an innovative format, and a plethora of side events to enjoy. In addition, there is all that Nice, the French Riviera, and Europe have to offer.

With about 1900 registered participants, the 2009 Aquatic Sciences meeting in Nice will join the two previous meetings outside North America (1492 attendees at Copenhagen, Denmark in 2000 and 2300 attendees at Santiago de Compostela, Spain, in 2005) as one of the most successful meetings in ASLO's history. Indeed, meetings outside North America are consistently successful, averaging just below 2,000 attendees compared to an average of 1,100 attendees to those ASLO organized in North America since year 2000 (excluding the Ocean Sciences meetings, co-organized with three other societies). These meetings help increase ASLO's membership and include a more balanced distribution of members among countries of origin (32 countries represented on average in meetings held in North America vs. 55 countries in Europe and 69 countries represented in the membership). It would be legitimate to ask whether meeting size may be a metric for success or whether smaller meetings are preferable. This is, of

course, largely a matter of personal preference, but there are some objective arguments for striving to organize the largest possible meetings. A primary consideration is financial in nature; since the costs of organizing a meeting, on the order of US \$1 million, do not scale proportionately to attendance, only a large attendance ensures the sustainability of ASLO meetings. In addition, there is a relationship between meeting size and the number of special sessions, implying that the diversity of topics covered increases with meeting size, with large meetings offering a broader repertoire of topics to attendees.

A fourth international meeting will be held outside North America, and likely at a continent other than Europe no later than 2013. ASLO is planning a meeting in Puerto Rico for February 2011, which, while part of the USA, will provide a bridge to the Latin-American community in aquatic sciences, which is still underrepresented in ASLO. These meetings will provide new opportunities to better serve our members. But, is the number of international meetings ASLO is running sufficient?

Since the year 2000, 18 % of the meetings ASLO has organized, including the co-organized Ocean Science meetings, took place outside North America, compared to 30% of ASLO members based outside North America. Yet, even though these figures sound somewhat imbalanced, meetings are probably where ASLO best recognizes its international dimension. Other indicators of the involvement of members outside North America in the society are even grimmer:

The board I chair has only two members working outside North America (Wilhem Granelli of Sweden and myself) out of 15 elected officers (13 %), and only one (John Dolan, co-editor of the ASLO Bulletin, American-born but based in France) out of 10 ex-officio members (10 %). I am the first President of ASLO affiliated with an institution outside North America out of 60 elected Presidents (1.6 %); but other offices, such as Treasurer and Secretary have never been held by members working outside North America (I am not sure that there was even ever one nominated to run for these offices). ASLO has 15 standing committees and subcommittees, none of them chaired by a non North-American member. ASLO recognizes outstanding members with a slate of awards, which have only been presented to 8 scientists from outside North America (2 out of 22 Lindeman Award recipients; 2 out of 27 Hutchinson Award recipients, 4 out of 15 recipients of the Redfield Life Time Achievement Award, 0 out of 7 recipients of the Ruth Patrick Award, 0 out of 5 recipients of the Citation for Scientific Excellence, and 0 out of 7 recipients of the Distinguished Service Award, cf. [www.aslo.org/information/awards.html](http://www.aslo.org/information/awards.html)). Yet, members based outside North America are enthusiastic contributors to the science ASLO promotes, with an important presence in the editorial boards of ASLO journals, authoring more than 50% of the papers *L&O* and *L&O-Methods* publish, participating in ASLO conferences as presenters and members of the planning committees in numbers matching, or exceeding, their 1/3 contribution to the membership.

Should we address this imbalance? I believe we should, as this will be consistent with our mission statement to "foster a diverse, international scientific community..." and one of

the principles guiding decisions of the Board of Directors pledges “(to)...offer equitable services to all members independently of geographic location” (cf. *L&O Bulletin* 17 (3), pages 80–81). So, how should we achieve this? As with other issues involving underrepresented minorities, a topic I will address in my next message, solving this situation requires a proactive attitude to break chicken-and-egg circles that tend to perpetuate this situation under “do-nothing” scenarios. The poor international diversity in many of the roles ASLO members can play stems, in my opinion from issues related to unawareness, (1) the fact that most of us know best our peers within our own national community than those outside, so that it is only natural for, for instance, our American colleagues – the largest contingent in the society – to, in general, think of other American colleagues when considering nominating others to offices in the board or awards (same will happen if the society was demographically nominated by citizens of, say, San Marino); and (2) the fact that members from outside North America are not sufficiently aware of the way the ASLO Board and ASLO committees operate, and have little or no tradition to nominate their peers to offices at societies or even for awards.

When I first joined the ASLO Board as a member-at-large, in 2000, I was entirely ignorant as to how society boards operate in the US, and the first Board meeting I joined was a shocking experience, due to the workings of rules, the so-called *Roberts’ rules of order*, that govern the discussion and decision process at board meetings, as alien an obscure to me as the – still obscure – rules of baseball. By now I have participated in board meetings of other societies (I am an *ex-officio* member of the CERF Board) and observed the same mechanism at play, which operate in most or all societies incorporated in the US. Henry M. Robert (1837–1923) published these rules in 1876 to guide discussions and decisions in ordinary societies. I have come to appreciate the merit’s of Robert’s rules of order as a way to structure discussions and walk out of meetings with a clear understanding of what was approved, an essential outcome of any meeting, which is not as straightforward as it seems. I have often walked out of meetings in Europe to find that different participants had entirely different understandings of what had been agreed. Indeed, I am convinced that the highly structured, deeply democratic mechanisms governing the functioning of American scientific societies explain why US-based scientific societies are so vigorous and energized and exert such magnetic attraction to scientists around the world that may not entirely understand their operation but surely benefit from the impetus they provide to our disciplines.

The Board has introduced actions to acknowledge ASLO’s international dimension further and facilitate the participation of all members, regardless of nationality – in the society. For instance, in February 2002, the ASLO Board acknowledged the growing international membership by adopting the phrase “*Advancing the science of limnology and oceanography*” as a more comprehensive representation of the full membership and purpose of ASLO. We have instituted a new mechanism for members to indicate their willingness and interest to serve in any of ASLO’s committee’s, through a link available during the membership renovation or application process, which you may

have already noticed (remember to renew your membership!). This may help break one of the chicken-and-egg mechanisms leading to a poor international representation (or in fact, any issue of underrepresented minorities). In addition, you don’t need to be an elected officer or a committee member to participate in ASLO. Any member may bring matters for discussion at the business meeting (next to be held on the evening of Monday 16 at the Nice meeting). Any member has the opportunity to join Board meetings if so desire (although voting rights are reserved to elected officers). If you happen to be by the meeting venues on the weekend prior to the conference, when Board meetings typically happen, and are curious to find out how the Board operates, think of joining us (please contact Helen Schneider, at the business office, if you would like to have a sample of what the Board meeting is like in Nice – pending on the volume of requests). Moreover, we are in the process of completing a questionnaire soliciting your inputs and views on what activities the society should promote. Your input is essential for us, please take the 5 minutes it will take to complete the questionnaire upon reception.

Lastly, I would be most interested to learn your views on the items discussed above, or any other society matters, either in person, if you are attending the meeting in Nice (we surely hope so!), or else in writing. Feel free to contact me with your views, questions or proposals to address these issues. The strength of ASLO rests with its members.



Carlos M. Duarte ASLO President

## MESSAGE FROM THE BUSINESS OFFICE

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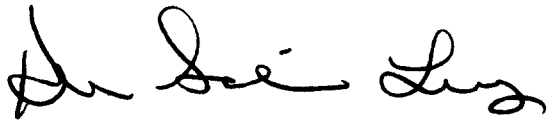
Another year has passed, and we are now processing renewals and subscriptions for 2009! As a reminder, the ASLO membership year runs from 1 January through 31 December. We would like to welcome over 600 new ASLO members who joined for 2009 as part of their registration process for the ASLO Aquatic Sciences Meeting in Nice, France. Enjoy your ASLO membership and use your membership benefits. Please let us know if we can answer any questions or be of help to you.

We want you to renew in 2010 and continue as an active ASLO member for many years to come.

For those of you who will be renewing your ASLO membership soon, you will notice that dues were not increased for 2009, and we have reduced the price for student members without a subscription to the journal to just \$10. All other categories and fees remain the same. Also added is a "Click Here" option making it easy for you to learn more about and to join one of the ASLO committees. We hope you will take advantage of this opportunity and get involved. It makes a difference in your society, it's fun, and it's a great way to meet other scientists.

We hope to see you in Nice. Over 2,000 scientists from around the world will gather during the last week in January to enjoy excellent science and the lovely "gold coast" of France. The meeting will be outstanding, and you won't want to miss the talks, posters, and ASLO awards that will be presented.

Please contact us if we can be of any help. We are here to serve you! Renew today!



Helen Schneider Lemay  
ASLO Business Manager

## REPORT FROM THE INFORMAL EDUCATION AND PUBLIC OUTREACH SUBCOMMITTEE

*ASLO Informal Education and Public Outreach Subcommittee, Janice McDonnell, Subcommittee Chair, Rutgers University, 71 Dudley Road, New Brunswick, NJ 08901; and Subcommittee members: Chris Parsons, Linda Duguay, Sue Cook, Lesley Smith, Gary Banta, Bob Chen, Adrienne Sponberg, and Gwyneth Sharp; [informaled@aslo.org](mailto:informaled@aslo.org)*

The Informal Education and Public Outreach Subcommittee has been actively working to identify and promote communication and partnerships between ASLO research scientists and educators. Our charge is to identify appropriate education resources and professional development opportunities that improve ASLO scientists' access to and participation in education and outreach. Here is a summary of some of our work to date.

### Introducing a new and improved ASLO education website

Our team has been working to update and improve the education portion of the ASLO website. The site features the best-of-the-best websites to help members find important information on how to improve the broader impacts of grant funded projects, resources to help improve effectiveness as a professor/educator including professional development

opportunities, recommended EPO programs for scientists to get involved in EPO, and educational resources and references of value in proposal writing or participation in education projects. Please visit the site at [www.aslo.org/education.html](http://www.aslo.org/education.html).

### ASLO Scientist Survey

A great deal of research has been conducted on the science literacy and teaching practices of K-12 classroom teachers. Much less is known about scientists' involvement in public education. In January 2008, ASLO and the Centers for Ocean Science Education Excellence Networked Ocean World (COSEE NOW) conducted an online survey of the ASLO membership to gather data on the education involvement, practices and needs of members to improve exchanges between scientists and educators. We learned a great deal from the survey and thank the 637 ASLO members who responded (an approximately 18% response rate). Here is a sampling of what we learned.

- A majority (69%) of the membership is involved in education and public outreach (EPO) with approximately 49% required to do EPO as part of their funding.
- We asked members what kinds of EPO they were involved in as part of their professional work. We learned ASLO members are contributing to a wide range of education efforts. The top activities were: teach science at the college level (64%), contribute data or content to public websites (42%), present at public meetings (40%), judge science fairs or other competitions (39%) and talk to K-12 students in classrooms (37%).
- Respondents' views of the greatest public benefit of scientists' engagement in EPO were to increase the public's understanding of science (81%), provide accurate information (59%), focus attention on environmental issues (59%) and increase the public's appreciation of science (56%). The greatest barriers to getting involved in public education were lack of time (77%) and financial resources (52%).
- We asked members to respond to a list of resources or training ASLO could offer that would assist them with EPO. Top responses included an education listserv focused on funding for education/outreach (36%), orientation to inquiry and hands-on science (36%), and understanding the effective use of models/demonstrations (34%).

The informal education committee will continue to analyze these data to encourage and support ASLO scientists' involvement in public education. The committee strives to provide members with information on effective practices for public education, especially developing and delivering websites/web products, making public presentations and contributing to teacher professional development. Finally, we hope to continue to provide members with opportunities to interact with science educators to develop educational programs and materials.

## L&O FEATURED ARTICLE

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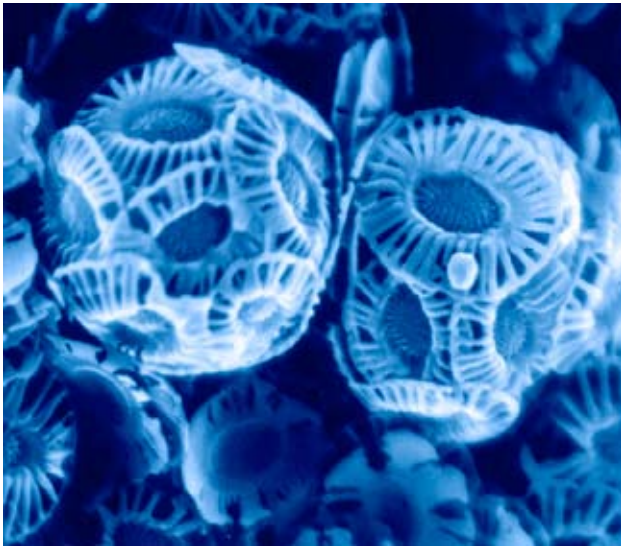
Beginning with the May 1999 issue of *Limnology and Oceanography*, selected articles have been made freely available for reading or download on the L&O Website a few weeks in advance of when the printed issue is mailed. Featured Articles receive no special attention in the printed issue. A paper may be featured for different reasons (e.g., to draw attention to an exceptional piece of research or to promote an area of research that the Associate Editor feels L&O readers should be more aware of). Each Featured Article is announced in the *Bulletin*, as well as to the LO-Feature Mailing List, and is accompanied by an introduction to the article by the Associate Editor who handled the paper discussing its significance.

The Featured Article, L&O Issue 5, Volume 53, 2008 is:

**Preferential grazing of *Oxyrrhis marina* on virus infected *Emiliania huxleyi* by Claire Evans and William H. Wilson. *Limnol. Oceanogr.* 53(5): 2035-2040.**

This article may be read online at: [http://aslo.org/lo/toc/vol\\_53/issue\\_5/2035.pdf](http://aslo.org/lo/toc/vol_53/issue_5/2035.pdf)

*Introductory comments by the Michael R. Landry (L&O Associate Editor):*



SEM image of virus infected *Emiliania huxleyi* (image by W. H. Wilson).

This month's L&O feature article by Evans and Wilson should capture the imaginations of laboratory experimentalists, plankton field ecologists, and biogeochemical modelers alike. It relates to our evolving understanding of the primary fates of phytoplankton in aquatic systems, i.e., the ways in which they die. In the oceans at least, phytoplankton mortality was initially thought to result almost entirely from the feeding of large metazooplankton (Steele 1974). We now recognize, of course, the importance of alternate fates—microzooplankton grazing (Calbet and Landry 2004), direct sinking (Billett et al. 1983), and cell lysis (Bratbak et al. 1993)—and to each we assign substantially different implications for elemental cycling, trophic transfer, and export processes. Field research has tended to view these mortality mechanisms as competing “either-or” propositions, the sum of the independently measured components of which should add up to the whole. They may however be inter-related and difficult to separate as to cause and effect.

In a simple yet effective laboratory study, Evans and Wilson have shown for the first time that virus-infected phytoplankton cells can be grazed preferentially by phagotrophic protists. Via this cropping, production that would have been released to the dissolved organic pool of the upper ocean via the viral shunt (Wilhelm and Suttle 1999) is channeled elsewhere to higher trophic levels and/or other uses. The mechanisms by which this twist of fate occurs—whether by increased size of infected cells, by modified cell surface chemistry or by release of small molecular signaling chemicals—remain speculative at present, but are sure to be the focus of interesting future research, as is also the more difficult task of documenting the relative importance of this phenomenon in natural systems. Still, it is intriguing to speculate on the possibility that the last actions (or strategy?) of a stricken cell may be to invite its consumers to clear it and a concentrated patch of its pathogens from the water. Now, that's payback!

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## OUTSTANDING L&O REVIEWERS

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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 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 these two outstanding scientists.



### DAVID BURDIGE

David J. Burdige is a professor and eminent scholar in the Department of Ocean, Earth, and Atmospheric Sciences at Old Dominion University, where he has been a faculty member since 1985. His research interests are broadly in marine

biogeochemistry, and he has spent much of his career studying biogeochemical processes in marine and estuarine sediments and their resulting effects on the cycling of carbon, nitrogen, and trace metals such as iron, manganese and copper. He also recently authored the book *Geochemistry of Marine Sediments* (Princeton Univ. Press, 2006).



### JOHN MELACK

John M. Melack is Professor and Associate Dean of the Bren School of Environmental Science and Management, and Professor in the Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara.

He has a B.A. from Cornell University and Ph.D. from Duke University. He is a Fellow of the American Association for the Advancement of Science, a U.S. representative to the International Society of Limnology, past President of the International Society of Salt Lake Research and is a member of Science Steering Committee for the Large Scale Biosphere-Atmosphere Experiment in Amazonia. His research has emphasized ecological processes in lakes, wetlands and streams, and hydrological and biogeochemical aspects of catchments. He has conducted multi-year studies in eastern Africa on saline and freshwater lakes, in tropical South America on floodplains, and in California on Mono Lake, high-elevation lakes and catchments, and coastal streams.

## GETTING TO KNOW YOUR L&O METHODS ASSOCIATE EDITORS

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The next time that you browse an issue of *L&O* or *L&O Methods*, we hope that you will take a moment to peruse the list of Associate Editors (AE) on the inside of the *L&O* front cover and on the *L&O: Methods* website ([www.aslo.org/lomethods/](http://www.aslo.org/lomethods/)). These are the people whose hard work determines what is published in *L&O* and *L&O: Methods*. ASLO acknowledges the important work that these people do for the society; AE's 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. For *L&O*, the AE's final job is to edit accepted manuscripts, suggesting wording and organizational changes to improve clarity. The *L&O: Methods* AE's often undertake this task as well, completing a thorough additional review focusing on improving the presentation of the authors' work.

*L&O* and *L&O Methods* 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. *L&O: Methods* is only in its 6th year of publication and is already ranked #3 of 17 limnology journals and #6 of 48 oceanography journals, in large part thanks to the dedicated efforts of its Associate Editors.



### ELIZABETH MINOR

Elizabeth Minor is an associate professor at the Large Lakes Observatory and the Department of Chemistry and Biochemistry at the University of Minnesota Duluth (Duluth, MN, USA).

Her research group studies natural organic matter (NOM) in lakes and oceans and their tributaries in order to understand how NOM structure affects its reactivity and ultimate fate. Approaches used include bulk and molecular-level characterization techniques (chromatography, mass spectrometry, FTIR, optical measurements) as well as the application of natural carbon isotopes (<sup>13</sup>C and <sup>14</sup>C) to constrain aquatic organic matter cycling. As an AE for *L&O: Methods*, she handles manuscripts

involving optical studies of organic matter, biomarker approaches, and molecular-level characterization of particulate and dissolved organic matter.



### DAVID THISTLE

David Thistle is a professor of oceanography at Florida State University. Trained as a deep-sea ecologist by Robert R. Hessler at Scripps Institution of Oceanography, Thistle's research in the deep sea has focused on the roles in community organization of biologically produced structures, disturbances caused by deep-sea storms, large epifauna,

and carbon dioxide sequestration. In shallow water, he has studied the importance of natural disturbances (e.g., ray pits, winter storms) and of the emergence of benthic animals. At present, Thistle is investigating range sizes of deep-sea species because substantial disagreement exists in the literature and the issue is fundamental to how deep-sea communities should be conceived. He has just returned from a cruise along the west coast of the US during which I collected along the 2700-m and the 3700-m isobaths. He will group the harpacticoid copepod individuals from these samples into nominal species based on morphological characters and then test the proposed groupings by comparing cytochrome *b* sequences among individuals. The maximum geographic separation among individuals that are found to be conspecific will provide an estimate of the minimum size of the species' range. For *L&O: Methods*, Thistle handles manuscripts that propose new methods in benthic ecology. The range of topics has been large and has included things as disparate as techniques for image analysis of specimens and the use of remotely operated vehicles for behavioral observations.

## ASLO 2009 AWARDS

### DISTINGUISHED SERVICE AWARD TO PAUL KEMP AND SUE FENG

Cited by **Peter Jumars**, School of Marine Sciences, University of Maine, Orono, ME 04469-5706; [jumars@maine.edu](mailto:jumars@maine.edu)



Perhaps few other readers are left who recall when ASLO was proud of its traditions of first-rate meetings, scholarly publication (singular) in the only true (cellulosic)

medium and devotion to King Ned Ludd. In late 1994, Sue Weiler, Executive Director of ASLO, planted the seeds of revolution by issuing a request in the paper version of this Bulletin to develop an ASLO home page in Mosaic, the

first "browser" software, itself introduced only a year earlier. In response to her call, in rode three other revolutionaries. ASLO's first website was a collaboration among David M. Anderson of NOAA, Boulder (website host), Alan Schussman, student at Whitman College, and Paul Kemp, Research Oceanographer at Brookhaven National Laboratory (authors of the web pages). Paul Kemp became webmaster in 1995, assisted initially by Alan Schussman. Since that beginning, ASLO has been near the cutting edge of web functionality and web publishing. It was the second scientific society in the world, for example, to implement an author-pays system for free access publication (FAP in ASLO's terminology). Issue 1 of Volume 1 of *L&O* (with all subsequent volumes) has been available electronically for a long time, first as part of a CD-ROM set and more recently online. ASLO's electronic dissemination of its publications was so advanced that bundling consortia such as BioOne and GeoScienceWorld, and even JSTOR found that they had relatively little to offer to ASLO. The website's fourth major makeover was completed in 2007 to allow multiple levels of personalized access.

Although we all saw these major milestones, I did not realize how much else Paul did until I rejoined the ASLO Board as President Elect in 2000. Part of that realization stemmed from comparing ASLO web services with those of the 65 or so other members of the Council of Scientific Society Presidents (CSSP). I honestly could not identify another society in our size category that had a more effective web presence. It is especially surprising how few societies have a functional, offsite backup of their web resources. The other service that I came to appreciate was Paul's contribution of long-term memory and calming stability to the ASLO Board, where he has served *ex officio* as Web Editor since 1995 and as Editor-in-Chief of *L&O: Methods* since 2002. Paul could not have contributed more had he been an elected member. No current staff or elected member has served ASLO longer. Because routine matters whose Board consideration was mandated by ASLO bylaws were occupying much of valuable Board meeting time, I asked Paul to devise a threaded electronic discussion and voting medium that followed Robert's Rules of Order, dubbed "e-Motion." It was functional in no time. Not until 2002 did I recognize how they did so much, i.e., that the workload was shared with Susana Feng, who became Managing Editor of *L&O: Methods* in 2002. Paul and Susana have engineered, intentionally or not, a complete ASLO makeover. No student member of ASLO in the current century can regard ASLO as retro or Luddite. Paul and Susana first envision, then patiently explain to the Board and then effectively implement ASLO's web identity. For their substantial, sustained and forward-looking contributions to every corner of the ASLO mission, Paul Kemp and Susana Feng are the recipients of the ASLO Distinguished Service Award.

## G. EVELYN HUTCHINSON AWARD TO MICHAEL PACE

Cited by **Stephen Carpenter**, *Center for Limnology, University of Wisconsin, Madison, Wisconsin 53706 USA; scarpen@wisc.edu*



The G.E. Hutchinson Award is made each year to a scientist whose work has inspired us and promises future outstanding accomplishments. In view of his excellent contributions to scientific understanding of freshwaters and oceans, and the ongoing impact of his insights, Michael Pace is the premier choice for this award.

After undergraduate training in Biology and English at the University of Virginia, Mike obtained graduate degrees at the University of Georgia with Karen Porter, herself a student of G.E. Hutchinson. Pace's early work compared the trophic ecology and feeding relationships of protozoa, rotifers and crustacean zooplankton. He also worked with Larry Pomeroy on a modeling analysis of coastal marine food webs. The papers from Georgia foreshadow Mike's future work. He writes with clarity and precision (perhaps a legacy of his early training in English). He addresses the role of animal body size in ecosystem phenomena. The papers integrate field observations with complex concepts, and reveal interests that span freshwaters and oceans.

By the early 1980s, limnologists were comparing the roles of external drivers and internal processes in lake characteristics. Mike addressed this issue by analyzing a diverse set of lakes during a postdoc at McGill University with Jacob Kalf. In a prescient paper in *CJFAS* in 1984, Pace showed that zooplankton body size, but not biomass, could explain deviations of lakes from phosphorus-chlorophyll regressions. His findings helped explain how primary producers could be regulated jointly by nutrients and grazing.

At the University of Hawaii (1983-1985), Mike continued his pioneering work on the role of protozoa in aquatic food webs – a topic that became one of the key insights for understanding how the microbial loop influences biogeochemical cycles. Pace also developed an empirical model to describe one of the first relationships between primary production and particle export. This relationship, published in *Nature* (1987), is widely cited and still used today for lake and ocean models of vertical flux of particles.

In 1986, Mike moved to the Institute of Ecosystem Studies in Millbrook, New York. There he continued his work on biogeochemical consequences of microbial processes, and the effects of metazoan food webs on microbes. He collaborated on comparative studies of microbial production in freshwater and marine environments, relationships of primary producers and consumers in aquatic and terrestrial environments, and trophic cascades across a wide variety of ecosystems. Mike added more ecosystems to his life list, with projects on the Hudson River and experimental lakes near the Wisconsin-Michigan border. Whole-lake experiments became an important tool for his research on microbial dynamics and trophic cascades.

By the late 1990s Pace was looking well beyond the shoreline to understand ecosystem processes in lakes. He

expanded the scope of his work to include terrestrial controls of organic carbon dynamics in Adirondack lakes. Mike was a leader of whole-lake stable-isotope enrichment experiments to evaluate the uses of terrestrial and lake-derived organic carbon by lake food webs. Pace circled back to the University of Virginia as a Professor in 2007. He continues to work on land-water interactions and the role of food webs in ecosystems, while expanding his horizons as an educator.

By all conventional measures of citation, publication and leadership, Mike Pace has made outstanding and sustained contributions to science. Yet his colleagues praise him most for attributes that are not measurable by statistics. In a field that is frequently contentious, Mike is open-minded and never dogmatic. Although he is a brilliant conceptual thinker, Mike grounds his papers carefully in observed patterns of nature. He is a generous collaborator. One correspondent noted that "Adding Mike to a team always makes it better". And he is a fine teacher. Each spring as we prepare for another field season in northern Wisconsin, we look forward to the next big question that Mike will pose on the porch of the cabin as dusk falls over the lake. Whatever it is, it will evoke intriguing discussion and debate. Such conversations do more than just facilitate science; they are the heart of science itself. For his ability to raise the level of scientific conversation, and his many more tangible accomplishments, Mike Pace is an exemplary winner of the Hutchinson award.

## RUTH PATRICK AWARD TO RICHARD W. BATTARBEE

Cited by **John P. Smol**, *Paleoecological Environmental Assessment and Research Lab (PEARL), Dept. Biology, Queen's University, Kingston, Ontario, Canada; smolj@queensu.ca*



Professor Richard Battarbee has made outstanding contributions to the reconstruction of environmental changes from biological and chemical records in dated lake sediments. He has played a pivotal role in the development of diatom microfossils as a principal paleolimnological tool, and pioneered the application of several techniques (e.g. transfer functions, dating by  $^{210}\text{Pb}$ ), now in common use in assessing the environmental status of lakes. These approaches have become critical tools for lake managers and policy makers. Rick has built up a research group (the Environmental Change Research Centre at University College London) of world renown, dedicated to the analysis of long-term limnological trends associated with atmospheric acid deposition, nutrient enrichment, climate change, and other environmental stressors. Its success stems from the imaginative use of multiple approaches at geographically widespread sites, and Battarbee's exceptional ability to synthesize the evidence obtained from these data.

Rick's research prowess in applying paleolimnological approaches to study environmental change has previously been recognized by several awards. For example, in 1989 he was awarded the Royal Geographical Society Back Award for his

acid rain research. Reflecting his international influence, he was elected as a Foreign Member, Norwegian Academy of Science and Letters (1991), presented with the Rector's Guest and Research Medal of the University of Helsinki (1994), Medal of Moscow State University (1995), and was made an honorary professor of geography at the University of Nanjing (China) in 2002. Queen Elizabeth II recognized him as a Pioneer of the Nation for his work on helping solve aquatic problems using paleolimnological approaches. In 2006, he was elected a Fellow of the Royal Society (London). Battarbee was the Chairman of the ESF Programme "Holocene Climate Variability (HOLIVAR)" and the leader of the PAGES-IGBP Programme "Human Impact on Lake Ecosystems (LIMPACS)". He was also a member of the PAGES-IGBP International Steering and Executive Committees and the Royal Society UK IGBP committee, and was an Associate Editor of the *Journal of Paleolimnology*. Not surprisingly, Prof Battarbee was elected (by acclamation) the first Chair of the International Paleolimnology Association (IPA).

Battarbee has published over 200 scientific papers and reports. His contributions have been wide-ranging, but generally can be categorized as the development and application of paleolimnological approaches to address issues of major societal concern related to the status of aquatic ecosystems, especially problems of acidification, eutrophication, salinisation and, more recently, climate change.

Rick's single most important contribution has been to surface water acidification research. In the 1980s surface water acidification was the most controversial environmental issues facing Europe and North America. His pioneering work using diatom-pH transfer functions and related techniques led to the definitive evidence that lake acidification was a problem not only in Sweden and Norway but also in the UK. For Battarbee's role in this work he was honoured by the Norwegian Academy of Science and Letters in 1991. His work in this area has continued unabated with the development of methods to set critical loads for air pollutants as well as the development and application of techniques to track recovery in freshwater ecosystems that is now occurring. Rick's recent work is concerned with the extent to which projected climate change might deflect the recovery process. Throughout the last 20 years Battarbee has acted as an adviser to the UK Government on acid rain policy.

Battarbee has also used these novel approaches to address other water quality issues. He and his team have also used paleolimnological methods to evaluate pollution trends in Lake Baikal, in European mountain lakes, and in Chinese lakes in the Yangtze region and on the Tibetan Plateau, to name just a few projects.

Rick Battarbee is an international leader in the field of environmental science and has spearheaded many of the paleolimnological approaches currently used around the world to provide many critical perspectives for understanding the effects of human impacts on aquatic ecosystems. As Dr Ruth Patrick was a pioneer in the use of diatoms as biomonitors of water quality, it seems especially appropriate for Rick to receive this award.

## ALFRED C. REDFIELD AWARD TO PETER J. WILLIAMS

*Cited by Paul del Giorgio, Microbial Ecology and Ecosystem Function, GRIL-UQAM, del\_giorgio.paul@uqam.ca*



Since publishing his first paper in oceanography (1968) and throughout his extensive career spanning over 40 years, Peter Williams has carried out research in the interface between oceanography, biogeochemistry and ecology, focusing on the role of dissolved organic matter and microbial communities in aquatic ecosystems. The starting point of his scientific interests was rather unusual, in that he carried out his Ph.D. research on the microbiology of brewing, which probably triggered his interest on the interactions between microbes and dissolved organic matter. His passion for aquatic microbes and organic matter only grew stronger thereafter, spilling over to the oceans, and has continued ever since. His interest in beer and other high-DOC liquids has never gone away either.

His background in industrial microbiology provided him with new tools, techniques and concepts that eventually resulted in a major advance in our understanding of the nature, use and role of dissolved organic matter in aquatic ecosystems, its utilization by bacteria, and the role of microbes in oceanic carbon cycles. His interest in aquatic carbon cycling led him to focus his research on planktonic primary production and to an early realization of the importance of respiration measurements, and thus for the need of improved methods to quantify these processes in marine systems. Peter's research yielded major contributions, such as the development of high-precision techniques for the measurement of dissolved oxygen concentrations, resolving the nature and dynamics of dissolved organic matter in ecosystems, evaluating and understanding primary production as derived from both bulk O<sub>2</sub> and tracer (<sup>14</sup>C) techniques, evaluating the importance of respiration rates in aquatic ecosystems, and the examination of patterns in the metabolic balance of oceanic communities. This research has generated a body of knowledge that laid the cornerstone for the investigation of metabolic processes and oxygen dynamics in aquatic ecosystems, with emphasis on those in the ocean, and that provided a basis from which to investigate the role of aquatic ecosystems in the fluxes of oxygen and carbon in the biosphere. These achievements represent the foundations upon which many current major international programs on the ocean's carbon budget were built.

The impact of Peter's achievements is augmented by his dedication to serve the scientific community, as reflected in his service in multiple panels and international committees, including the ASLO Board, ASLO Awards Committee, Planning Committees for ASLO conferences, and third party conferences. His editorial work is also outstanding having co-edited three major books and been editor of a number of journal volumes. In addition, Peter has mentored and supervised a large number graduate students and postdocs, who have themselves become successful members of the scientific community.

Peter has had vigorous scientific debates and discussions on a variety of topics throughout his career, and while he is passionate about his views, he is able to maintain a constructive, balanced and open-minded attitude and to encourage, rather than suppress, discussion and even help direct our arguments. He has demonstrated a remarkable balance between the passion in the pursuit of his ideas, the perspective necessary to evaluate the conflicting views of other scientists, and the need to re-assess his own positions. This, together with his inexhaustible energy, curiosity, self-deprecation, and wit, makes him an excellent role model for young and older scientists alike.

As a celebration of his rich and fruitful academic and scientific career, ASLO has honored Peter leB Williams with this year's Alfred C. Redfield Lifetime Achievement Award, for his outstanding contributions to our understanding of oceanic productivity, carbon cycling and metabolic balance, for his role in shaping current views on the importance of microbial processes in the oceans, and for his relentless dedication to the advancement of aquatic ecology and biogeochemistry. Congratulations Peter!

#### JOHN MARTIN AWARD TO KOEHL & STRICKLER 1981

KOEHL, M. A. R., and J. R. STRICKLER. 1981. Copepod feeding currents: food capture at low Reynolds number. *Limnol. Oceanogr.* 26: 1062-1073.



Copepod feeding was controversial in the late 1970s. Papers appeared with subtitles like “A plea for reason” and “A plea to end the black box approach” (Boyd 1976; Roman

and Rublee 1980). The prevailing opinion was that copepods used their feeding appendages to create swirling currents that brought food particles close enough for capture and that the spacing of small setae on the second maxilla gave it the properties of a sieve, thus determining the sizes of particles that could be strained efficiently from the water (O’Connors et al. 1980). Koehl and Strickler falsified that view, using a combination of observation and modeling, and set copepod feeding studies off in a completely new direction.

The landmark paper demonstrated convincingly that the best way to understand copepod feeding was by combining careful observations using high-speed movies (500 frames/sec) and the application of basic physical scaling using the Reynolds number. In contrast to the prevailing views of copepod feeding, Koehl and Strickler showed that complex movements of a suite of appendages were required to move whole parcels of water, with embedded particles, around and through the second maxilla. A reader of the paper is left with the impression that copepods are capable of relatively sophisticated behaviors for concentrating food from the dilute pelagic environment, and that simple physical principles can

help explain these behaviors. By showing that active behavior was involved in copepod feeding, this paper opened the door to subsequent studies of chemo- and mechanosensation by copepods and a deeper understanding of how interactions between grazer and grazed can structure pelagic food webs.

This paper’s straightforward explanation of the role of viscosity in governing particle motion at very small spatial scales is very readable and has been incorporated into many introductory-level textbooks. Consider this summary, from the abstract: “In the viscous world of a feeding copepod, water flow is laminar, bristled appendages behave as solid paddles rather [than] open rakes, particles can neither be scooped up nor left behind because appendages have thick layers of water adhering to them, and water and particle movement stops immediately when an animal stops beating its appendages”.

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#### RAYMOND L. LINDEMAN AWARD TO ALEXANDRE POULAIN

*Cited by Beatrix Beisner, Département des sciences biologiques, Université du Québec à Montréal (UQAM), CP 8888, Succ. Centre Ville, Montréal, QC, Canada H3C 3P8; beisner.beatrix@uqam.ca*

The winner of the Lindeman award this year (2009) is Alexandre Poulain. Dr. Poulain is currently a postdoctoral fellow at the Massachusetts Institute of Technology. The work discussed in his paper: **Poulain, Alexandre J. et al. Potential for Mercury Reduction by Microbes in the High Arctic, Applied and Environmental Microbiology 73(7):2230-2238** was completed as part of his PhD at the Université de Montréal in Québec, Canada.

Alex Poulain’s article has had a particularly strong impact on our understanding of the impact of pollutants in the supposedly pristine High Arctic. His paper deals with the expression of aquatic bacterial mercury resistance in aquatic polar ecosystems. In remote polar region of the Canadian High Arctic, Poulain found, for the first time, that microbes endemic to coastal and marine environments have the potential to affect the toxicity and environmental mobility of heavy metals such as mercury through the expression of mercury resistance genes. Indeed, the discovery that merA genes, coding for the mercuric reductase, were both present and expressed further suggests that microbes may use a broader range of resistance strategies allowing them to breakdown the neurotoxic MeHg. Microbes therefore would not only affect the pool of methylable inorganic Hg by controlling its evasion but also potentially degrade MeHg and thereby directly affect its levels in Arctic

environments. Using a simple ecosystem model, Poulain and his co-authors suggested that microbes are likely to be key players in Hg recycling, producing up to 90% of the pool of elemental Hg in coastal waters; especially under sea-ice where light is absent most of the year.

From the perspective of Hg risks to marine mammals, fish and humans in the Arctic, this paper clearly demonstrates that microbial communities – which operate in the cold and dark – may offer a key, if not *the* key, to understanding puzzling Hg trends in mammals like belugas. Along with light-driven processes (which operate seasonally), the microbial reduction process is shown to be an important control on Hg speciation, thus setting the stage for the entry of mercury into the foodweb. Mercury trends in the atmosphere and Hg depletion events have not been convincingly connected to levels in aquatic animals – something that these microbial processes may in the end explain. Microbial reduction provides a direct, climate-related control on biological Hg.

Poulain's paper presents a very complete story that makes a convincing case for a new and unexpected mechanism of microbially-mediated mercury reduction in polar regions. The combination of molecular work, fieldwork, and modeling represent a dedicated effort to get a complete story in one, very readable paper. The comments from the nominator make it clear that, despite the long author list, the student was the driving force on the work, which is important in a Lindeman award. Because of climate change and warming in the arctic, and the serious issues of trace metal contamination across the Arctic Sea, this paper is an important one. Comments from the Faculty of 1000, for which this paper was selected, suggests that this paper is already changing our ideas about how mercury gets into the food chain.

## EXCELLENCE IN EDUCATION AWARD TO BENJAMIN CUKER

*Cited by Letise (Houser) LaFeir, National Marine  
Sanctuary Foundation, Silver Spring, Maryland, 20910 USA;  
letise@nmsfocean.org*



Although there are many educators who have demonstrated “excellence in teaching and mentoring,” there is one, Dr. Benjamin Cuker, who has set an extraordinarily high standard for ASLO's first award for Excellence in Education. Teaching and mentoring are critical components to the future of the limnology and oceanography disciplines, and thereby

ASLO, by helping to train a group of knowledgeable, driven, and diverse scientists. Ben has been a leader in this effort, in both formal and informal capacities.

Ben learned the value of dedicated teachers during his high school years in Detroit, MI, and has continued to apply that lesson throughout his career. Since 1988, Ben has served on the faculty in the Department of Marine and Environmental Science at Hampton University (Hampton, VA). He also previously taught at Shaw University (Raleigh, NC) for seven years. He conducts aquatic research, coordinates the graduate

program in Environmental Studies and teaches ecology and marine biology courses at Hampton. His research interests are in estuarine ecology, limnology of turbid systems, benthic ecology and evolutionary ecology of aquatic communities. Beyond his duties as a professor and researcher, he has dedicated much of his career to promoting diversity in the aquatic sciences. Notably, he has created such student-based programs as the ASLO Multicultural Program (ASLOMP), Multicultural Students at Sea Together (MAST), and the Hall-Bonner Program for Minority Doctoral Scholars in the Oceans Sciences.

ASLOMP has been running since 1990, and has helped change the reach of the society and has greatly increased the diversity of limnology and oceanography at large. Due, in part, to the network of support in the program, many participants have gone on to accomplished careers, acting as mentors to other students, and a few have even created programs of their own inspired, no doubt, by the success of Ben's efforts. The second program, MAST, is a hands-on experience in which participants learn to sail and live aboard a vessel, while studying marine science, policy, and the heritage of African Americans and Native Americans on the Chesapeake Bay. Since its inception in 2000, the program has given many students a deeper appreciation for their connection to maritime history, providing a valuable context for their academic pursuits. Finally, the Hall-Bonner Program, which began in 2003, is a more targeted effort to support minority doctoral scholars in the ocean sciences at Old Dominion University and the Virginia Institute of Marine Science. Those students who are selected for the program receive full funding and participate in career enriching activities to supplement their degree. The three initiatives, combined, have resulted in minority students—African American, Hispanic, Native American, Alaskan Native, and Pacific Islander—graduating or expected to graduate with more than 400 bachelor's degrees, 140 master's degrees, and 30 doctorates in marine science or related fields.

Due to his many educational efforts, Ben was given the ASLO Distinguished Service Award in 1993 and named a Pew Fellow in Marine Conservation in 1999 (funded launch of MAST). He has served on many advisory committees (e.g., the Mid-Atlantic Center for Ocean Science Education Excellence/COSEE), has been active on several government and agency panels (e.g., for the National Science Foundation), and has been featured in various articles (e.g., in *The Scientist*). For ASLO, he has been a Member-At-Large on the Executive Board and chaired the Committee on Under-Represented Minorities in Limnology and Oceanography (CURMLO).

Through the courses he has taught, the students he has advised, and the educational programs he has created and directed, Ben has influenced hundreds of students across the nation. Even beyond the students, there are many other scientists and educators who have become colleagues, partners, and avid supporters of Ben's visionary programs and teaching methods. There is no doubt that they would all attest to his worthiness to receive the ASLO Excellence in Education Award, especially in its inaugural year. Ben is an accomplished scientist, a model mentor, and even more, a good person to get to know.

# ASLO MEETING HIGHLIGHTS

## ASLO NICE 2009: THE OCEANOGRAPHIC MUSEUM OF MONACO

*Nadia Ounais, Musée océanographique de Monaco, Avenue Saint-Martin, MC 98000 Monaco; n.ounais@oceanomc*

An impressive white-stone structure overlooking the Mediterranean Sea from a height of 90 meters, the Oceanographic Museum was inaugurated on 29 March 1910 and is the founding work of Prince Albert I of Monaco. Born in 1848, Prince Albert I of Monaco dedicated much of his life to the study of the sea and oceans. After a long period of military and maritime training and several years of travel on the Seven Seas, the Prince embarked on an oceanographic career, encouraged by such scientific personalities as Alphonse Milne-Edwards. Very early, Prince Albert I understood the importance of relationships between living creatures and their environment, the influence of great natural phenomena on life in the oceans and the life cycle. He was also a “father” of the oceanographic science he sought to create. This is why he founded the Institut Océanographique in 1906. The Institut Océanographique, Fondation Albert Ier, Prince de Monaco exercises the activities for which it was founded through two establishments located respectively, in Paris, and in Monaco. While the Paris establishment is oriented essentially towards teaching, the Museum in Monaco is more generally dedicated to public education and research. The library, regularly augmented by new works, offers researchers and the public

a unique collection of oceanographic books and periodicals. The Oceanographic Museum today displays in its exhibition halls and its aquarium the wonders of life in the seas, recent developments and the latest discoveries marking progress in marine biology and oceanography. Its missions are:

- Educating and raising awareness as broadly as possible to the importance of the role of the seas and oceans, emphasizing the key environmental stakes today and cutting-edge scientific developments,
- Hosting researchers from around the globe international and publishing the results of their work,
- Preserving, enriching and enhancing collections to form an exceptionally rich scientific and artistic heritage.

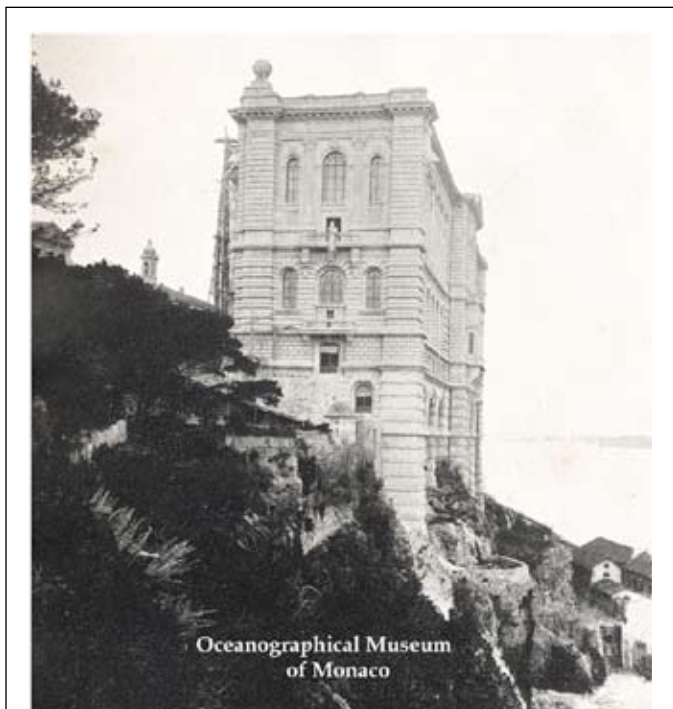
The Oceanographic Museum has several large collections, all relating to the sea. The most important of the Museum’s collections is made up of Natural History samples and specimens collected during the oceanographic voyages of Prince Albert I. The collection includes ten of thousands of specimens including a large number of type specimens. Even today, researchers come to Monaco from all over the world to consult the type specimens in the collection. The Museum also features a large collection of naturalist paintings and drawings, ethnographic artefacts and artworks, models, films and photographs.

The permanent exhibition, “A Sailor’s Career”, presents the work of its Founder. In particular, there is the onboard laboratory of L’Hirondelle, one of Prince Albert I’s ships from which observations were made that led to the discovery – rewarded by a Nobel prize in 1913 to Dr Richer – on the phenomenon of anaphylaxis. Anaphylaxis is a cataclysmic physiological allergic-type phenomenon linked to the specific properties of certain toxins. Thus, anaphylaxis began as an oceanographic discovery!

Other exhibitions, permanent and temporary, present scientific and artistic themes. The latest, “Polar Ice, for future generations...” presently on display at the Oceanographic Museum, is a genuine manifesto. It takes visitors deep into the polar world, with its wealth and fragility, asking the essential question: “what will remain of our planet for future generations?” Thus, the Oceanographic Museum of Monaco brings together Art and Science in a single venue to give them their true dimension: that of life, expressed in one Europe’s finest and oldest aquariums.

The Aquarium displays over 6,000 specimens belonging to 400 fish species and 200 invertebrate species from the Mediterranean and tropical seas. These animals are shown in their magnificently recreated natural settings. This absolutely unique presentation is made possible thanks to highly sophisticated techniques based on the implementation of natural ecological processes. Living coral reefs are this Aquarium’s great originality, with 90 tanks reconstructing the true image of the different marine ecosystems as they exist in the wild.

The Aquarium of Monaco has always been a pioneer in the display and maintenance of live corals.



A view of the Oceanographic Museum before its inauguration. Image from the ASLO Image Library. Base image scanned from a photo in: Kofoid, C.A. 1910. ‘The Biological Stations of Europe’ US Bureau of Education Bulletin No. 4.

Today, the techniques developed by the Aquarium team have led to reproducing over 70 species of hard coral in the coral farm located in the Museum's underground floors, thereby reducing the need to collect samples in the wild and even opening up the possibility of restocking in depleted areas. The reef ecosystems reconstructed in aquaria are natural laboratories in which a range of different studies can be carried out by the Museum itself or affiliated independent laboratories like the Scientific Centre of Monaco (see the article in this issue). Work is carried out on hard coral ecophysiology, notably calcification, photosynthesis, respiration and response to ultraviolet radiation.

Coral ecosystems, especially when they are well stocked and vibrant with a rich and colorful fauna, have a powerful impact on the public. The majority of visitors are overwhelmed by an emotion that encourages a willingness to observe and understand. Special emphasis is placed on threats to these ecosystems (acidification of the oceans, rise in sea level, increase in seawater temperature) and on the need for citizens to adopt a conservation ethic. Reconstructed biotopes provide reef-dwelling species with ideal living conditions. Many invertebrates and fishes reproduce regularly in these aquaria and many species are raised in captivity using state-of-the-art techniques derived directly from aquaculture; they include such threatened species as seahorses and the Banggai cardinal fish.

We hope to see ASLO conference attendees; the Oceanographic Museum in Monaco is a short train (15 min) or bus trip (30 min) from Nice!

Further info: [http://www.oceano.mc/anglais/sommaireinfos\\_anglais.htm](http://www.oceano.mc/anglais/sommaireinfos_anglais.htm)

### **ASLO NICE 2009: THE SCIENTIFIC CENTER OF MONACO**

**Denis Allemand**, *Centre Scientifique de Monaco, Avenue Saint-Martin, MC 98000 Monaco; allemand@centrescientifique.mc*

The *Centre Scientifique de Monaco* (CSM) is a cutting-edge laboratory committed to fundamental research. It is a Monegasque government laboratory founded in 1960 by Prince Rainier III. Scientific research in Monaco has been a tradition for over a century. It began with Prince Albert I, born 161 years ago. He explained his commitment and passion for Sciences in these terms:

*“I would very much have liked to be able, by broadening for you the horizon of oceanographic studies, to succeed in showing you that marine areas, far vaster than areas on land, comprise countless subjects for study from which biologists and after them, philosophers, would find material and intellectual riches for humanity”* (Bulletin du Musée Océanographique, 1905, N° 56, page 13).

For 20 years the CSM has undertaken world renowned research in the biology of tropical and Mediterranean coral ecosystems in relation with global climate change. Its originality lies in the development of coral cultures in controlled

conditions, and in the development of an integrated research program, spanning the molecular and cellular level to the scale of the organism and ecosystem by two complementary research teams; Physiology-Biochemistry (directed by Dr Sylvie Tambutté) and Ecophysiology-Ecology (directed by Dr Christine Ferrier-Pagès). The permanent staff numbers 15 scientists and technicians. Studies are conducted in the laboratory and in the field using ultramodern methods in ecology, biochemistry and molecular biology.

Coralligenous assemblages in the Mediterranean and coral reefs in tropical environments, both play a key role in the equilibrium of the planet and in the maintenance of marine biodiversity. Coral reefs can be considered as oases of diversity in the oceans: occupying less than 0.2% of the oceans' surface area, they present more than 30% of the marine fauna known to date! They precipitate nearly half of the calcium carbonate on the surface of the Earth, thereby playing an essential role in the carbon dioxide cycle. They protect the coasts from erosion and provide an economic resource vital to human populations. Coralligenous assemblages are also home to a wide species diversity and attract divers, for their landscape and heritage value. Unfortunately, these ecosystems are under serious threat: massive mortality in the Mediterranean and bleaching in the tropics has led to unparalleled reduction of these organisms on a global scale, which should alert us on the drastic effects of climate change on marine ecosystems.

It is with this perspective, that marine biomineralization and symbiosis, the key biological processes in these ecosystems, are particular foci at the CSM, approached with different complementary methods of study.

**Biom mineralization** is the biological process through which living organisms transform ions in solution into highly organized mineral structures, biominerals. Corals are the major builders on Earth with 2000 km-long reef formations but current changes in ocean chemistry greatly affect this process. Biominerals are composite materials with both an inorganic and an organic fraction. The organic fraction, which is poorly known, is composed of a framework of organic macromolecules, called the organic matrix, which controls the shape and mineralogy of the inorganic fraction.

We study Biom mineralization using several approaches: i) physiological methods such as radiotracers for both ions and organic molecules, ii) histological methods using both light and electron microscopy, confocal microscopy and



Corals are cultured under controlled conditions at the Scientific Center (image by E. Tambutté).

immunohistochemistry, iii) biochemical and immunological methods to characterize the organic fraction, and iv) molecular methods to identify genes involved in the biomineralization process.

Understanding biomineralization mechanisms is essential for several applications. Coral skeletons are indeed widely used as environmental archives for reconstruction of past climate (palaeoclimatology), but the “vital effect” imposed by biological activities of corals make the signal difficult to interpret. In order to improve the reading of skeletal paleomarkers, we are making “Experimental Paleoclimatology” by incubating corals growing on glass slides in controlled conditions. This allows accurate calibration of markers versus environmental parameters (temperature, CO<sub>2</sub>, light, nutritional status, seawater composition...) which will improve the use of coral skeletons in geochemistry and paleoclimatology. Coral skeletons are also used as bio-implants in bone surgery and dentistry. Our results show that coral may contain important macromolecules, which may act on osteoblasts after implantation. Finally, perhaps the most important aspect of our work is to further understanding of how changes in environmental parameters will affect coral growth and calcification. We were the first to demonstrate that increase in CO<sub>2</sub> concentration and temperature may act synergistically, increasing effects and we recently proposed some physiological explanations of the sensitivity of calcification to CO<sub>2</sub> increase and extended our studies to temperate corals.

**Symbiosis** is another key biological process underpinning the success of corals and their development in oligotrophic

tropical waters. Indeed, corals, like many other Cnidarians, have the peculiarity of “culturing” unicellular algae inside their cells. These symbiotic algae, through photosynthesis, make corals potentially independent of heterotrophic nutrition. We have demonstrated that the coral host, unlike “standard” animals, absorbs and concentrates CO<sub>2</sub> to allow photosynthesis of its symbionts, thus allowing the coral to regulate photosynthesis of its endosymbiotic partner. Corals are also able to absorb inorganic as well as organic nitrogen compounds. In order to ensure photosynthesis of their symbionts, corals are restricted to the upper level of the sea, thereby exposing them to the sun’s rays and oxygen radicals, which are potentially damaging to host cells. However, the algal symbionts protect corals from ‘sunburn’ and oxidative stress by producing substances of pharmaceutical value for humans. The coral host conserves its capacity to feed heterotrophically and we have found that coral feeding greatly enhances photosynthetic and calcification rates.

For further information and a complete bibliography of publications: [www.centrescientifique.mc](http://www.centrescientifique.mc)

## ASLO MEMBER NEWS

### ROGER FRANCOIS RECEIVES 2008 A.G. HUNTSMAN AWARD



The Huntsman Foundation has selected Dr. Roger Francois as the winner of the 2008 A.G. Huntsman Award for his groundbreaking research and leadership in marine geochemistry. The medal was presented to Dr. Francois Thursday November 27 at the Bedford Institute of Oceanography, Halifax, Nova Scotia.

Francois holds a Canada Research Chair in the Department of Earth and Ocean Sciences, University of British Columbia. He obtained his Ph.D. from the University of British Columbia in 1987 and spent the subsequent fifteen years of his career at the Department of Marine Chemistry and Geochemistry at the Woods Hole Oceanographic Institution, where he is still an adjunct scientist. He has been actively involved in large international programs with a biogeochemical focus, such as JGOFS and GEOTRACES.

Francois’ research is centered at the intersection of physical, chemical and biological processes and has influenced our understanding of climate-related changes in ocean circulation and ocean chemistry. His research has focused partly on the global carbon, nitrogen and silica cycles (past and present), and more recently on the global biogeochemical cycling of metals. He has been particularly innovative in applying novel techniques to address processes that have occurred in the past million years. Specifically, he has developed the use of light stable isotopes for understanding algal production and nutrient cycling in the ocean, and for determining past changes in water column stratification. Additionally, he has developed tracers that have paved the way



A coral microcolony of *Galaxea fascicularis*, a model coral used at the Scientific Center (image by E. Tambutti).

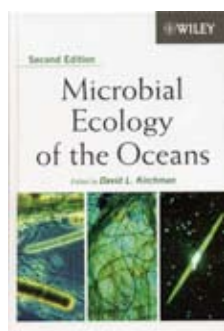
for the reconstruction of past ocean circulation and its impact on global climate and his innovative techniques for measuring sedimentation processes are being used to explore the history of sediment burial. Dr. Francois is internationally renowned for his deeply insightful research in marine biogeochemistry, his innovative skill in data acquisition and analysis, and his interpretation of the complex behaviour of the ocean–atmosphere system over long-term climatic timescales.

Have you or a colleague recently received an award or prestigious appointment? Send your news to [bulletin-editors@aslo.org](mailto:bulletin-editors@aslo.org).

## BOOK REVIEWS

DAVID L. KIRCHMAN (EDS). 2008. **Microbial Ecology of the Oceans, 2nd Edition**. Edited by David L. Kirchman Wiley. ISBN: 978-0-470-04344-8. 594 p. US\$99.95

Reviewed by **Hugh Ducklow**, *The Ecosystem Center, Marine Biological Laboratory, 7 MBL Street, Woods Hole MA 02543, USA; [hducklow@mbl.edu](mailto:hducklow@mbl.edu)*



I have to confess a colossal error in judgment. Back in 1999 when Dave Kirchman invited me to contribute a chapter to the first edition of *Microbial Ecology of the Oceans* (Kirchman 2001), I thought to myself, and may even have told Dave, the last thing we need is yet another compilation of articles on various topics in marine microbial ecology. I was so wrong. The first edition of Kirchman's book was a landmark event in our field.

Many different criteria signal the maturation of scientific fields: a critical mass of scientists and students sharing a governing paradigm, a large and diverse funding base, publication of key papers in *Science* and *Nature*, growth of citation networks, recognition by colleagues in other fields, prize juries and so on. But perhaps none of these encapsulates the status and maturity of a field so much as a textbook that sets out a coherent viewpoint, recruits and trains new scientists and identifies new directions. Coming about twenty five years after the initial explosion of discoveries in marine microbiology, *Microbial Ecology of the Oceans* did this. Now, a scant ten years later we have the second edition. The field has arguably grown more in this period than in its whole history up to 2001, and the new book outshines the original accordingly.

Like its predecessor, the new edition mixes insightful treatments of traditional topics (e.g., bottom-up and top-down controls on microbial growth and respiration by resources, predators and viruses; nitrogen cycling, organic matter) with path-breaking reviews of relatively new areas such as community structure, metagenomics, single-cell activities and picoeukaryotes. Comparison with the first edition shows the dramatic impacts wrought in our field by genomic concepts and methods. The first edition was mostly traditional in focus,

but notably did include a chapter by Giovannoni on the evolution and diversity of marine prokaryotes and several other chapters contained brief surveys of taxonomic or genomic findings. In contrast, in this new edition, virtually every chapter has a section or more on new knowledge obtained through genomic approaches. We learn for example about the revised taxonomies and phylogenies of *Bacteria*, *Archaea* and *Eukarya*, protists, bacteriophages, picoeukaryotes (autotrophic and heterotrophic), photoheterotrophs and diazotrophs. Moreover, through explicit or implicit discussions in several chapters, we begin to see the outlines of a new research area.

We are on the brink of being able to combine bulk methods of measuring microbial activities with new cell-specific, genomic and metagenomic approaches to localize the activity of specific microbial phylotypes and individual cells in time and space. This is experimental microbial community ecology, in which we can start to identify the environmental, biotic and population dynamic factors influencing microbial community structure and its spatial and temporal patterns. As a result too, of knowledge gained through the union of old and new approaches as reviewed in this book, we can at last lay to rest the “great plate count anomaly” describing the discrepancy between direct counts and plate counts of bacteria in seawater. This problem was first defined half a century ago in *Limnology and Oceanography* by Jannasch and Jones (1959), well before the advent of epifluorescence microscopy.

As noted above, textbooks legitimize paradigms, so it is interesting to summarize the state of understanding before Kirchman's first edition with that emerging today following the second. Before the 1990's we could culture and thus identify about 1% of the bacteria in the sea and had not yet heard of archaea. *Prochlorococcus*, the most abundant autotroph on the planet, had just been discovered with flow cytometry. A varying fraction of bacteria was ‘viable’ but unculturable (i.e., on agar plates) because they were stressed or damaged; and they were small because they were starved and shrunken. Nonetheless the bacteria that were active constituted an important and no longer controversial share of the marine carbon cycle, metabolizing about 50% of the oceanic primary production. The allocation between growth and respiration was poorly defined. The controls on the activity were becoming clearer, but without better insight going beyond bulk approaches we lacked useful resolution and true mechanistic understanding of microbial dynamics.

Today, in contrast, and as reported in the two books by Kirchman and his team of experts, we have a much finer and at the same time more comprehensive and ecumenical understanding. We know the outlines, and in many cases the details of taxonomy of all major microbial groups and their probable evolutionary relationships. More bacteria in several new taxonomic groups can be grown and studied in the lab. Bacterial communities are dynamic, with species successions, large-scale geographic patterns and shifting balances among highly active and less active cells, inactive, apparently dormant and dead cells. We know vastly more about the distribution of various capabilities in microbial groups through

genomic surveys. Some genes are found in a few specialized groups (e.g., nitrification and N-fixation) whereas others are widespread as results of multiple evolutionary events and lateral gene exchanges. Such widely distributed capabilities include photoheterotrophy and other kinds of mixotrophy which are found in many distantly related groups, especially in oligotrophic oceans. Marine microbes are the extreme examples in the tree of life of the hedgehog (knowing one great thing) and fox (knowing many things) strategies of being (Berlin, 1953).

The new book contains several useful features. Besides being profusely well-illustrated with about ten figures and tables per chapter, there are text boxes defining or elaborating key terms and concepts and numbered summaries of each chapter. Several, though not all, chapters have concluding forward-looking sections. Several chapters have in-depth analyses of new and publically-accessible databases compiled specifically for this book. Each chapter is 25-35 pages long (exclusive of references) and most can be read in a sitting. Each chapter has a long and comprehensive list of references. Coverage naturally emphasizes newer developments but some chapters have impressive historical treatments too.

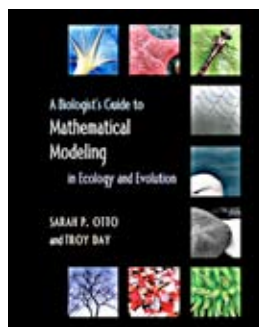
We look forward to the third edition, when you will again hear microbial ecologists and other oceanographers say “The new Kirchman is out,” or in answer to a student’s question, “Go look in Kirchman!”

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**SARAH P. OTTO AND T. DAY. 2007. A Biologists Guide to Mathematical Modeling in Ecology and Evolution.** Princeton University Press, ISBN13: 978-0-691-12344-8 (hardcover) 752p. US\$65.00

Reviewed by **Edward Laws**, School of the Coast and Environment, Louisiana State University, Baton Rouge, LA 70803, USA; edlaws@lsu.edu



Authors Sarah Otto and Troy Day have courageously written a 700-page text on mathematics for biologists. The authors seem aware that mathematics is not the long suit of many biologists, although they do assume knowledge of elementary algebra and calculus. However, they have included chapters that introduce important concepts and methods in matrix algebra and probability theory

on the assumption that these are not in the toolbox of most biologists.

The good news is that this book is very well written. The authors have clearly made an effort to present material in a didactic manner. The text is supplemented with five appendices and three primers that are intended to make the remainder of the text more comprehensible. In the Preface, the authors comment, “For courses in mathematical modeling, we expect it would take a full year to cover all of the material of the text.” I found this comment revealing, because it suggests that the authors have never tried to use the book to teach a full-year course on mathematical modeling.

In my opinion, there is no way that a class of even very bright graduate students could get through the material in this book in one school year, and certainly not a class of biologists who needed to come up to speed on functions and approximations (primer 1), linear algebra (primer 2), and probability theory (primer 3). Much of the material presented in chapters 7-15, including (1) equilibria and stability analysis, (2) dynamics of class-structured populations and models with periodic behavior, (3) evolutionary invasion analysis, and (4) discrete and continuous stochastic models, are topics that require a considerable amount of class time as well as laboratory time (computer work with relevant software packages) for the concepts and information to sink in. To present much of this material to a class in a way that would be comprehensible to the students would require spending one 50-minute lecture on probably no more than 4-5 pages of text. A conscientious instructor would probably need at least three and probably four semesters to do an effective job of teaching the material in this book.

How many biology graduate students will want to devote four semesters to learning about mathematical modeling? I suspect the answer is practically none. So who is going to buy this book and make full use of it? One could probably get through the first six chapters (250 pages) in one semester. But the remainder, which is most of the book, will require going slowly to take full advantage of the information that is presented and to give that information a chance to sink in. And one cannot pick and choose from selected chapters, because the discussion in the later chapters builds on concepts and information presented in earlier chapters. Clearly much thought and planning has gone into the presentation of material in this book. But only a very dedicated and motivated student will want to put in the time and effort required to go from cover to cover.

This is clearly a book that will be of interest to Ph.D. students studying evolutionary biology. It is a book that they may well want to read from cover to cover as part of their preparation for Ph.D. research. And it will be a good reference for scientists with similar interests. I do not see this book being used by students with a general interest in evolutionary biology. Beyond page 250, it is 450 pages of pretty intense mathematics, and to absorb all the information in those pages is going to take lots of time from a dedicated student. So I imagine the audience will not be large, but for that audience, this is an exceptionally well-organized and well-written book.

**K. SZEROCZYŃSKA, K. AND K. SARMAJA-KORJONEN.** 2007. **Atlas of subfossil Cladocera from Central and Northern Europe.** Publisher: Friends of the Lower Vistula Society. pp 84. ISBN 978-83-924919-6-5. Price 35€ in Europe, 43 € outside Europe. To order: send an email to [aborygeniznadwisly@wp.pl](mailto:aborygeniznadwisly@wp.pl), or [uroczadolina@wp.pl](mailto:uroczadolina@wp.pl)

Reviewed by **Leszek A. Bledzki**, Mount Holyoke College, Department of Biological Sciences & the Center for the Environment, South Hadley, MA 01075, USA; [lbledzki@mholyoke.edu](mailto:lbledzki@mholyoke.edu)



If lakes are archives of Earth's history, then subfossil Cladocera can be thought of as one of the foundations of paleolimnology. Cladocera remains can provide one of the most exciting resources of modern paleolimnology, permitting not only the exploration of past ecological conditions of lakes, but also of local climate change over several thousand years.

The Atlas of subfossil Cladocera presents headshields, shells and postabdomens collected from 404 sites located throughout central and northern Europe. It describes and illustrates 55 species and 19 higher taxons of the most common of the Cladocera species remains preserved in lake sediments. Furthermore, it describes the latest development of the field by presenting the description of ehipia. Additionally, the authors have prepared a detailed description of Cladocera morphology, and laboratory methods, along with the basis of identification and cladoceran analysis. Each of the species described is illustrated using photographs of real remains, showing typical fragments of shells or postabdomens. The Atlas is a valuable addition to a not well-known paper published in Russian by Smirnov (1978). The Smirnov paper, which is rarely found in libraries, provides the key to the identification of Cladocera using only their headshields. The Atlas is divided into 6 chapters: 1. From lake to diagram; 2. List of cladoceran species with described remains; 3. Descriptions of subfossil remains; 4. List of sites where the remains presented were found; 5. References; and finally, 6. Index of Cladocera taxa.

The Atlas is dedicated to the pioneers of Cladocera analysis, namely to the memory of an American - David Frey, Finn - Pentti Ahlonen and Pole - J.S. Mikulski, who was also my mentor. I will always remember when, as a senior limnology student, I had approached Professor Mikulski with the slide of an unknown Cladocera specimen, which no one in the Hydrobiology Department had been able to help me identify. Professor Mikulski examined it using a compound microscope, then covered the slide with another glass slide and then, to my surprise, forcefully pressed the two slides against each other, damaging the only specimen I had! After another look through the microscope, he proudly announced, "Well, it was the *Holopedium gibberum*, but I have never seen the whole specimen before".

It must be stated that while identification of living Cladocera is not an easy task, identification from remains is much more difficult! Now, the authors of the atlas have made

the task easier, providing us with the illustrated description of the Cladocera remains. It is an especially valuable book for less experienced young cladoceran analysts, to whom it is also dedicated. This atlas should be on the shelf of all Cladocera scientists.

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**FRANCK COURCHAMP, LUDEK BEREK, AND JOANNA GASCOIGNE.** 2008. **Allee Effects in Ecology and Conservation.** Oxford University Press. ISBN 978-0-19-857030-1. 256 p. US\$90.00

Reviewed by **Jonathan A.D. Fisher**, Department of Biology, Queen's University, Kingston, Ontario K7L 3N6, Canada; [jonathan.fisher@queensu.ca](mailto:jonathan.fisher@queensu.ca) and **Kenneth T. Frank**, Bedford Institute of Oceanography, Canadian Department of Fisheries and Oceans, Dartmouth, Nova Scotia, B2Y 4A2, Canada; [FrankK@mar.dfo-mpo.gc.ca](mailto:FrankK@mar.dfo-mpo.gc.ca)



"Allee, or not to be, that is the question!"

An 'Allee effect' refers to a decline in fitness of an individual organism caused by declines in population size or density. The name of this phenomenon recognizes the contributions of Warder Clyde Allee, an early 20<sup>th</sup> century American behavioural ecologist who tested the importance of density dependent processes on individual fitness.

Importantly, these effects contrast the long held perspective that decreases in population density lead to higher fitness due to reduced competition. One important implication of an Allee effect is the potential existence of a quantifiable threshold for adult population sizes below which negative fitness consequences would lead to extinction. These effects therefore fit within the growing body of research that acknowledges the roles of positive interactions within and among species. Moreover, as the title of the book suggests, the authors describe Allee effects as highly applicable to conservation issues and, unfortunately, such effects are becoming increasingly apparent given the trend towards widespread population declines. In six chapters, the authors provide a succinct summary of a range of examples, models and implications of Allee effects developed within recent decades. Perhaps of particular interest to readers of *Limnology and Oceanography*, starting with the cover photo of a sardine school avoiding a predatory seal, the examples illustrate the many contributions of aquatic studies (>20% of the volume's

references) to this research field. The authors look ahead towards a continued research focus on deducing the extent of Allee effects on genes, populations and communities and revealing the implications of such effects on the conservation and management of terrestrial and aquatic ecosystems.

In addition to introducing Allee's early works, a main message of Chapter 1 (*What are Allee effects?*) is the distinction made between component Allee effects (components of an individual's fitness) and demographic Allee effects (the sum of an individual's fitness). This division is critical and maintained throughout the remainder of the chapters. The authors further describe and illustrate clearly how a least one component Allee effect must underlie a demographic Allee effect, but the presence of a component effect does not necessarily lead to a demographic effect. In a testament to how rapidly and widely this field has developed, it is notable that a rigorous definition of an Allee effect emerged only within the last decade. Perhaps as a result of this lag, readers are required to navigate a particularly jargon-rich field of biology from parallel developments in this field, a task that is assisted by a collection of terms defined in Box 1.1.

The second chapter (*Mechanisms for Allee effects*) showcases the mechanisms that contribute to component and demographic Allee effects, with a focus on mechanisms that alter reproduction, survival and cooperation with changing population density. This chapter provides examples from a wide taxonomic and geographic range -- plants to ants and many vertebrates, leading to analyses of how multiple Allee effects can interact within species. For example, using Atlantic cod (*Gadus morhua*), the authors illustrate both the multiple potential Allee effects and the difficulties in partitioning cause and effect, even in intensively studied populations.

Chapter 3 (*Population dynamics: modelling demographic and Allee effects*) provides many examples of the utility of modeling approaches to deduce and predict demographic Allee effects. Owing to the widespread application of models, this is the longest chapter (almost 1/3 of the book). However, the authors provide readers with an easy to follow stepwise progression from simple deterministic, individual population models to complex stochastic and stage structured population models and ultimately to models of the influence of Allee effects on community dynamics.

In the fourth chapter (*Genetics and evolution*), the authors provide a view of an emerging subfield of Allee effects, based largely on studies of plant populations. Together with these suggestive patterns and examples from a wider variety of taxa, the authors acknowledge the existence of ample room for future tests to evaluate multiple genetic and evolutionary mechanisms, including inbreeding depression, genetic susceptibility to Allee effects, evolved mechanisms to avoid Allee effects, and Allee effects on selection pressures.

The penultimate chapter (*Conservation and management*) provides a comprehensive synthesis of the dominant issues that underlie much of the recent surge in studies of Allee effects. These topics span the range of applied problems where Allee effects emerge from endangered species

to species invasions and overexploitation to eradication programs. Importantly, the chapter directly addresses detecting Allee effects and provides a view of the implications of these dynamics for the precautionary approach to resource conservation and management.

Finally, Chapter 6 (*Conclusions and perspectives*), among other topics, provides an expanded view of problems associated with demonstrating Allee effects beyond those introduced in the first chapter. This is an important section, as it makes reference to earlier examples but it was surprisingly disconnected from this chapter's predictions for the future of research on Allee effects. For example, assessing the influence of confounding variables appears key to strengthening research in this field of research. In their conclusion, the authors reveal the extent of their enthusiasm and advocacy for research on this topic. Overall the book is quite an excellent summary of the field to date and it provides many ideas for future studies. There is a wide range of examples reviewed with a decent focus on methodological limitations. It was quite refreshing to see the assembly, interpretation and synthesis of such a diverse literature on this important topic of paramount importance to resource conservation.

“A vital addition to the field.”\*



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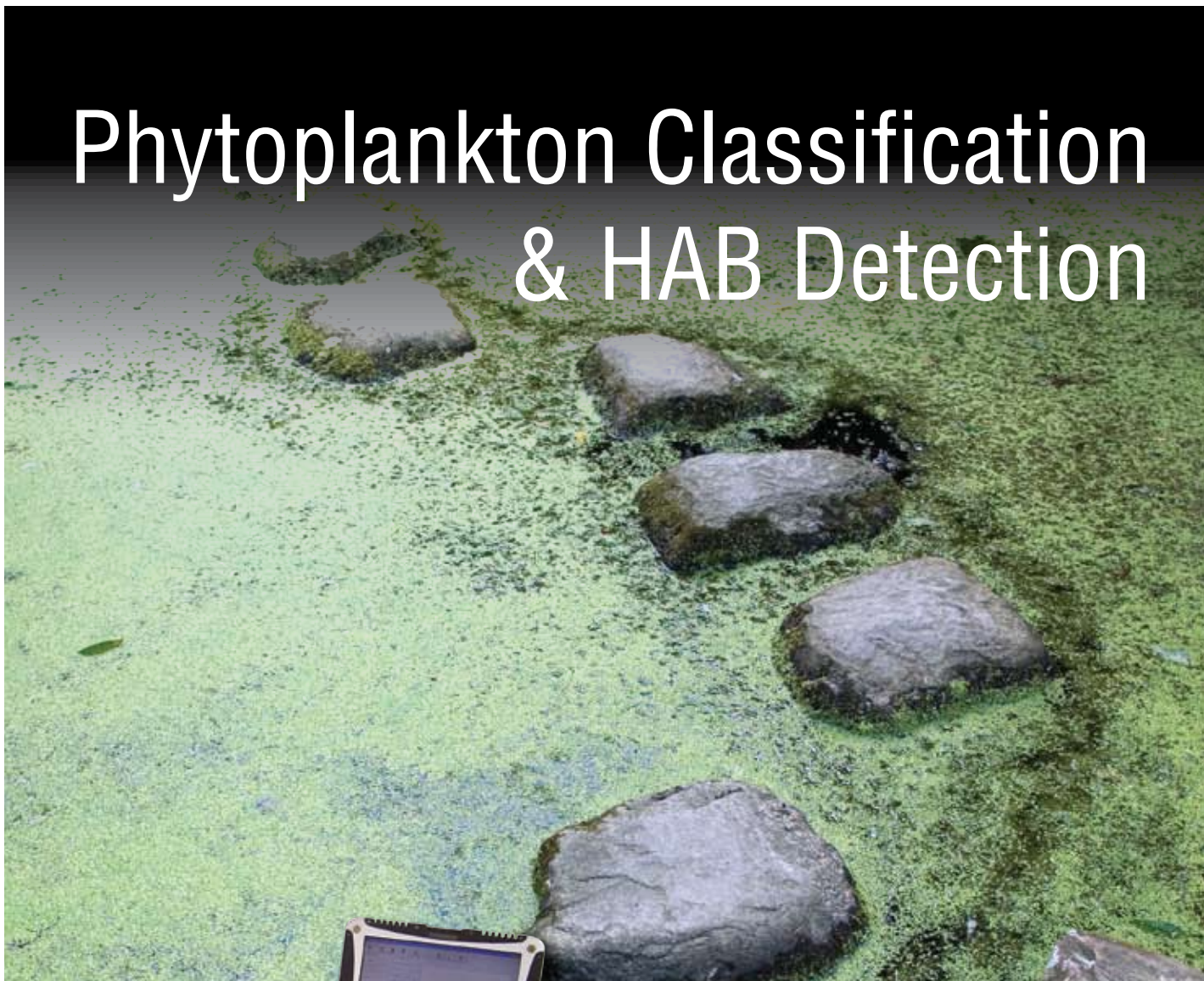
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