Volume 12 (3) September 2003

Pages 59-62

LIMNOLOGY AND OCEANOGRAPHY
BULLETIN

Published by the American Society of Limnology and Oceanography

BOOK REVIEWS

HANSELL, DENNIS A. and CRAIG A. CARLSON (eds.) 2002. **Biogeochemistry of Marine Dissolved Organic Matter**. Academic Press. ISBN 0-12-323841-2 (hardbound). xxii + 774 p. US $89.95.

Reviewed by ***Peter J. le B. Williams,*** *School of Ocean Sciences, University of Wales, Bangor, Menai Bridge, Anglesey, United Kingdom LL59 5PP; pjlw@bangor.ac.uk*

Biogeochemistry of Marine Dissolved Organic Matter is a multi-author book, comprising some 16 chapters written by acknowledged leaders in the field. The book, without exception authoritative and up-to-date, impressed me in a number of ways. Many chapters contain comprehensive summaries of published work in concise and informative tables—these will be found to be invaluable and much thumbed. The text gives the impression of a strong steer from the editors. The chapters it would appear were sent out for peer reviewing, no mean accomplishment for a work of such size. The authors have maintained a high degree of consistency in the units used, which will be much appreciated by readers wishing to compare data from different chapters**.** (There is the occasional lapse into the SI-not-recommended Gtonne unit and one strange regression to Leslie Cooper's old and now redundant μg-at unit.) The book is a great credit to the editors and their team of authors and those interested in the ocean's carbon cycle, and beyond, will find it a valuable addition to their bookshelves.

In a number of places, the book gives consideration to the title word "dissolved," but "organic" is taken as read. Many would relegate discussion of the distinction between the terms "organic" and "inorganic" as a mere matter of semantics; I would not. The compound in the grey area—urea—plays an important role in biogeochemical cycles. Unlike all other "true" natural organics, urea is hydrolyzed, rather than oxidized, to its inorganic constituents on decomposition. Despite this characteristic, it is commonly used as a test compound in organic analysis. In her chapter, Bronk acknowledges that some authors (rightly to my mind) regard urea as an inorganic excretion product. She finds herself forced to adopt the conventional, alternative view that it is an organic compound. We could be leading ourselves astray.

The book begins with an authoritative and beautiful account on the development and necessity of the subject by the late John Hedges. His chapter and the recent Citation for Scientific Excellence posthumously awarded by ASLO serve to remind us how much we miss John's thoughtful contribution to the subject. Then follows a chapter by Sharp on the methodology for DOM analysis. His Figure 2 shows the remarkable improvement in methodology since the HTCO fracas in the late 1980s. The striking thing that emerges is when it comes to getting the right answer, the analyst is clearly far more important than the analytical method. While this is certainly not a new finding, it stands in distinct conflict with Sharp's opinion (pp. 42-43) of "wet chemical oxidation methods which are not recommended for modern routine DOC analyses," an assertion that sent a shiver down my spine. Surely, if his Figure 2 tells us anything, it is that we should "not recommend" the analyst before the analytical method. Sharp's valuable contribution to the improvement of DOM analysis over the past decade has been to focus on quality control and he discusses the notion of "community precision." In this he is reflecting a shifting mood internationally over the ownership of data from the individual to the community. In the former circumstance, quality is very much a personal choice; in the latter it becomes a matter of professional, if not contractual, responsibility.

The next chapter, written by Benner, begins with a thoughtful analysis of molecular-size distribution. He arrives at the interesting, and to me surprising, conclusion that the C:N:P composition of the high MW and low MW fractions are much the same. His pie charts in Figure 2 are a sobering portrayal of

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.

Editor: Greg Cutter, Old Dominion University, Norfolk,VA 23529-0276 USA, Tel: 757-683-4929, gcutter@odu.edu

Associate Editor: Fred C. Dobbs, Old Dominion University, Norfolk,VA 23529-0276 USA, Tel: 757-683-5329, fdobbs@odu.edu

ASLO Business Manager: Helen Schneider Lemay, ASLO Business Office, Waco, TX 76710 USA, Tel: 254-399-9635 or 800-929-2756, Fax: 254-776-3767, business@aslo.org http://www.sgmeet.com/aslo

Advertising: Helen Schneider Lemay, ASLO Business Manager, Tel: 254-399-9635 or 800-929-2756; business@aslo.org

The *L&O Bulletin* is published quarterly by the American Society of Limnology and Oceanography, 5400 Bosque Blvd., Suite 680, Waco, TX 76710 USA. Postage paid at Waco, Texas. POSTMASTER: Send address changes to ASLO Business Office, 5400 Bosque Blvd., Suite 680, Waco, TX 76710 USA.

Subscription price to regular members is included in annual dues. Information on institutional subscriptions is available upon request from the ASLO Business Office.

Views expressed in this publication do not necessarily reflect official positions of the American Society of Limnology and Oceanography unless expressly stated.

The *L&O Bulletin* publishes brief, peer-reviewed articles of broad interest to the ASLO membership, Letters to the *Bulletin* (typically responses to articles), as well as ASLO News on a quarterly basis. Information on the preparation and submission of articles and letters can be found on the ASLO web site (www.aslo.org). It is recommended that you contact the editor before preparing an article or letter.

what we do not know. I found the section on NMR analysis especially valuable, as it brought together findings from a fast-developing field; the answers are there, if we can only interpret the signals. Benner is of the view that they point to carbohydrate being a major component of the high MW fraction. Having read his and Mopper and Kieber's later chapter on photo-oxidation, I wondered if we should not be giving more attention to organic acids and their condensation products. I was struck by the frequency with which they occurred as photo-oxidation products in Mopper and Kieber's Appendix 1. A better understanding of these compounds might help resolve the conundrum of recalcitrant-molecule production in the oceans.

Carlson's following chapter on production and removal processes contains tabular summaries of observations that will be of enormous worth. I would have valued some summary of the section on production of organic material; his assessment would have been helpful to the reader. Then follows a wide-ranging discussion of removal processes. He, like others in the book, casts his discussion in the framework of Kirchman et al.'s categories—labile, semi-labile, and refractory—as if molecular structure were the primary if not sole determinant of biological stability. As we now know that the inorganic nutrient environment on occasions appears to be the overriding factor, there is nagging doubt in my mind, as there appears to be in his, whether the separation into labile and semi-labile has merit—worse, it may constrain our thinking.

Then ensues a lively (what else would you expect from Debbie Bronk?) chapter on the dynamics of DON. She ends each of her sections with a short comment on research priorities, comments that are invaluable. I think few would question her observation "there has just got to be an easier way to measure DON."

The next chapter, a *tour de force* by Karl and Björkman on DOP, begins with an authoritative and fascinating account of the development of the subject. They argue that in the case of DOP assimilation, the conversion of polymers to monomers is the bottleneck controlling mineralization; there are strands of other evidence to suggest this is a more widespread feature. There is an extensive consideration of the analysis of phosphate and organic phosphorus. I found particularly interesting consideration of the co-analysis of arsenic; it is clear in the authors' minds there is still much, if not all, to learn regarding the biogeochemistry of arsenic in seawater. Then follows an analysis of a major DOP database the authors compiled and named GOOD (Global Open Ocean DOP). (Dave Karl is the undisputed master of the acronym, e.g., MAGIC, ALOHA, SANTA CLAUS, and HOTSEX, the last subsequently altered for reasons of political correctness.) The interesting thing that emerges from the analysis is the regional difference in deep-water DOP concentration.

Then follows a chapter by Wells on colloidal OM and trace metals, arguably technically and conceptually the most difficult aspect of the study of DOM. The author makes the point that we are caught between the limitations of the available methodology and the difficulty of working with extremely dilute solutions. Even to the novice the problems look formidable. Two interesting pieces of information I gained from the text were first, calculations imply a turnover time of "a few hours" for colloidal DOM, and second, the association of different metals to different size fractions of the colloidal DOM. It seems to me that this chapter, as many others in the book, will be a landmark paper.

Much the same comment applies to the chapter on isotope chemistry by Bauer. He brings together information on the ^{13}C and ^{14}C isotopes in a very accessible and informative manner. Most helpful to the non-isotope chemist is that the two isotopes are reported in the same units. Bauer discusses mass-balance analyses for the sources of DOM by solving a set of simultaneous equations. The calculations give the remarkable answer that the coastal ocean is the overriding source term for deep-water DOC, exceeding the input from the surface from 25 to 100-fold. Scaling calculations suggest that although this is a surprising result, it is not implausible, and will call for a major revision of our thinking about carbon transport to the deep ocean and its fate on arrival.

The chapter by Mopper and Kieber on photochemistry contains a wealth of information in four very valuable tables. The text begins with a thoughtful and timely discussion of the complex interactions between microbiological and photochemical processes. It was interesting to me that ammonia seems to be both produced and consumed photochemically. Mopper and Kieber leave us with the clear realization that with the photochemistry of sea

water, there are more questions than answers.

The next two chapters consider the light-absorbing properties of DOM, the so-called "colored" DOM (CDOM). The first of these, by Blough and Del Vecchio, focuses on the coastal zone and starts with a compilation of observations. The chapter is heavily empirical; what I missed was some physiochemical basis as a framework for the field observations. This bias is bound up with the origins of the subject, where the absorption of DOM was needed to correct satellite-color observations to extract the chlorophyll signal. Subsequently it was realized there was information in this correction term. In the second chapter, Nelson and Siegel consider CDOM in the open ocean and a number of remarkable facts emerge. First, whereas there is a positive and generally close relationship between CDOM and DOC in inshore waters, in the open ocean the relationship is weakly negative. Second, they estimate CDOM accounts for 40-80% (ca. 50% on average) of the absorption of light in the open oceans. They show a remarkable map (Figure 5c) of computed DOC distribution, based apparently on a temperature algorithm, an image that struck me as a real glimpse into the future.

A chapter by Cauwet provides a very thoughtful review of DOM in the coastal zone. He compiles the discharges of DOC by major river systems. What surprised me was how poorly European rivers were characterized by comparison with those of other continents. There is a very detailed discussion of the removal process in estuaries and the point is made that circumstances are more complex than the simple passage through this zone. Cauwet offers us the delightfully muted observation (pp. 588-589) that "In the estuarine flocculation literature it appears that each author has seen what he expected, relative to his own field," a generalization that goes well beyond DOM flocculation in estuaries!

Burdige's chapter dealing with pore-water DOM begins with a discussion of modeled profiles using an advection-diffusion model. It's an unfamiliar field to me; I found the chapter interesting but hard going, mainly, in my case, sorting out the meaning of the various constants. It's all there, but if you are a beginner, you simply have to work hard at it. His Figure 9 is probably a pointer to the level of complexity we may need to embrace when modeling DOM decomposition in the water column.

Then follows a chapter by Leif Anderson that stands out as the only one having a focus on a specific geographical area, the Arctic Ocean, which at first sight seems out of line with the structure of the book. However, Anderson convincingly makes his case that as a major site of deep-water formation, this ocean requires special consideration. The chapter starts with a very helpful discussion of the hydrography of the Arctic Basin and follows with a discussion of the sources of DOC; the more extensive coverage of the Arctic rivers nicely supplements Cauwet's chapter. Anderson's chapter concludes with a remarkable budget (Table III) for DOC fluxes in and out of the Arctic Ocean. The total flux is of the order of 100 Tg C per year, which he is able to quantify with a precision of slightly better than 10%. If nothing else in the book convinces you of progress made over the past decade, this result surely must.

In Chapter 15, Hansell puts all the pieces together. He starts with a very lucid summary of global DOC and its seasonality, then goes on to discuss net DOC production, net community production, and new production. The material is brought together very nicely and the conclusion is that the net production of DOC is a not insignificant proportion of net community production. Then follows an analysis of the export of DOC, the point being made that the timing of DOC mineralization in relation to period of mixing is critical. The chapter leaves us feeling, quite rightly, that we now have a good understanding of the mechanism and scale of DOC export out of the euphotic zone and its subsequent fate. The chapter ends with valuable, broad pointers to the future.

One might expect Hansell's chapter to be the finale, however, it is followed by Christian and Thomas Anderson's chapter on modeling marine DOM biogeochemistry. Relegating them to "tail-end Charlies" seemed a little odd to me; maybe it is part of a move within the marine DOM community to let modelers know where their place is! Whatever the reason, we are treated to a considered and accessible review of the structure of models by the authors. One is left with the impression that biogeochemical models have passed a major divide and are now important sources of understanding. The chapter brings the curtain down on a high note with a thoughtful discussion of the future of the subject.

There remains one fascinating and as-yet-unanswered question—if the correct blank had been established when the HTCO method was first developed in the mid-1980s, would we have ended up knowing as much about DOM as we currently do? Maybe somewhere in an almost parallel universe they got the blanks right the first time, and I'll bet a bottle of good malt that the equivalent book there is much thinner. Funny old world, isn't it!

Note from the Associate Editor: See the previous issue of the Bulletin, 12(2), pages 38-39, for a review of a related book on fresh- and brackish-water systems, ***Aquatic Ecosystems: Interactivity of Dissolved Organic Matter,*** *edited by S. Findlay and R. Sinsabaugh.*