www.limnology.org

SIL news

Volume 54 - June 2009

While care is taken to accurately report information, SILnews is not responsible for information and/or advertisements published herein and does not endorse, approve or recommend products, programs or opinions expressed.

In This Issue

Material for the December 2009 issue should be sent to the Editor by:

1 OCTOBER 2009

Dr. Ramesh D. Gulati
NIOO/Centre of Limnology
Post Box 1299
3600 BG Maarssen
The Netherlands
Fax: +31.294.232224
E-mail: r.gulati@nioo.knaw.nl

Contributions on a PC formatted disk, in any standard word processor or DOS (ASCII) text, or as e-mail attachments, will assist the Editor.

Editorial

I believe it is not a must to write an editorial for every issue of the *SILnews*. It is, nevertheless, a privilege that an editor has, and I am happy I have so far used it more frequently than some would to. I am sorry to say that once again I have to start with sad news, the death on 2nd March, 2009 at the age of 91 years of Prof. Dr. H.B. Noel Hynes at Manoir Lac Brome, Quebec, Knowlton, Canada. Many of us have known that Dr. Hynes was a pioneer stream ecologist; his death is, therefore, a great loss to limnology *per se* (Dr. Hynes' detailed obituary follows directly after this editorial). I also got the sad and belated news about the demise of Dr. Roger Pourriot, a famous French limnologist. The news of Dr. Pourriot's passing away on 24th August 2008 reached me only recently: it was very distressing to learn that he had been suffering from cancer for some time. Those in touch with French limnology certainly know of Dr. Pourriot, who was not only a famous French limnologist—and an expert on rotifer ecology—but also by disposition a naturalist. To commemorate Roger's death, a Scientific Meeting was organized on 18th May 2009 in Paris by the Zoological Society of France and French Association of Limnologists. For details, please contact Dr. Pierre Clement (pierre.clement@univ-lyon1.fr) and Claude Rougier (claude.rougier34@orange.fr). I hope Dr. Clement and Dr. Rougier would like to report more on this Meeting in a subsequent issue of this *SILnews* Letter.

I am both glad and enthused by the response of *SILnews* readers to my invitation to contribute to *SILnews.* There is this time a great diversity of articles and information on limnological studies from various regions in all continents. South Africa, the venue of the forthcoming SIL Congress in 2010, is well represented by three articles, one of which is by Dr Rob Hart (University of KwaZulu-Natal) concerning the typically silt-laden turbid reservoir systems of S. Africa. Here, Rob Hart also appeals to all fellow limnologists not to be dissuaded to attend the SIL 2010 by the problems, including financial cuts, facing reservoir limnology in South Africa. I thank Rob for contributing regularly to the *SILnews* as well as coordinating the inputs from his S. African colleagues. Rob's help has gone a long way to introduce us to the basics of S. African limnology, and thereby get acquainted with the problems and perspectives of reservoir limnology from this relatively the best developed country in the vast continent, Africa. I am confident such contributions are working as a *hors d'oeuvre* for the limnologists, young and old, to attend in large numbers the SIL 2010 (please see Announcement of the SIL 2010 on a subsequent page in this *SILnews* if you missed to read it earlier.

Limnological studies in other geographical regions ranging from Australia, North America to Europe (including countries in the both Mediterranean region and the north), are well represented here. From the United States, "A *Century of Limnology at Cornell University"* by Dr. Nelson Hairston and Dr. Gene Likens is a beguiling story devoted primarily to the teaching of *general limnology* by James G. Needham at Cornell University, starting in spring semester 1908, and onwards. The authors will welcome information concerning any other classical teaching courses in limnology held in Europe (Germany, Switzerland, or England?) previous to Needham's limnology *course* at the Cornell.

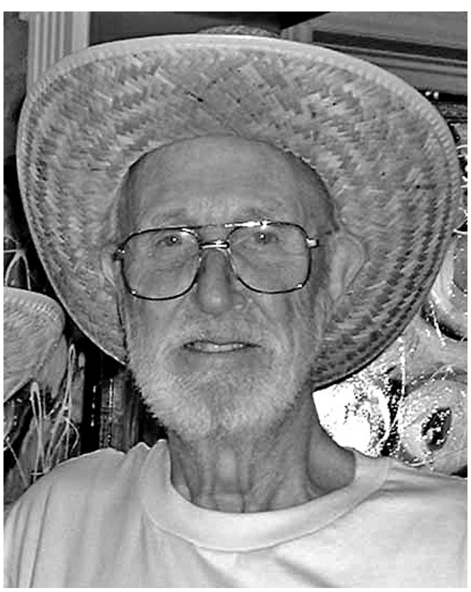
Last, I welcome new or novel ideas, including letters to the editor, and invite feedbacks from our readers to make the reading of this news letter more engaging. As you most probably noted, the hard copy version of the *SILnews* has been suspended since December 2008 to cut financial costs. One positive upshot of this is that *SILnews* contributors will feel less confronted by the space constraint (and more work for the editor!). Your contributions for December 2009 Issue should reach me by 1 October 2009.

Ramesh D. Gulati
Editor *SILnews*

Obituary
H.B.Noel Hynes, 1917-2009

H. B. Noel Hynes, internationally renowned freshwater biologist and Distinguished Emeritus Professor at the University of Waterloo, died peacefully at Manoir Lac Brome in Knowlton, Québec, on March 2nd, at the age of 91. Dr. Hynes was a pioneer in modern stream ecology, considered by many to be the father of the field. His most widely known contributions, *The Biology of Polluted Waters* (1960) and *The Ecology of Running Waters* (1971, reprinted in 2001), combined his own work with truly global interpretations of the literature and had immediate and lasting influence on both applied and basic aquatic biology. Similarly, his Elgardo Baldi Memorial Lecture "The Stream and Its Valley" at the Societas Internationalis Limnologiciae meeting in 1974 was a lucid synthesis of ideas about the connections between rivers and their drainage basins that expanded aquatic ecology to the landscape scale and stimulated new lines of research into nutrient cycling, the importance of allochthonous inputs and the effects of land-use on aquatic systems.

Noel published 190 papers, the first in 1940, the last in 2008, including two citation classics and 44 reflecting his lifelong interest in stoneflies. These publications cover topics as diverse as the parasites of sticklebacks and the control of migratory locusts, and are based on work conducted from Australia to the Arctic.



They include pioneering work on stream drift and recolonization, the fate of autumn-shed leaves, the estimation of secondary production, groundwater discharge and recharge, and the importance of the hyporheic zone. During the course of his career, he supervised more than 30 graduate students and post-doctoral fellows, and advised and mentored countless others, both at Waterloo and internationally. As a supervisor he was encouraging and supportive, offering constructive suggestions and effortlessly transforming paragraphs of students' tortured prose to a few expressive sentences. His clarity of thought and expression set a very high standard, but he was always open to talk about ideas, new or old. Whether in the lab or beside his backyard pool, conversation with Noel always yielded more information than expected. His casual mentions of 'that paper by …' prevented the reinvention of many wheels. His facility with and love of languages were daunting: he was fluent in French and Italian, understood German, and delighted in advising us that Swahili was a very simple language that everyone should know.

He received honorary doctorates from the University of London, the University of New Brunswick and the University of Waterloo. He was a Fellow of the Royal Society of Canada and received their Centennial Medal in 1967. He also received the Hilary Jolly Award from the Australian Limnological Society (1984) and the inaugural Award of Excellence from the North American Benthological Society (1988). The Canadian Rivers Institute at the University of New Brunswick holds a Hynes Lecture Series, and the North American Benthological Society gives a Hynes Award for New Investigators in his honour. In 1998 Dr. Hynes received the Naumann-Thienemann Medal, the highest award available to an aquatic biologist, by the Societas Internationalis Limnologiciae, "for establishment of the field of lotic limnology as a major, rich and varied discipline, and for wide-ranging contributions that brought innovative research, insight, and synthesis to all aspects of lotic ecosystems for six decades."

Born in Devizes, England, Noel Hynes exhibited an interest in biology, especially entomology, at a very early age. He graduated in biology from Imperial College (now part of the University of London) in 1938 and obtained a Ph.D. from the University of London in 1941. His thesis research focused on Plecoptera in the English Lake District. After a year in Trinidad, where he was sent by the British Colonial Office to learn about tropical biology, Dr. Hynes joined their locust-control program and worked in Kenya, Ethiopia and Somalia.

In1946, he and his wife Mary returned to England where he took up a university lectureship in Liverpool. At Liverpool University, he established a research program, largely funded through industrial contracts. His reports were not necessarily what the industries wanted to hear, but were too rigorous to be rejected.

Dr. Hynes moved with his family to Canada in 1964, as the first full-time Chair of the Department of Biology at the University of Waterloo. While building the Department, he established an active research program and wrote *The Ecology of Running Waters.* After serving as Chair, he declined higher administrative posts to concentrate on research and teaching. He retired from the university in 1984, but remained active counseling students, serving on editorial boards and advising government agencies for many more years.

Noel loved to share stories of his field adventures in Africa, Australia, North America and Europe. He included many of these, together with sometimes pointed opinions on the world we inhabit and evidence of his love of language, in his autobiography *Nunc Dimittis: A Life in the River of Time* (2001). His wife, Mary, passed away in 1999. He is survived by his four children, nine grandchildren and eleven great grandchildren.

The 31st Congress of SIL

The 31st Congress of SIL will be held from 15 to 20 August 2010 in Cape Town, also referred to as the Mother City of South Africa. Overlooking the city is Table Mountain from where the best views of the city and surrounds are seen. The area is a national park and encompasses the incredibly scenic Table Mountain Chain stretching from Signal Hill in the north to Cape Point in the south and the seas and coastline of the peninsula. The narrow finger of land with its beautiful valleys, bays and beaches is surrounded by the waters of the Atlantic Ocean in the west and the warmer waters of False Bay. The Park is recognised for its extraordinarily rich, diverse and unique fauna and flora - with rugged cliffs, steep slopes and sandy flats. It is a truly remarkable natural, scenic, historical, cultural and recreational asset and although debatable, nowhere else in the world does an area of such spectacular beauty and such rich biodiversity exist almost entirely within a metropolitan area.

Some 2 200 species of plants are found on the mountain and has been declared a World Heritage Site, with many members of the famous Proteaceae family. The dassie (rock hyrax) is the most common animal not to forget the porcupines, mongooses and even snakes. Five dams have been built before 1907 to supply the city of Cape Town with water. They have been the subject of several limnological investigations. The world famous Kirstenbosch botanical gardens are situated on the eastern slopes of the mountain, not far from the University of Cape Town and Groote Schuur hospital where the world's first heart transplant was done by Dr. Chris Barnard.

Visits to Kirstenbosch and Table Mountain will be options for the mid-congress excursions during the 31st SIL Congress in 2010.

View of Table Mountain and the City of Cape Town

Diarise the dates and visit http://sil2010.ufs.ac.za

Johan U. Grobbelaar
Chairperson of the LOC
Grobbeju.sci@ufs.ac.za

SIL Meeting in Nanjing, China 24-27 October, 2009

Global change and freshwater environments During the 30th SIL Congress in Montreal in August 2007, a motion encouraging non-Congress SIL meetings was passed by the International Committee. Such meetings are considered to serve the society at large. The follow-up meeting will be held from October 24 to 27, 2009 in Nanjing, China. The theme of the meeting is *global change and freshwater environments*, and the topics include: 1) global change and its impact on freshwater ecosystems; 2) human accelerated environmental changes in freshwaters; 3) algal blooms in freshwaters: ecological mechanisms and consequences; 4) aquatic toxicology and water quality safety of freshwaters; 5) resource use and conservation of freshwaters;, and 6) ecosystem services and restoration of freshwaters.

There will be a special session for students to discuss their respective studies in limnology and exchange information. A limited number of scholarships is available for supporting students to participate in this meeting. The scholarships will cover registration fee, meals and accommodation.

Prof. Gene Likens has kindly agreed to act as chairman of the scientific committee and Prof. Zhengwen Liu is the chair of the organizing committee. For more information please contact:

Dr. Zhengwen Liu Nanjing,
Institute of Geography and Limnology,
Chinese Academy of Sciences,
East Beijing Road 73, Nanjing 210008, China
E-mail: silsym@126.com
Fax: 0086-25-57714759.

Regional Limnology: Reports On Lakes and Reservoirs

Reservoirs in South Africa, and silt-laden turbid systems in particular

South Africa is indubitably a water-scarce nation. Rainfall is low (annual average ~500 mm) and extremely variable between years; evaporation increases radically from east to west across the country and exceeds precipitation over much more than half its land area (DWAF 1986; Davies & Day 1998), rendering much of the country semi-arid to arid. The country accordingly experiences water shortages at least cyclically, and global warming raises prospects of regional exacerbation of this constraint. Reservoirs (colloquially termed dams) are pivotal water supply sources. Some 500 'large' reservoirs (each storing > 1 million m^3), that are spatially distributed broadly in concordance with major river drainage systems and local demand (Fig 1), collectively store around 28.6 x $10^9 m^3$, roughly 50 % of the country's mean annual runoff. In addition, there are over 150,000 smaller reservoirs and farm dams which remain basically unexplored limnologically.

South Africa's acclaimed Water Act of 1998 promulgated an equitable entitlement of water to society at large; the accomplishment of this right for most urban/peri-urban and some rural residents has, however, inevitably increased demands on the country's undoubtedly most limiting natural resource. Concomitant increases in waste-water return flows exacerbate declines in water quality, a problem which equals or surpasses the constraints on quantity. Nutrient enrichment and salinization are major, almost ubiquitous concerns (Oberholster & Ashton 2008). However, catchment geology and climate, and changing land-use intensity and practices, lead to an additional water quality issue – that of elevated mineral turbidity. Although Dallas & Day (2004) conclude that turbidity, largely owing to its commonplace natural occurrence in rivers, is 'not a particularly significant water quality variable' in South Africa, it is a defined criterion for 9 of 15 listed water uses (Kempster et al 1980). More importantly, it has fundamental impacts on the

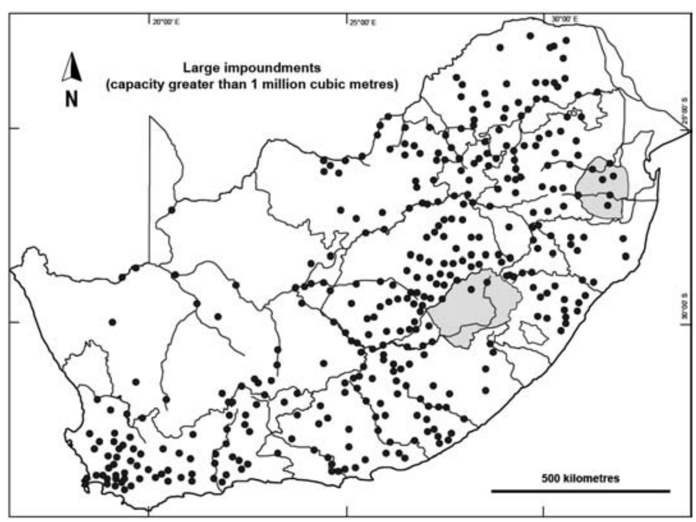


Fig 1. The distribution of 497 large reservoirs in relation to major rivers in South Africa (from Oberholster & Ashton 2008, with authors permission.)

structural and functional limnology of affected reservoirs (and rivers). Here, I sketch some of the features of turbid reservoirs as elucidated by South African limnologists who spearheaded or contributed substantially to reservoir limnology in general in past decades when such water bodies were a focus of attention. Broad generalizations are necessitated by space limitations; for elaboration, interested readers are referred to a regional synthesis by Allanson et al (1990) and a recent review (Hart & Hart 2006).

Low rainfall limits vegetation cover; soil organic matter content is commensurately low, and along with underlying geology and topography, much of the country is vulnerable to severe erosion, especially during erratic high rainfall events. Accordingly, rivers carry great quantities of sediment, jocularly but uncomfortably referred to as 'South Africa's major export'. River reservoirs inevitably impound such sediment-laden water, rendering a large proportion of reservoirs 'turbid' with suspended sediments, and Secchi depths commonly below 40 cm (Fig 2). Otherwise 'clear-water' systems also become transiently turbid during drought years (see Fig 3) when reduced water depth resulting from operational draw-down allows sediment re-suspension. This renders it difficult to quantify the number of reservoirs that can be termed turbid. Suffice it to say, they are abundant.

The foremost direct impact of suspended particles is increased (back)scattering of light, reducing its vertical penetration and the depth of the euphotic zone. Localized surface heating is increased, potentially enhancing physical stability of the water column, and evaporative loss. The underwater light climate is altered both quantitatively and qualitatively, with long wavelength light predominating (imparting the reddish hues characteristic of turbid waters), and selectively influencing the primary producer assemblages. Chemical effects are foremost related to the huge surface area (commonly of the order of m^2/ml) provided by astronomical densities ($10^6 - 10^7$/ml) of suspended clay particles and colloids. Selective chemical adsorption of nutrients and toxicants in particular, along with various dissolved organics, render this particle milieu variously attractive or inhibitory to saprobic and autotrophic biota. The effects of mineral suspensoids on autotrophs, primary consum-

Fig 2. Some examples of turbid reservoirs. a) South Africas second largest reservoir, Vanderkloof Dam (formerly Lake le Roux), on the Orange River, a prominent limnological study site (Allanson & Jackson 1983). b) Bridle Drift Dam on the Buffalo River, East London. c) A much younger author, collecting zooplankton in Vanderkloof Dam. d) Wagendrift Dam on the Bushmans River, Estcourt. Photos (except c) by RC Hart.

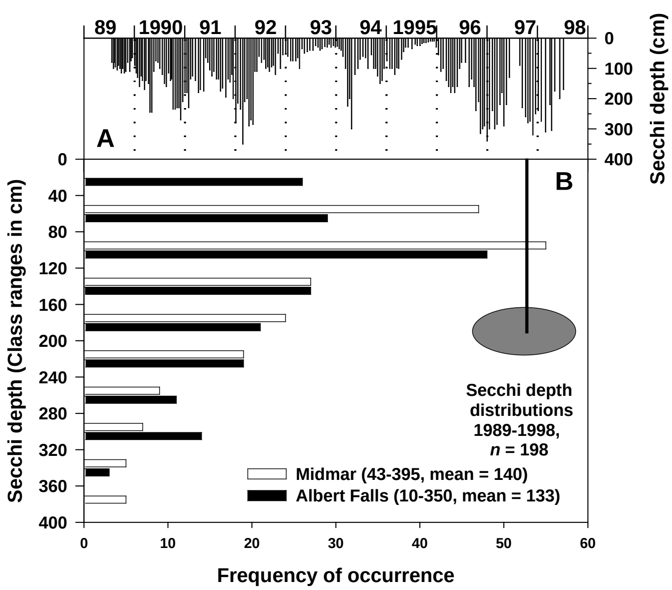


Fig 3. A) Secchi depth transparency values in Albert Falls Dam. B) Frequency distribution of Secchi depth values in Midmar and Albert Falls two typically clear-water (non-turbid) reservoirs in a mesic KwaZulu-Natal region that become turbid during drought conditions see 1993 and 1995 in panel A. (Hart, original data.)

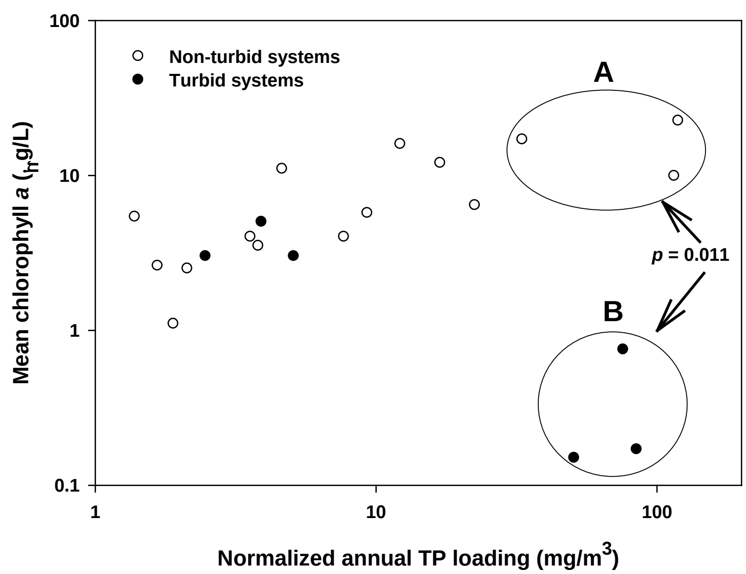


Fig 4. Annual mean chlorophyll content as a function of phosphorus loading in 21 impoundments (Walmsley & Butty 1980). Reservoirs with mean annual Secchi depth <40 cm are identified as turbid. Average ratios of P loading to chlorophyll differ vastly and significantly (t test, p = 0.008) between turbid and non-turbid systems (1570 vs. 23; n = 6 vs. 15, respectively). Response differences are especially marked at high P loading rates (compare groups A and B).

ers, and consequent food web cascades are of both major fundamental interest and practical importance in reservoir management.

On the positive side, reduction of euphotic depth constrains the biological consequences of eutrophication. Based on a subset of 21 reservoirs compared in the 1970's (Walmsley & Butty 1980), Fig 4 shows the depression of chlorophyll-nutrient relationship relative to non-turbid systems. Light limitation essentially constrains the ability of autotrophs to respond to increased nutrient loading, although undesirable cyanophyte taxa may be favoured (Oberholster & Ashton 2008; see Fig 4 in Hart 2006).

With increasing salinization however – an example of which is shown in Fig 5, the 'protective' buffering influence of light limitation becomes tenuous. Concurrent changes in 'zeta potential' affect stability of the sediment suspension; silt-particles coalesce (Grobler et al 1981) and gravitational deposition is accelerated. The rapid dissipation of sediment-laden river plumes manifest in oceanic waters is a clear analogy. Year-to-year variations in TDS commonly relate to hydrological changes (dilution and flushing effects). Accordingly in dry years, when water supply is more limited, commensurate increases in salinity raise prospects of relaxed light limitation and associated algal proliferation. This is a potential time bomb awaiting detonation.

Pioneering studies on Vanderkloof Dam (Figs 2a, 2c) clearly revealed that the depressive influence of suspended sediments on primary production extends through the trophic cascade. Long-term data reveal the direct relationship between zooplankton biomass and Secchi depth (Fig 6), with corresponding changes in fish CPUE (Fig 5 in Hart 1986). Accompanying changes in zooplankton community structure – especially the reduction of filter-feeding daphnids – correspond to the increasing dominance of nutritionally inferior particles in the food environment (Hart 1988). Visual predation is impaired, allowing the occurrence of remarkably large-bodied taxa such as *Daphnia gibba* and *Lovenula* spp., taxa with body lengths > 3.5 mm otherwise characteristic of temporary ephemeral (fishless) inland 'pans' and 'vleis'. In short, turbidity associated with suspended sediments collectively exerts undeniably profound influences on reservoir ecosystems.

Unfortunately, national support for reservoir limnology in South Africa was effectively terminated in the late 1980's, when the limited funding available was re-directed almost exclusively to lotic limnology on the grounds that rivers are effectively the major natural inland water ecosystems. Today, however, as reservoirs face increasing pollution, aggravated by widely acknowledged infrastructural and managerial collapses in waste water treatment, virtual absence of current capacity in reservoir limnology and management bodes ominously for the future. And the proverbial crystal ball may be too muddy for fortune-tellers to read!

But don't let this account dissuade your attendance of SIL 2010. Tap water is generally excellent in South African towns and metropolises. Indeed, I almost ritualistically indulge in a long drink of washroom tap water in Jan Smuts (now O.R. Tambo) international airport when I return to South Africa from abroad – and yet await any detrimental effects of my exclusive use of tap water as drinking water! (I underlined the first sentence in this last paragraph to underscore Rob Hart's encouraging plea to all *SILnews* readers to attend the SIL 2010: Ramesh Gulati, Editor *SILnews*)

References

Allanson BR, Hart RC, O'Keeffe JH & Robarts RD (1990). Inland waters of southern Africa. An ecological perspective. *Monographiae Biologicae* 64. Kluwer Academic Publishers, Dordrecht. 458 pp.

Allanson BR & Jackson PBN (1983). Limnology and fisheries potential of Lake le Roux. *South Afrcan National Scientific Programmes Report* No 77. 182 pp.

Bruwer CA, van Vliet HR, Sartory DP & Kempster PL (1985). An assessment of water related problems of the Vaal River between Barrage and Douglas weir. Department of Water Affairs, Hydrological Research Institute, *Technical Report* TR 121. 185 pp.

Davies B & Day J 1998. *Vanishing waters*. University of Cape Town Press. 487 pp.

DWAF 1986. *Management of the water resources of the Republic of South Africa*. Department of Water Affairs, Pretoria. xxviii + 466 pp.

Oberholster PJ & Ashton PJ 2008. State of the Nation Report: An overview of the current status of water quality and eutrophication in South African rivers and reservoirs: *CSIR/NRE/WR/IR/2008/0075/C*, pp. 1-15.

Grobler DC, Davies E & Young L 1981. The stability of sediment/water suspensions as a function of water chemistry. Water year + 10 and then? Department of Water Affairs, Forestry and Environmental Conservation, *Technical Report* TR 114, 33-46.

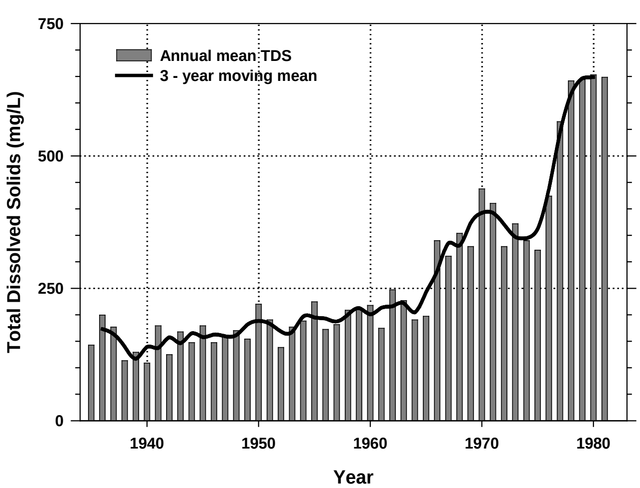


Fig 5. Mean annual TDS levels in Vaal River Barrage water (redrawn from Fig 1.2 of Bruwer et al 1985.) Prevailing TDS values around 540 mg/L in 2007/2008 suggest that former progressive increases in TDS have fortunately been contained.

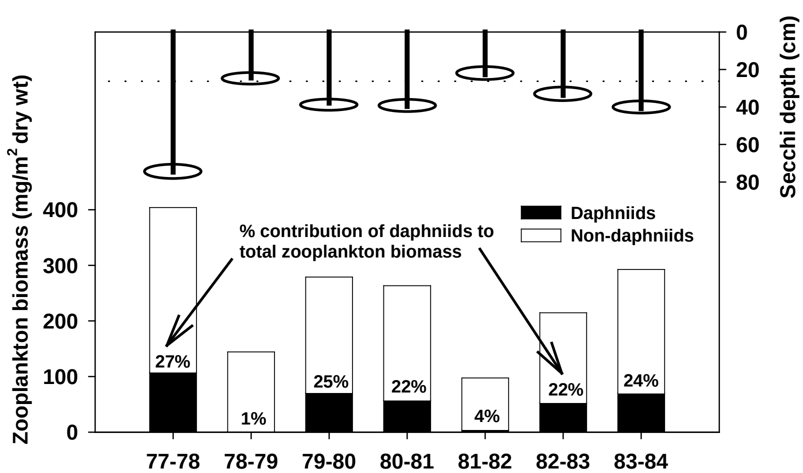


Fig 6. Mean annual total zooplankton biomass in Vanderkloof Dam correlated directly (r2 = 0.86) with mean annual turbidity (Secchi Depth) between 1977 and 1984; daphniid components were effectively excluded at Secchi depths below ~25 cm (Hart 1986, 1988).

Hart RC 1986. Zooplankton abundance, community structure and dynamics in relation to inorganic turbidity, and their implications for a potential fishery in subtropical Lake le Roux, South Africa. *Freshwater Biology* 16, 351-371.

Hart RC 1988. Zooplankton feeding rates in relation to suspended sediment content: potential influences on community structure in a turbid reservoir. *Freshwater Biology* 19, 123-139.

Hart RC 2006. Food web (bio)manipulation of South African reservoirs – viable eutrophication management prospect or illusory pipe dream? A reflective commentary and position paper. *Water SA* 32, 567-573.

Hart R & Hart RC 2006. Reservoirs and their management: A review of the literature since 1990. *Water Research Commission Report* No KV 173/06. 288 pp.

Kempster PL, Hattingh WHJ & van Vliet HR 1980. Summarized water quality criteria. Department of Water Affairs, Forestry and Environmental Conservation, *Technical Report* TR 108, 45 pp.

Walmsley RD & Butty M (eds) 1980. The limnology of some selected South African impoundments. *A collaborative report by the Water Research Commission and the National Institute for Water Research. Council for Scientific and Industrial Research*, Pretoria; 229 pp.

Rob C Hart,
Professor Emeritus,
School of Biological and Conservation Sciences,
University of KwaZulu-Natal,
Pietermaritzburg.
E-mail: hartr@ukzn.ac.za

Status of temporary wetlands of the Western Cape, South Africa

Temporary wetlands have a high ecological value and fulfil important ecosystem services, but are threatened worldwide. The status and structuring processes of these systems are largely unknown, despite the need of this knowledge for a good conservation policy. Although in some regions of South Africa >50% of wetlands are destroyed, they still form an important type of aquatic system in the country. According to the Water Act of 1998, South African water resources must be protected, used, developed, conserved, managed and controlled in ways that take into account the protection of aquatic ecosystems and their biological diversity. The Resource Directed Measures (RDM) provide an instrument to implement this Water Act. It is especially important to find out to what extent changing hydrological regimes may have an impact on structure and diversity of these vulnerable ecosystems. Both groundwater abstraction and climate change may induce shifts in the hydroregime of these systems that may have significant consequences for the temporary wetland biota.

During the last five years we have been studying the current state of temporary wetlands in selected regions of the Western Cape (Figure 1). Our study provided information concerning the current and past status of Western Cape wetland habitats and their nature value as determined by remote sensing techniques and flagship taxa. More specifically, we have classified satellite images of the Western Cape (South Africa) and determined the occurrence and changing patterns of wetlands over the last twenty years. Next, we sampled Western Cape temporary wetlands from seven different regions in the winter of 2004 and from one region in the winter of 2005. The status of large branchiopods was assessed by means of these samples and literature.

We detected still a lot of temporary and permanent wetlands in the area (in winter on average about 0.23 wetlands per km²; in summer about 0.09 wetlands per km²). The average distance to the nearest wetland was larger in summer (Figure 2). No decrease in the area of wetlands was observed over the last 20 years, which is in contrast with expectations. The observed

Figure 1. Examples of temporary wetlands in the Western Cape.

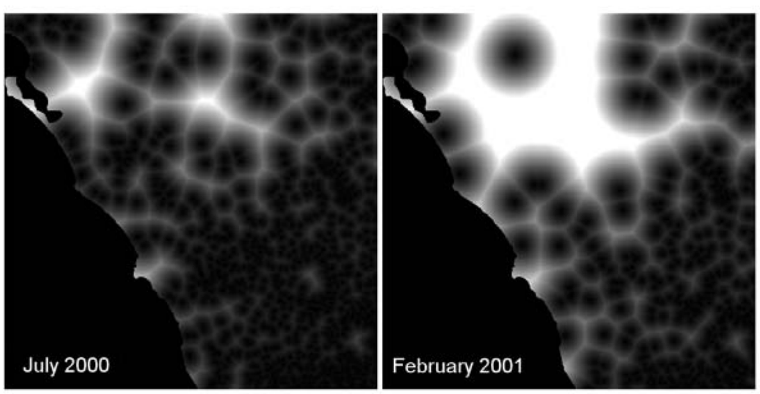


Figure 2. Visualisation of the distance of each pixel to the nearest wetland in the winter of 2000 (left) and in the summer of 2001 (right); light shading = long distance, dark shading = short distance to the nearest wetland.

Figure 3. Large branchiopods of the Western Cape: left: Conchostraca (Leptestheria rubidgei); right: Anostraca (Streptocephalus purcelli).

pattern can be related to the relatively low resolution of the used satellite images (about 30 by 30 meter), the influence of rainfall on the filling pattern of the wetlands and the unintentional creation of new wetlands by man (for example by the construction of roads). High spatial resolution images would most likely give more accurate results. Therefore, we plead for more detailed studies concerning this topic.

Several large branchiopod species (Figure 3) are threatened or already extinct in the temporary wetlands of the Western Cape, since only a few species and populations were collected during the extensive field samplings of 2004 and 2005. The declining status of these flagship species suggests that their habitat is threatened. Habitat destruction, land use changes and climate change are probably the most important threats to the persistence of these wetlands and their typical biota.

For detailed information of this research, we refer to the Ph.D. thesis of Els De Roeck, which can be downloaded from: http://hdl.handle.net/1979/1686.

Else De Roeck,
Freshwater Biology,
Royal Belgian Institute for Natural Sciences,
Vautierstraat 22, B-1040, Brussels
E-mail: Els.DeRoeck@naturalsciences.be

Luc Brendonck,
Laboratory of Aquatic Ecology and
Evolutionary Biology,
K.U.Leuven,
Charles Deberiotstraat 32, B-3000
Leuven, Brussels.
E-mail: Luc.Brendonck@bio.kuleuven.be

Sedimentary archive of palaeolimnological record from lakes of Western Cape, South Africa

South African coastal lakes are widely known for their rich aquatic biodiversity. They primarily originated by the drowning of estuarine valleys and several of them have natural surface connections to the sea (Hart 1995). Depending on the geomorphological origin, these lakes are categorised into three groups (Hill, 1975): a) drowned valley type, which is always associated with river systems, b) inundation lake, which is formed behind the coastal sand dunes in low-lying land and can be connected to a river system, and c) drowned deflation basin, which is formed by wind erosion. The lakes lay on Unconsolidated Quaternary or reworked tertiary marine sands (Howard-Williams and Allanson, 1978) overlying base rocks of the Cape Granite Suite and Malmesbury Group (Theron et al., 1992). The lakes in northern coast are still almost pristine although a number of Western Cape lakes are adversely affected by anthropogenic activities. Many of these latter lakes are particularly interesting due to their shallowness (average depth 1-14 m), nitrogen limited conditions and unique position in winter rainfall Mediterranean climate region. These warm temperate and mainly freshwater lakes broadly share a similar geological origin and stratigraphy, and experience strong wind that results near complete absence of water column stratification. Many of these lakes suffer from ecological consequences of eutrophication driven changes in plant species. Eutrophication also reduces inflows into the lakes. This along with macrophyte encroachment in the relatively remote lakes has drawn considerable attention to local authorities and researchers. Submerged macrophyte explosion, for example, in Cape flat lakes is considered to have been triggered by eutrophication. This is often combated with expensive dredging operations or application of toxic chemicals, or both. Accelerated farming and agricultural activities in the catchment lead to increased supply of nutrients that results in eutrophication. Moreover, recent industrial developments accompanied by urbanisation have caused increased supply of several organic (e.g., PAHs) and inorganic (trace metals) pollutants into these lakes, and have led to negative impact on lake ecosystem (Das et al., 2008a,b).

Sediment cores recovered from shallow Western Cape lakes have served as an excellent repository of past records. Anthropogenic imprints preserved in sediments of hyper-eutrophic Zeekoevlei (vlei is an Afrikaans word for lake), the largest freshwater lake in South Africa, provide a palaeolimnological record of human induced changes within the lake, and in the catchments (Das et al., 2008c, 2009). Zeekoevlei has a century long history of anthropogenic abuse, where seepage from nearby wastewater treatment plant has caused hyper-eutrophic conditions. In addition, damming, submerged macrophyte eradication, and dredging have triggered changes in plankton and macrophyte species.

Photo: A view of Zeekoevlei, South Africa, August 2004. Photo: Dr. SK Das

The area surrounding Verlorenvlei, a shallow freshwater oligotrophic estuarine Western Cape coastal lake, is particularly famous for archaeological remains. Meadows et al. (1996) analysed sedimentary fossil pollen record recovered from this lake. The authors (see references below) provide insight into the complex interactions between climate change, sea-level fluctuations, vegetation change, lake hydrology and human activities in the coastal region during late Holocene. Furthermore, Das et al. (unpublished) reconstructed the palaeoproductivity in Verlorenvlei for last 1000 years, and linked the cyanobacterial fluctuation to the catchment derived nutrient supply and macrophyte dominance.

Shallow lakes, in general, are neglected in geochemical research and shallow coastal lakes in South Africa are among the least biogeochemically investigated water bodies in the world. There is therefore a tremendous scope for research towards discriminating the natural *vs.* anthropogenic affects on the extremely complex environment. The research is necessary in the quest for information on the extent of human interference in the earth system.

References

Das S. K., Routh J. and A. N. Roychoudhury, 2008a. Sources and historic changes in polycyclic aromatic hydrocarbons input in a shallow lake, Zeekoevlei, South Africa. Organic Geochemistry 39, 1109-1112

Das S. K., Routh J., Roychoudhury A. N. and J. V. Klump, 2008b. Provenance and depositional history of trace metals, major ions and organic matter in Zeekoevlei, South Africa: a lacustrine record of recent urbanization. Applied Geochemistry 23, 2496-2511

Das S. K., Routh J., Roychoudhury A. N. and J. V. Klump, 2008c. Elemental (C, N, H and P) and stable isotope ($\delta^{15}N$ and $\delta^{13}C$) signatures in sediments from Zeekoevlei, South Africa-A record of human intervention in the lake. Journal of Paleolimnology 39, 349-360

Das S. K., Routh J. and A. N. Roychoudhury, 2009. Biomarker evidences of macrophyte and plankton community changes in a shallow lake, Zeekoevlei, South Africa. Journal of Paleolimnology 41, 507-521

Meadows, M. E., Baxter A. J., and J. Parkingtonl, 1996. Late Holocene environments at Verlorenvlei, Western Cape province, South Africa. Quaternary International 33, 81-95

Hart, R. C., 1995. Coastal lakes. In: Wetlands of South Africa. G. Cowan (Ed.) Department of Environment Affairs and Tourism, Pretoria, South Africa. pp 103-130

Hill B. J., 1975. The origin of southern African coastal lakes. Transactions of the Royal Society of South Africa 41, 225-240

Howard-William S. C. and B. R. Allanson, 1981. an integrated study on literoral and pelagic primary production in a southern African coastal lake. Archiv für Hydrobiologie 92, 507-534

Theron, J. N., Greese, P. G., Siegfried, H. P. and J. Rogers, 1992. The Geology of Cape Town Area. Department of Mineral and Energy Affairs, Republic of South Africa, pp. 41-50

Dr. Supriyo Kumar Das,
Department of Geographical and Earth Sciences,
University of Glasgow,
Glasgow, G12 8QQ UK
E-mail: Supriyo.Das@ges.gla.ac.uk

Figure 1. 'Blue Waters' lake (Collie) formed in 1962.

Australia's mining boom leads to a boom in new lakes

Australia is a major producer for many of the world's minerals and mining is the most significant industry contributing to the Australian economy (Mudd, 2007). However, a growing scale of mining continues to leave legacies of large open-cut operations with a depth that ensures part of the pit is often positioned below local groundwater tables (Radhakrishnan *et al.*, submitted). Once dewatering operations cease, these voids can form pit lakes with water from surface sources and groundwater returning to pre-mining levels. Quality of pit lake water can vary considerably, depending on surrounding geologies and exposure of material previously buried. Acid mine drainage (AMD) is an example where exposed materials are oxidised and release acidity resulting in pit lake waters of low pH and typically elevated concentrations of heavy metals (Banks *et al.*, 1997). Conversely, such acidic lakes have extremely low concentrations of carbon and phosphorus (Castro & Moore, 1997). However, where remediation can achieve suitable water quality these pit lakes may become a valuable asset to Australian communities and the environment (McCullough & Lund, 2006).

Low acidity mine lakes

Coal mining in southern Western Australia has produced pit lakes that range in surface area from <1 to 10 ha, depths from <10 to 70 m and age from 5 to 50 years (Lund & McCullough, 2008) (Figure). Although Collie

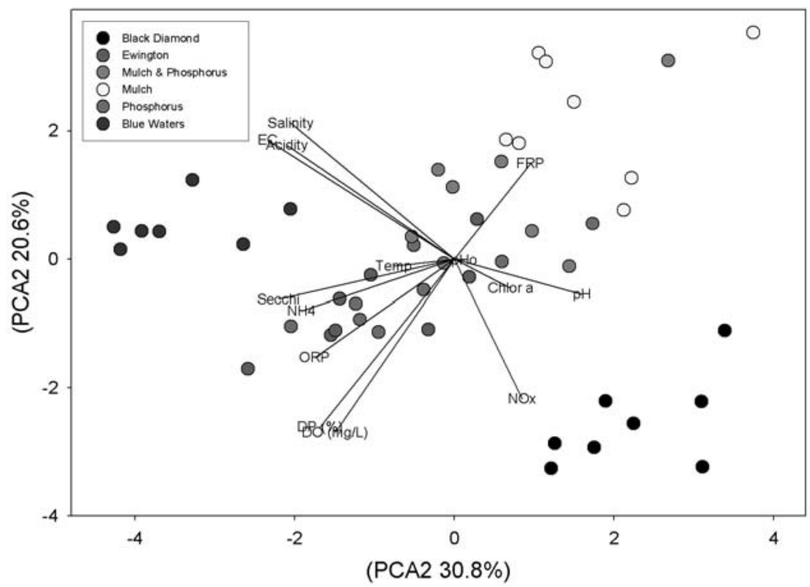


Figure 2. Effect of carbon and phosphorus amendments on mine pit lake water quality over 7 months. Blue Waters Lake pH is lowest at 4.1, Lake Ewington is pH 4.3 and Black Diamond pH is highest at 5.5.

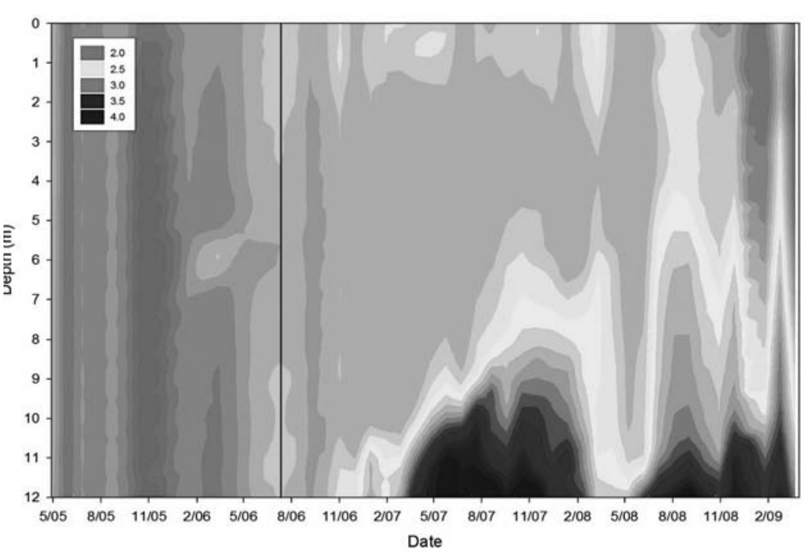


Figure 3. pH changes in northern Australia GAEW pit lake from May 2005 to March 2009. The black line indicates the beginning of organic dosing.

coal pit produces low amounts of acid mine drainage, low natural alkalinity produces pH as low as 3.5 in some pit lakes. Low pH is accompanied by low metal concentrations in pit lake waters, except for aluminum, which at high concentrations is often a toxic species (Neil *et al.*, submitted). Analysis of historic Collie pit lake water quality data from 1995 to present has shown that in the absence of significant surface acidity inputs, acidity within the pit lakes slowly declines but without a commensurate change in pH. Increases in pH are only due to inputs of circum-neutral groundwater or surface waters. Experimental water quality remediation by additions of organic matter and phosphorus direct the lakes to a different water quality evolution trajectory from that of natural remediation processes (Figure 1).

In order to minimise wall exposure and subsequent acid production, a new pit lake, Lake Kepwari, was rapidly filled by a diversion from the Collie River over three winters until 2005 (Oldham *et al.*, 2009). The volume of Lake Kepwari is now 24 GL, with a maximum depth of 65 m and surface area of 10 ha. The proposed end use for this pit lake was contact recreation such as water skiing (Evans & Ashton, 2000). However, although the river water initially raised water pH, the pH has now decreased to 4.8 with elevated metal concentrations (Salmon *et al.*, 2008). This pit lake is good example of how government-supported rehabilitation, lacking in understanding of ongoing limnological acidity-generating processes, has resulted in water quality unsuited to the proposed end-use.

High acidity mine lakes

Garrick East pit lake (North Queensland, north-eastern Australia) is located within the semi-arid tropics and was mined during the 1990s. The lake has a pH of 2.4 with such high concentrations of dissolved metals and sulphate that they form crystals of epsomite underwater. Following successful microcosm pilot studies (McCullough *et al.*, 2006; McCullough *et al.*, 2008b), the lake was split with an earthen barrier and one side was remediated by dosing the 70 ML treatment lake section with dried sewage sludge (60 t), liquid sewage sludge (3,200 t) and municipal green waste (980 t). Water quality was monitored in both pre- and post-dosing in the treatment section and in three control pit lakes over the last few years (McCullough *et al.*, 2008a). Following organic additions, pit lake water chemistry indicated large pH increases through internal sulphate reduction processes. Nevertheless, pH declined again after 12 months of increase and subsequently it recovered and declined again. This decline is thought due to ongoing surface water acidity inputs and water column mixing during heavy cyclonic rainfall events. Nevertheless, this study suggests that addition of low-grade organic materials show promise for remediation of strongly acidic mine waters, particularly in a tropical climate.

Planned formation of pit lake environments worldwide is still at an early stage of development and actual realisation of these often significant water resources is even less frequently explored. After more than half a century of the first large flooded mining pits occurring, the question how to utilise and manage pit lakes remains a challenge for the Australian mining industry, governments, and communities.

References

Banks, D.; Younger, P. L.; Arnesen, R.-T.; Iversen, E. R. & Banks, S. B. (1997). Mine-water chemistry: the good, the bad and the ugly. *Environmental Geology* 32: 157-174.

Bell, L. C. (2001). Establishment of native ecosystems after mining - Australian experience across diverse biogeographic zones. *Ecological Engineering* 17: 179-186.

Castro, J. M. & Moore, J. N. (1997). Pit lakes: their characteristics and the potential for their remediation. *Environmental Geology* 39: 254-260.

Evans, L. H. & Ashton, P. J. (2000). *Value-added closure planning*. Proceedings of the 4th International and 25th National Minerals Council of Australia Environmental Workshop. October 29th - November 2nd, Minerals Council of Australia, 393-409pp.

Lund, M. A. & McCullough, C. D. (2008). *Limnology and ecology of low sulphate, poorly-buffered, acidic coal pit lakes in Collie, Western Australia*. Proceedings of the 10th International Mine Water Association (IMWA) Congress. Karlovy Vary, Czech Republic. Rapantova, N. & Hrkal, Z. (eds.), 591-594pp.

McCullough, C. D. & Lund, M. A. (2006). Opportunities for sustainable mining pit lakes in Australia. *Mine Water and the Environment* 25: 220-226.

McCullough, C. D.; Lund, M. A. & May, J. M. (2006). *Microcosm testing of municipal sewage and green waste for full-scale remediation of an acid coal pit lake, in semi-arid tropical Australia*. Proceedings of the 7th International Conference on Acid Rock Drainage (ICARD). St Louis, Missouri, USA. Barnhisel, R. I. (ed.) American Society of Mining and Reclamation (ASMR), 1,177-1,197pp.

McCullough, C. D.; Lund, M. A. & May, J. M. (2008a). *Field scale trials treating acidity in coal pit lakes using sewage and green waste*. Proceedings of the 10th International Mine Water Association (IMWA) Congress. Karlovy Vary, Czech Republic. Rapantova, N. & Hrkal, Z. (eds.), 599-602pp.

McCullough, C. D.; Lund, M. A. & May, J. M. (2008b). *Treating acidity in coal pit lakes using sewage and green waste: microcosm and field scale trials at the Collinsville Coal Project (Queensland)*. ACARP Project Report C14052. Australian Coal Association Research Program, Perth, Australia. 112pp. Unpublished report to Australian Coal Association Research Programme.

Mudd, G. M. (2007). *The Sustainability of Mining in Australia: Key Production Trends and their Environmental Implications for the Future*. Research Report No RR5. Department of Civil Engineering, Monash University and Mineral Policy Institute,

Neil, L. L.; McCullough, C. D.; Lund, M. A.; Tsvetnenko, Y. & Evans, L. (submitted). Toxicity assessment of acid mine drainage pit lake water remediated with limestone and phosphorus. *Ecotoxicology and Environmental Safety*

Oldham, C.; Salmon, S. U.; Hipsey, M. R. & Ivey, G. N. (2009). Modelling pit lake water quality - Coupling of lake stratification dynamics, lake ecology, aqueous geochemistry and sediment diagenesis. In, *Workbook of Technologies for the Management of Metal Mine and Metallurgical Process Drainage,* Castendyk, D.; Eary, T. & Park, B. (eds.) Society for Mining Engineering (SME), Kentucky, USA,

Radhakrishnan, N.; McCullough, C. D. & Lund, M. A. (submitted). Pit lakes in Australia. In, *Acidic Pit Lakes - Legacies of surface mining on coal and metal ores,* Geller, W. & Schultze, M. (eds.) Springer, Berlin, Germany,

Salmon, S. U.; Oldham, C. & Ivey, G. N. (2008). Assessing internal and external controls on lake water quality: limitations on organic carbon-driven alkalinity generation in acidic pit lakes. *Water Resources Research* 44: W10414.

Clint McCullough and Mark Lund
Mine Water and Environment Research Group
Edith Cowan University,
Western Australia 6027
Australia
http://www.ecu.edu.au/chs/cem/CSML-ECU/
E-mail: c.mccullough@ecu.edu.au

Re-operation of large dams to improve the condition of regulated rivers: An integrated adaptive management approach (Mitta Mitta River, south-eastern Australia)

Flow regulation and water extraction have significantly modified the flow regimes of rivers throughout the world and have contributed to the decline in the biophysical condition of these rivers (Ward & Stanford 1995). To ameliorate this decline, environmental flows have been implemented, or are being considered for implementation in many rivers (Arthington et al 2006). However, in most regulated rivers only a small proportion of water is allocated for environmental purposes. To achieve a significant improvement in the condition of regulated rivers it is essential that consumptive water is also released from dams in a way that achieves environmental benefits at the same time as meeting supply requirements. The challenge for river managers is to alter the operation of dams and weirs to deliver environmental benefits at the same time sustain the industries and communities that rely on water from these systems.

Introducing changes into the operation of dams and weirs is not a straightforward process, as the social, economic and environmental impacts of proposed changes need to be considered (Freeman 2000). Sustainable changes will most likely be achieved through an integrated adaptive management approach, where organisations responsible for water policy, river operations and river health partner with multidisciplinary research teams and engage communities in a meaningful way. Dam re-operation projects have been undertaken in the USA through the Sustainable Rivers Project (SRP), a partnership between The Nature Conservancy and the U.S. Army Corps of Engineers. The SRP aims to minimise the environmental and social threats posed by dams and achieve more ecologically sustainable flows, while maintaining or enhancing project benefits (Hickey & Warner 2005).

Improvements to dam operation have been tested in the Mitta Mitta River in south-eastern Australia, a highly regulated tributary of the iconic Murray River. The Mitta Mitta River often experiences long periods of constant flow due to the operations of Dartmouth Dam. Traditionally, operational practice was to delay water transfers from Dartmouth Reservoir to Hume Reservoir further downstream for as long as possible to minimise the risk of unnecessarily transferring water. Consequently, when transfers were required, river managers were compelled to manage releases near bank-full flows with limited variability, often for extended periods of time.

The Murray-Darling Basin Commission has worked towards increasing the variability of flows in the Mitta Mitta River through managed variable releases from Dartmouth Dam. A series of pulsed releases have been attempted four times in the eight year period 2001-2008 with the explicit intention of providing environmental benefits for the Mitta Mitta River and learning by doing (i.e. adaptive management). This is an example of a 'resource-neutral' approach where environmental benefits are achieved without requiring additional environmental water allocations. Studies of the ecological responses to these pulsed flows have observed changes in water quality, increases in river productivity on the peak of the flow pulses, and increases in algal and macroinvertebrate biodiversity that indicate a shift towards conditions observed in less regulated rivers (Watts et al. 2005; 2006; 2008). Much of the ecological benefits to regulated reaches has come about through increased wetting of instream habitat (Figure 1) and scouring of instream habitat during high volume releases. The environmental responses to the pulsed flows were influenced by antecedent hydrological conditions and many of the responses were short-lived.

One of the key elements of this case study is the long-term relationship between water managers, research scientists and the community. This relationship has enabled adaptive management, where learning and reflection following each variable flow trial has been incorporated into subsequent flow management decisions. The success of this project (in terms of improving our understanding of the system, informing operational activities, and informing the wider water reform process) results from factors that combine to promote a desire to learn, to listen and to change behaviour (Allen et al. 2009). This case study demonstrates that environmental benefits can be achieved at the same time as ensuring the delivery of consumptive water. It also highlights the need for agencies to have a flexible approach to flow management to enable them to respond to opportunities to alter dam operations as they arise.

Figure 1. Comparison of a reach of the Mitta Mitta River during a constant low flow period (discharge 870ML/d on 5/11/07) and during the peak of a flow pulse (discharge 5480ML/day on 21/11/07) during a trial variable flow release.

References

Allan C, Watts R.J., Commens S. & Ryder D.S. (2009) Using adaptive management to meet multiple goals for flows along the Mitta Mitta River in south-eastern Australia. In: *Adaptive Environmental Management: A practical guide*. Eds C. Allan and G. Stankey, Springer.

Arthington, A.H., Bunn, S.E., Poff, N. & Naiman, R.J. (2006) The challenge of providing environmental flow rules to sustain river ecosystems. *Ecological Applications*: 16: 1311-1318.

Freeman, D. M. (2000). Wicked Water Problems: Sociology and Local Water Organizations in Addressing Water Resources Policy. *Journal of the American Water Resources Association, 36*(3), 483-491.

Hickey, J. & Warner, A. (2005) River project brings together Corps, The Nature Conservancy. *The Corps Environment,* 6(2): 10-12.

Ward, J.V. & Stanford, J.A. (1995) Ecological connectivity in alluvial river ecosystems and its disruption by flow regulation. *Regulated Rivers: Research and Management*, 11: 105-119.

Watts, R. J., Nye, E. R., Thompson, L. A., Ryder, D. S., Burns, A., & Lightfoot, K. (2005). *Environmental monitoring of the Mitta Mitta River associated with the major transfer of water resources from Dartmouth Reservoir to Hume Reservoir 2004/2005. Report to the Murray-Darling Basin Commission. Environmental Consultancy report number 97*. Wagga Wagga, Australia: Charles Sturt University, Johnstone Centre.

Watts, R. J., Ryder, D. S., Burns, A., Wilson, A. L., Nye, E. R., Zander, A. & Dehaan, R.(2006). *Responses of biofilms to cyclic releases during a low flow period in the Mitta Mitta River, Victoria, Australia. Report to the Murray Darling Basin Commission*. Wagga Wagga, NSW: Institute for Land Water and Society Charles Sturt University.

Watts R.J., Ryder D.S., Burns A., Zander A, Wilson A.L. & Dehaan R. (2008). *Monitoring of a pulsed release in the Mitta Mitta River, Victoria, during the bulk water transfer from Dartmouth Dam to Hume Dam 2007-08*. Report to the Murray Darling Basin Commission. Institute for Land Water & Society Report # 45, Charles Sturt University, Thurgoona, NSW.

Prof. Robyn Watts
Institute for Land, Water & Society,
Charles Sturt University, Albury, Australia
E-mail: rwatts@csu.edu.au

Dr. Darren Ryder
School of Environmental and Rural Science,
University of New England, Armidale, Australia
E-mail: dryder2@une.edu.au

Sarah Commens
Murray-Darling Basin Authority, Canberra, Australia
E-mail: Sarah.Commens@mdba.gov.au

Dr. Catherine Allan
Institute for Land, Water & Society,
Charles Sturt University, Albury, Australia
E-mail: callan@csu.edu.au

Danish Limnology today – an ecohydrology case study

The start of Danish limnology can be traced to May 1897, when Carl Wesenberg-Lund established his first small field laboratory at the banks of Lake Fure north of Copenhagen. Later, in 1911, he moved the laboratory to the town of Hillerød, and it later became an integrated part of the University of Copenhagen. Today, limnological research takes place at several Danish universities, and a record of Danish limnology would not be complete without mentioning the activities at University of Southern Denmark, Aarhus University, and the National Environmental Research Institute (now part of Aarhus University), in addition to the work still carried out at the Freshwater Biological Laboratory in Hillerød. However, space and time do not permit us to provide a full record of Danish limnological research here, so we will restrict our focus to activities in the Ecohydrology Group at our own department, ENSPAC, at Roskilde University.

Impact from climate change on freshwater resources and ecosystems is an issue of growing international concern. In addition to increasing temperatures, climate change will potentially affect both the amount and the seasonality of

Fig. 1: A typical East Danish stream affected by water abstraction.

Fig 2: Co-author Martin Olsen in the field.

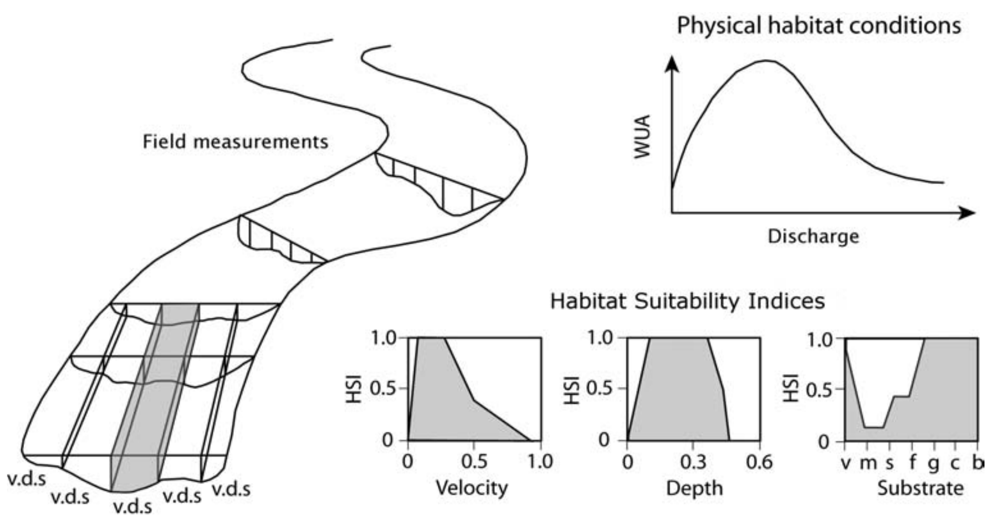


Fig. 3: Conceptual framework for the establishment of a habitat model. Physical stream parameters (e.g. water velocity, depth and substrate type) is measured in the field (a). Brown trout preferences are measured in their natural habitat and integrated in the model (b). Habitat Weigthed Usable Area (WUA) is then calculated for each cell in the stream and summed for the entire stream (c).

precipitation and evaporation, which in turn affect stream discharges as well as the ecological condition of streams. Indeed, climate change projections add complexity to the existing conflict between water demands to satisfy human/industrial needs and to conserve streams as biologically diverse and healthy ecosystems. Solutions to this intensifying conflict require a holistic approach whereby stream biota is related to their physical environment at the watershed scale, as also required by the EU Water Framework Directive (WFD). Water quality criteria for assessment of ecological status in freshwater ecosystems have to relate to reference conditions. Therefore, it is particularly important to understand how climate change affects the environmental conditions in stream waters and if the stream water quality targets set in relation to reference conditions are achievable. To answer this question, it is necessary to understand the interactions between climate, hydrological alterations and hydromorphology, and the impacts of hydromorphological (habitat) changes on stream biota. In Denmark, climate change is expected to have a substantial impact on the hydrological system including both groundwater and river flows. Stream discharge levels in Denmark are already strongly affected by groundwater abstraction (for drinking water, and for industrial and agricultural purposes), which results in very low stream flows during summers [Fig. 1]. This situation is expected to deteriorate further with climate change. The very low summer water flow bring about poor physical conditions for fish and benthic invertebrates.

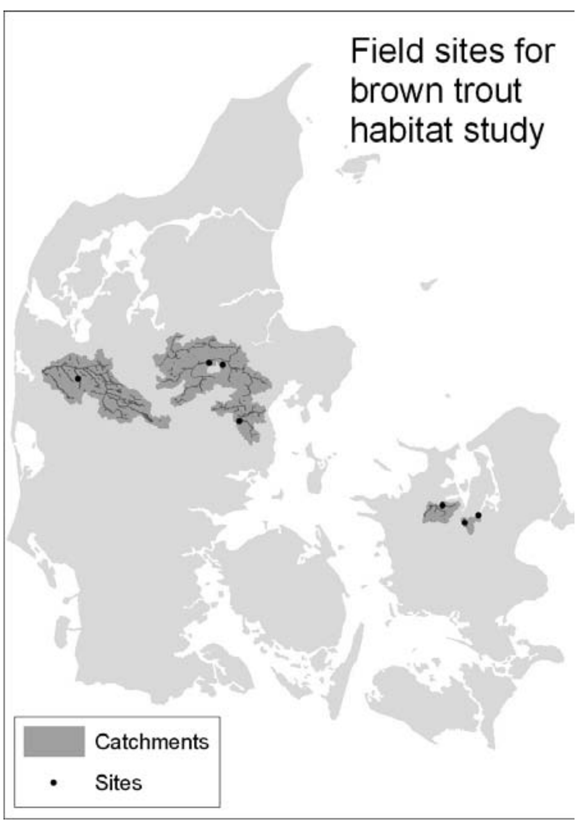


Fig. 4: Field sites for brown trout habitat studies.

In this project, climate-hydrological modeling of run-off conditions is simulated for selected catchments representing different geomorphological river types. The hydrological model setup uses historical climate and groundwater abstraction data and takes advantage of recent technological developments in remote sensing and information (GIS) technology to represent spatial catchment control variables. The model is validated using discharge and groundwater level observations. Removing time series of abstraction data finally simulates run-off reference conditions. Data collection and analysis [Fig. 2] are used to build and set up habitat-hydraulic and non-linear mixed effect models to simulate physical habitat conditions (habitat suitability indices) [Fig. 3] of brown trout (*Salmo trutta*) based off the different stream types present in Denmark [Fig. 4]. Brown trout is chosen because it is an established fish indicator species in Denmark. In addition, macrophytes are being studied because of their ecological significance and strong relationship with hydromorphology and water quality. In particular, the significance of low-flows, water temperature and O_2-levels on physical habitat quality for both trout and macrophytes is investigated and incorporated in the model if significant. For determining habitat requirements and preference conditions for trout, electro-fishing and measurements of stream-profiles, depth, velocity, water quality (O_2, temperature and pH), substrate composition, cover and in-stream density of macrophytes are done several times in the year. The type of riparian vegetation and degree of cover and management (e.g. different degrees of cuttings) of the stream are registered and combined with high-resolution digital air photos, satellite images and GIS data of the stream reaches to relate land use and land cover to stream habitat conditions. The hydrological model is combined with the habitat model using climate and management (abstraction) data to simulate past and present physical habitat quality. Deviation between simulated reference conditions (excluding abstraction) and reality simulations indicate the physical stream condition. Relationships between the bio-indicators (macrophytes, trout) and control-/output-factors from the catchment/in-stream model (e.g. water flow, temperature, O_2, land use, cover) are studied in order to set criteria for these factors to reach good ecological status. A retrospective analysis of climate and management impacts on habitat hydraulic conditions, water temperature, water quality and ecological conditions for trout in streams is performed. It is conducted comparing the eco-hydrological model simulations and existing long-term ecological monitoring data such as brown trout density estimates and the Danish Stream Fauna Index (DSFI). Furthermore, simulation of future changes in physical habitat conditions is done using climate predictions as inputs for the combined hydrological-habitat model assessment system.

Martin Olsen, John Conallin and Søren Laurentius Nielsen,
ENSPAC, Roskilde University,
PO Box 260, DK-4000 Roskilde,
Denmark
E-mail: nielsen@ruc.dk

Research at the interface of limnology and fisheries: Finnish lakes and Lake Tanganyika

Finland is one of the few European countries with flourishing commercial freshwater fisheries and, as elsewhere in the Nordic countries, recreational fishing is increasing in importance (Lehtonen et al. 2008). This importance of fishing is reflected in the abundance of fish-related limnological research in Finland. The Finnish Game and Fisheries Research Institute is the major governmental research institution producing scientific information required for rational management. But the factors affecting population fluctuations of the major fish species, food web interactions involving fish, and the role of fish in the eutrophication of inland waters, have mainly been studied by the research groups at the universities of Helsinki, Joensuu, Jyväskylä and Turku.

Fish yields from Pyhäjärvi, a large, shallow lake in southwestern Finland (61°N, 22°E; 155 km^2, mean depth 5.4 m), have been of particular interest, because they are much higher than expected from published relationships between yield and nutrients or primary production in lakes (yield 34 kg ha^{-1} a^{-1}; total phosphorus 12-19 mg m^{-3}; phytoplankton primary productivity 26-56 g C m^{-2} a^{-1}; Sarvala et al. 1998). The main targets of the fishery are the planktivorous coregonids, vendace and whitefish (*Coregonus* *albula* and *C. lavaretus*). The basis for the high catches was studied from 1983 in a series of long-term ecosystem and fisheries projects, and turned out to be the unusually efficient fishery - all trophic relationships were within the normal range in lakes, but the annual harvest approaches the total production of vendace (Sarvala et al. 1998).

With gradual eutrophication of Pyhäjärvi since the late 1980s, it became clear that the fish community also affected water quality, with the role of vendace appearing somewhat contradictory. As the most specialized zooplankton feeder in North European lakes, vendace is a keystone species in the pelagic system, and its feeding has cascading effects in the food web. On the other hand, vendace is an effective competitor that during periods of strong stock seems to exclude other pelagic fish species from the central open waters of the lake (Sarvala et al. 1998), preventing their deleterious water quality effects. In the 1980s, when the fish community in Pyhäjärvi was dominated by vendace, the water quality was still relatively good, and the chlorophyll/phosphorus relationship was practically identical to that in lakes with low abundance of planktivorous fish and high abundance of large cladocerans. In the 1990s, when vendace stock was weak and the fish community was dominated by coarse fish, the chlorophyll/phosphorus relationship still showed similar slope but at a higher level, approaching the situation in lakes with abundant planktivores and small cladocerans (Ventelä et al. 2007). The coarse fish harvest has been subsidized since 1995, and more than 1,500,000 kg of fish (20-50 kg ha^{-1} a^{-1}) have been removed. The highest catches were in 2002-2004, resulting in a drastic decline of algal biomass, in spite of a recovering vendace stock. During the intensified biomanipulation in 2002-2004, the chlorophyll/phosphorus ratio quickly shifted to a clearly lower level, but returned to intermediate values in 2005-2006 with decreased fishing efficiency after 2004 combined with very strong vendace year-classes. These changes in the chlorophyll-phosphorus relationship confirmed that the water quality improvements were at least partly caused by the cascading effects of the intensified fishery although temporarily reduced external loading due to simultaneous drought was also important (Ventelä et al. 2007). Thus, in Pyhäjärvi, a sustainable commercial fishery seems to be the key element in maintaining the balance between fish and water quality. In fact, Pyhäjärvi has for decades been the object of intensive though unintentional biomanipulation by commercial fishermen (Sarvala et al. 1998).

Intentional manipulation of the fish community has also been successfully used in the internationally well-known large-scale restoration project of the Enonselkä basin in Lake Vesijärvi in southern Finland (61ºN, 25º30'E; 26 km^2, mean depth 6 m) (Kairesalo et al. 1999). A combination of a removal fishery targeted on adult roach (*Rutilus rutilus*), simultaneous regulation of the gill-net fishery in favour of big fish, and supplementary pikeperch stocking seems to have been successful in maintaining a healthy balance between the piscivores, planktivores and water quality (Ruuhijärvi et al. 2005). Food web interactions were also found important in the northern Lake Inari where the program of fish stocking, designed to compensate for catch losses caused by water level regulation, had to be amended to take better account of the predator-prey balance (Salonen et al. 2007).

Experience gained from Pyhäjärvi studies was applied in 1992-2001 in East Africa in the FAO/Finnida Research for the Management of the Fisheries on Lake Tanganyika, known as the LTR project, and its continuation Lake Tanganyika Fisheries Monitoring Program (Lindqvist et al. 1999, www.fao.org/fi/ltr). This was the first lake-wide ecosystem study on Tanganyika, working out the biological basis of the fishery. Collaboration with local scientists has continued after the official project period; for example, the trophic relationships in the pelagic community were clarified using stable isotopes (Sarvala et al. 2003 and unpublished). In 2009 a student and teacher exchange program targeting the limnology and fisheries of Lake Tanganyika is being launched between three Finnish universities and the Dar es Salaam and Burundi universities. An overview of the carbon flow in the pelagic ecosystem suggested that relative to primary production, the total fisheries yield in Lake Tanganyika is within the typical range in lakes (Sarvala et al. 1999). The present fishery of the planktivorous

Fig.1.Late autumn tranquility at Pyhäjärvi boat harbour

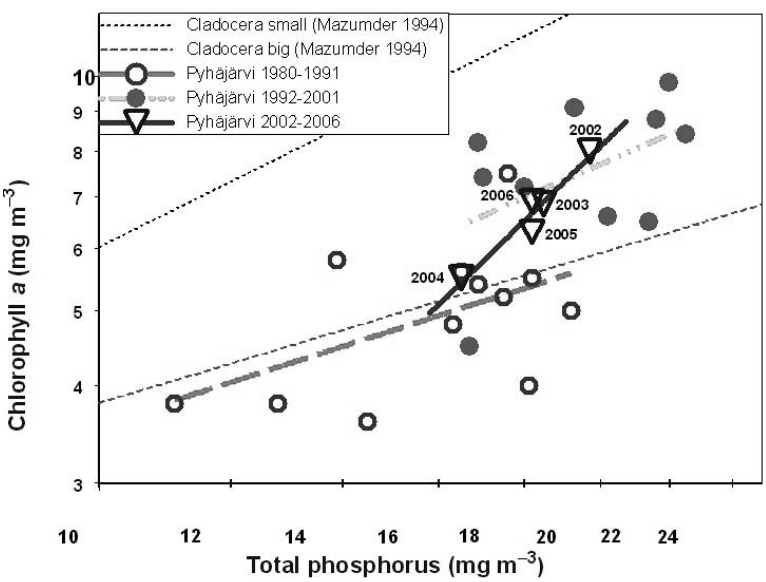


Fig. 2. Chlorophyll/phosphorus relationship in Pyhäjärvi in 1980-2006. Regressions indicated separately for the periods 1980-1991, 1992-2001, and 2002-2006. The oblique lines denote average relationships for non-stratified lakes with small Daphnia and abundant planktivorous fish (upper line) and for lakes with large Daphnia and sparse planktivorous fish (lower line) (from Ventelä et al. 2007).

clupeids seems sustainable, although the yields are approaching the potential set by zooplankton food production. The harvest rates of the piscivores, in contrast, are extremely high, with possible overexploitation (Sarvala et al. 2002). Recently concerns have arisen that limnological changes caused by climate change could threaten the fisheries of Tanganyika, but so far the observed variations in catches mainly reflect changes in fishing practices and short-term environmental fluctuations, not directional climate change (Sarvala et al. 2006).

Although Tanganyika is very different from the rather shallow boreal lakes, the Finnish experience illustrates how sound scientific understanding of basic limnological processes can transcend inter-lake and regional differences. Knowledge transfer and collaboration for better lake management truly can operate at the global scale according to the established aims of SIL.

References

Kairesalo, T., Laine, S., Luokkanen, E., Malinen, T. & Keto, J. 1999. Direct and indirect mechanisms behind successful biomanipulation. Hydrobiologia 395/396: 99-106.

Lehtonen, H., Rask, M., Pakkasmaa, S. & Hesthagen, T. 2008. Freshwater fishes, their biodiversity, habitats and fisheries in the Nordic countries. Aquatic Ecosystem Health & Management 11: 298-309.

Lindqvist, O.V., Mölsä, H., Salonen, K. & Sarvala, J. (eds.) 1999. From Limnology to Fisheries: Lake Tanganyika and Other Large Lakes, Developments in Hydrobiology (Hydrobiologia 407), Kluwer. 224 p.

Ruuhijärvi, J., Malinen, T., Ala-Opas, P. & Tuomaala, A. 2005. Fish stocks of Lake Vesijärvi: from nuisance to flourishing fishery in 15 years. Verh. Internat. Verein. Limnol. 29: 384-389.

Salonen, E., Niva, T., Raineva, S., Pukkila, H. & Savikko, A. 2007. Säännöstellyn Inarijärven ja sen sivuvesistöjen kalataloudellinen velvoitetarkkailu. Toimintakertomus 2006. Kala- ja riistaraportteja 417. 33 pp + appendix. (In Finnish.)

Sarvala, J., Helminen, H. & Auvinen, H. 1998. Portrait of a flourishing freshwater fishery: Pyhäjärvi, a lake in SW-Finland. Boreal Env. Res. 3: 329–345.

Sarvala, J., Badende, S., Chitamwebwa, D., Juvonen, P. , Mwape, L., Mölsä, H., Mulimbwa, N., Salonen, K., Tarvainen, M. & Vuorio, K. 2003. Size-fractionated $\delta^{15}N$ and $\delta^{13}C$ isotope ratios elucidate the role of the microbial food web in the pelagial of Lake Tanganyika. Aquatic Ecosystem Health & Management 6: 241–250.

Sarvala, J., Langenberg, V.T., Salonen, K., Chitamwebwa, D., Coulter, G.W., Huttula, T., Kanyaru, R., Kotilainen, P., Makasa, L., Mulimbwa, N. & Mölsä, H. 2006. Fish catches from Lake Tanganyika mainly reflect changes in fishery practices, not climate. Verh. Int. Ver. Limnol. 29: 1182-1188.

Sarvala, J., Salonen, K., Järvinen, M., Aro, E., Huttula, T., Kotilainen, P., Kurki, H., Langenberg, V., Mannini, P., Peltonen, A., Plisnier, P.-D., Vuorinen, I., Mölsä, H. & Lindqvist, O. V. 1999. Trophic structure of Lake Tanganyika: carbon flows in the pelagic food web. Hydrobiologia 407: 155–179.

Ventelä, A.-M., Tarvainen, M., Helminen, H. & Sarvala, J. 2007. Long-term management of Pyhäjärvi (southwest Finland): eutrophication, restoration – recovery? Lake and Reservoir Management 23: 428-438.

Professor Jouko Sarvala,
Section of Ecology, Department of Biology, University of Turku,
FI-20014 Turku, Finland
E-mail: jouko.sarvala@utu.fi

Fig. 3. Purse seiner heading for night fishing on Lake Tanganyika (Mpulungu, Zambia)

Freshwater ecosystems play an important role in the landscape carbon cycling

Because freshwater ecosystems cover only a small fraction of the Earth's surface area (Downing et al. 2006), they have often been neglected as potentially important components in landscape energy or element cycles. However, recent studies have shown that lakes and rivers play a significant role in the transport, storage, and decay processes of the terrestrially-fixed carbon not only regionally but also globally (Cole et al. 2007). Thus, lakes and rivers as biogeochemically active sites can exert a disproportionately large impact on carbon mass balances and cycling rates.

There are about 56 000 lakes larger than one hectare in Finland, covering 10 % of the country's total area. Consequently, lakes have always played an important role in Finnish landscape. They are also extremely important as recreational sites (Figure 2). The cold climate and flat topography provide favourable conditions for organic matter accumulation. Peatlands cover about one-third of the land area and lakes are typically coloured by humic substances. Thus, carbon cycling has been a topical issue in Finnish limnological research for decades. Finnish lakes are predominantly net heterotrophic, evading carbon gases into the atmosphere and burying organic carbon in sediments. Already in early 1980s, a net heterotrophy of some humic lakes was suggested by Salonen et al. (1983). Presently, Finnish lakes have been shown to be supersaturated with both CO_2 (carbon dioxide) and CH_4 (methane) throughout the year, releasing carbon gases continually to the atmosphere during the ice-free period and accumulating high amounts of CO_2 and CH_4 in the water column during the ice cover period (Kortelainen et al. 2006, Juutinen et al. 2008).

Eutrophic lakes not only fix more CO_2 from the atmosphere than oligotrophic lakes, they also process terrestrially-fixed carbon more effectively. Subpopulations of 209 and 122 lakes, located between latitudes 60° and 69°, were randomly selected from the Nordic Lake Survey data base for carbon gas (Kortelainen et al. 2006, Juutinen et al. 2008) and sediment C stock studies (Kortelainen et al. 2004), respectively. Catchment land use represents the typical pattern in the boreal zone: lakes are predominantly surrounded by forests and peatlands with lower proportions of agricultural land. Although most of organic carbon in Finnish lakes as in boreal lakes in general originates from surrounding forests and peatlands, our results demonstrated that eutrophic lakes, surrounded by agricultural land are important sources of CO_2 (Figure 1) and CH_4 into the atmosphere (Juutinen et al. 2008). Two contrasting sources of CO_2 in lakes were identified on the basis of statistical analysis of the data; weathering processes in the catchments and decomposition of organic matter. Calcareous catchments release considerable amounts of carbon to lakes as bicarbonate and carbonate. Thus, elevated TIC (total inorganic carbon) concentrations were associated with agricultural land in the catchment, whereas elevated TOC (total organic carbon) concentrations were observed in lakes with high peatland proportion in the catchment (Rantakari & Kortelainen 2008).

Spatially representative and randomly selected lake data bases demonstrate that Finnish lakes contribute significantly both to landscape C pools and fluxes and consequently to catchment C sequestration in the boreal zone. Both CO_2 and CH_4 evasion into the atmosphere and areal C stock in the sediment were highest in small, shallow lakes; small lakes can thus be considered as biogeochemical "hot spots" within the terrestrial landscape. Lakes are important conduits for transferring terrestrially fixed C into the atmosphere. The annual CO_2 emission from Finnish lakes was estimated as 1.4 Tg C, approximately 20% of the average annual C accumulation in Finnish forest soils and tree biomass (covering 51% of the total area of Finland) in the 1990s (Kortelainen et al. 2006). Average annual C accumulation in lake sediments during the Holocene was significantly lower, although areal C stocks in lakes are significantly larger than in forest soils (Kortelainen et al. 2004).

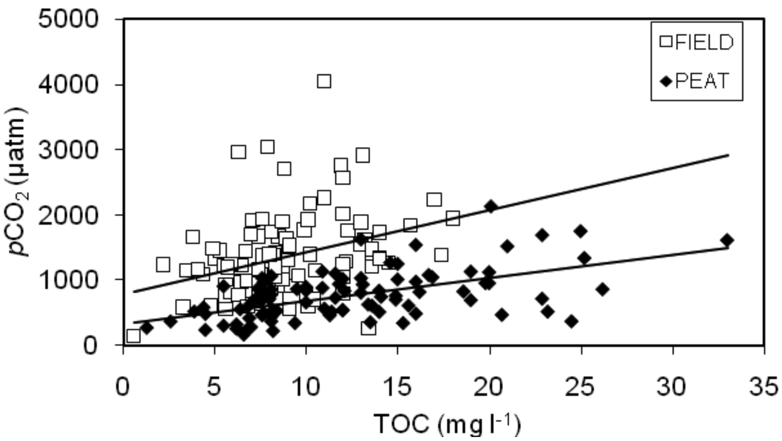


Figure 1. The relationship between the TOC content and pCO_2 (partial pressure of CO_2) in autumn samples in randomly selected Finnish lakes, surrounded by different land use patterns: PEAT (peatland > 35 % and agricultural land < 8 %) and FIELD (agricultural land > 10 % and peatland < 12 %) (Rantakari & Kortelainen 2008).

Figure 2. Lake Vasamonjärvi in Ylikiiminki village (photo: Kalervo Ojutkangas).

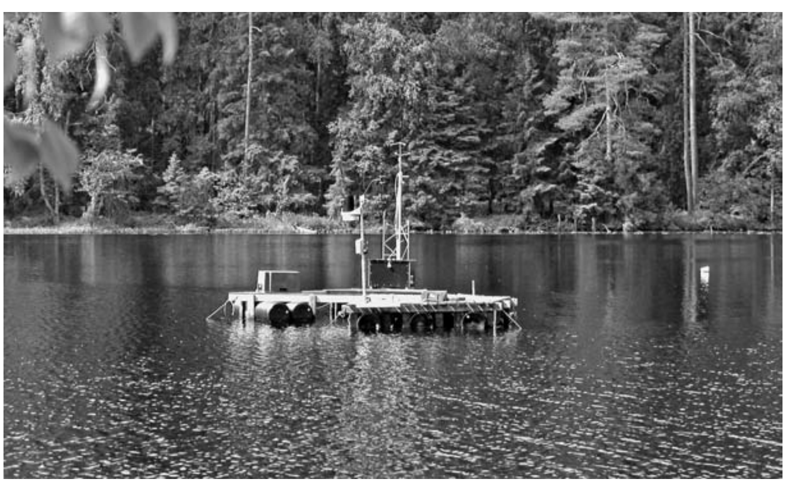


Figure 3. The eddy covariance technique has been used since 2002 to measure continuous open water CO_2 exchange (NEE) between Lake Valkea Kotinen (located close to Lammi Biological station) and the atmosphere (photo: Ilpo Hakala).

Climate change scenarios predict increasing precipitation and temperature for Northern Europe, which can further significantly contribute to biogeochemical cycles. For example, methane emissions from lake littorals have been shown to increase with increasing temperature (Kankaala & Bergström 2004), which can significantly contribute to freshwater methane emissions. Further, the total area of artificial lakes is growing, and they are even more efficient carbon sinks than natural lakes. Downing et al. (2008) estimated world's farm ponds alone to bury (annually) more organic carbon than the oceans and all manmade impoundments to bury four times as much carbon as the world's oceans.

Modern techniques have been recently applied to Finnish limnological research. Stable isotope analysis (SIA) has provided comprehensive information for example on the important role of methanotrophic bacteria as a carbon source for zooplankton (Kankaala et al. 2006). Lack of the integration between aquatic and terrestrial ecologists has limited the ability to deal with large topographically heterogenous lanscapes where C balances are strongly influenced by spatial interactions among ecosystems including metabolically active interfaces for element cycling. Consequently, the Finnish limnologists have been working in close collaboration with forest ecologists and atmospheric physicists and successfully applied the micrometeorological eddy covariance (EC) technique in lacustrine carbon gas exchange studies (Figure 3). The continuous measurements with the same technique as used in terrestrial systems not only enable smooth integration over the landscape but also provide detailed information on lake-atmospheric dynamics (Vesala et al. 2006).

References

Cole, J.J., Prairie, Y.T., Caraco, N.F., McDowell, W.H., Tranvik, L.J., Striegl, R.G., Duarte, C.M., Kortelainen, P.L., Downing, J.A., Middelburg, J. & Melack, J.M. 2007. Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget. Ecosystems 10: 171-184.

Downing, J.A., Cole, J.J., Middelburg J.J., Striegl, R.G., Duarte, C.M., Kortelainen, P., Prairie, Y.T. & Laube, K.A. 2008. Sediment organic carbon burial in agriculturally eutrophic impoundments over the last century. Global Biogeochemical Cycles 22, GB1018, doi:10.1029/2006GB002854.

Downing, J.A., Prairie, Y.T., Cole, J.J., Duarte, C.M., Tranvik, L.J., Striegl, R.G., McDowell, W.H., Kortelainen, P., Caraco, N.F., Melack, J.M. & Middelburg J. 2006. The global abundance and distribution of lakes, ponds, and impoundments. Limnology and Oceanography 51 (5) 2388-2397.
Juutinen, S., Rantakari, M., Kortelainen, P., Huttunen, J.T., Larmola, T., Alm, J., Silvola, J. & Martikainen, P.J. 2009. Methane dynamics in different boreal lake types. Biogeosciences 6: 209-223.
Kankaala P. & Bergström I. 2004. Emission and oxidation of methane in Equisetum fluviatile stands growing on organic sediment and sand bottoms. Biogeochemistry 67: 21–37.
Kankaala, P., Taipale, S., Grey, J., Sonninen, E., Arvola, L. & Jones, R. I. 2006, Experimental delta C-13 evidence for a contribution of methane to pelagic food webs in lakes. Limnology and Oceanography 51(6): 2821-2827.
Kortelainen, P., Pajunen, H., Rantakari, M. & Saarnisto, M. 2004. A large carbon pool and small sink in boreal Holocene lake sediments. Global Change Biology 10: 1648-1653.
Kortelainen, P., Rantakari, M., Huttunen, J.T., Mattsson, T., Alm, J., Juutinen, S., Larmola, T., Silvola, J. & Martikainen, P.J. 2006. Sediment respiration and lake trophic state are important predictors of large CO_2 evasion from small boreal lakes. Global Change Biology 12: 1554-1567.
Rantakari, M. & Kortelainen, P. 2008. Controls of organic and inorganic carbon in randomly selected Boreal lakes in varied catchments Biogeochemistry 91:151-162.
Salonen, K., Kononen K. & Arvola L. 1983. Respiration of plankton in two small polyhumic lakes. Hydrobiologia, 101: 65–70.
Vesala, T., Huotari, J., Rannik, U., Suni, T., Smolander, S., Sogachev, A., Launiainen, S. & Ojala, A. 2006. Eddy covariance measurements of carbon exchange and latent and sensible heat fluxes over a boreal lake for a full open-water period. Journal of Geophysical Research vol. 111, D11101, doi: 10.1029/2005JD006365, 2006.

Pirkko Kortelainen,
Finnish Environment Institute,
P.O. Box 140,
FI-00251 Helsinki,
Finland
E-mail: pirkko.kortelainen@ymparisto.fi

Groundwater ecosystem functioning and assessment of the ecological status

Groundwater systems are - from a volume perspective - by far the most important limnic ecosystems. They carry the world's most significant amount of freshwater available to human purposes. Healthy aquifers deliver essential ecosystem services, i.e. the purification of recharge water and the storage of high quality water over decades in significant quantities. In the European Union, almost 70% of drinking water derives from groundwater. In addition, numerous ecosystems, e.g. streams and wetlands, directly depend on groundwater quantity and quality.

Aquifers are ecosystems that are complex in structure, dimension, and connectivity. They harbour a vast and almost unrecognized diversity of microorganisms and fauna (Danielopol and Pospisil 2000, Griebler and Lueders 2008). It is believed that groundwater ecosystems almost exclusively rely on organic carbon coming from the surface. Thus, it is not surprising that the numbers of invertebrates found drastically decrease with depth so that at 100 m below ground, 10,000 L of pumped groundwater might contain just one specimen. In contrast, porous aquifers harbour a steady number of microorganisms; mainly bacteria. Gravel and sandy sediments contain 10^6 to 10^8 cells g^{-1} sediment Assuming an even distribution of cells, < 1 % of the particle surfaces is colonized. Thus, attached bacteria are mainly organised as microcolonies, not multilayered biofilms. How can these be a valuable food source for groundwater invertebrates – even if the latter are the world champions in starving?

And how do groundwater microbial communities manage to sustain the same abundances with depth, although infiltrating organic carbon rapidly decreases to low levels (< 1 mg L^{-1}) without further changing with depth, obviously insufficient to sustain the present microbial biomass? Indeed, there are alternative carbon sources, namely deep oil reserves and coal deposits and the almost infinite amount of inorganic carbon, which (theoretically) can be transferred into biomass via chemolithoautotrophic primary production. However, except for some evidence we completely lack numbers.

One reason for the stable bacterial biomass along with depletion of organic carbon might be a parallel decrease in ecosystem complexity and thus reduced grazing and preying pressure by fauna and microeukaryotes. So far, we lack information on maintenance energy needed

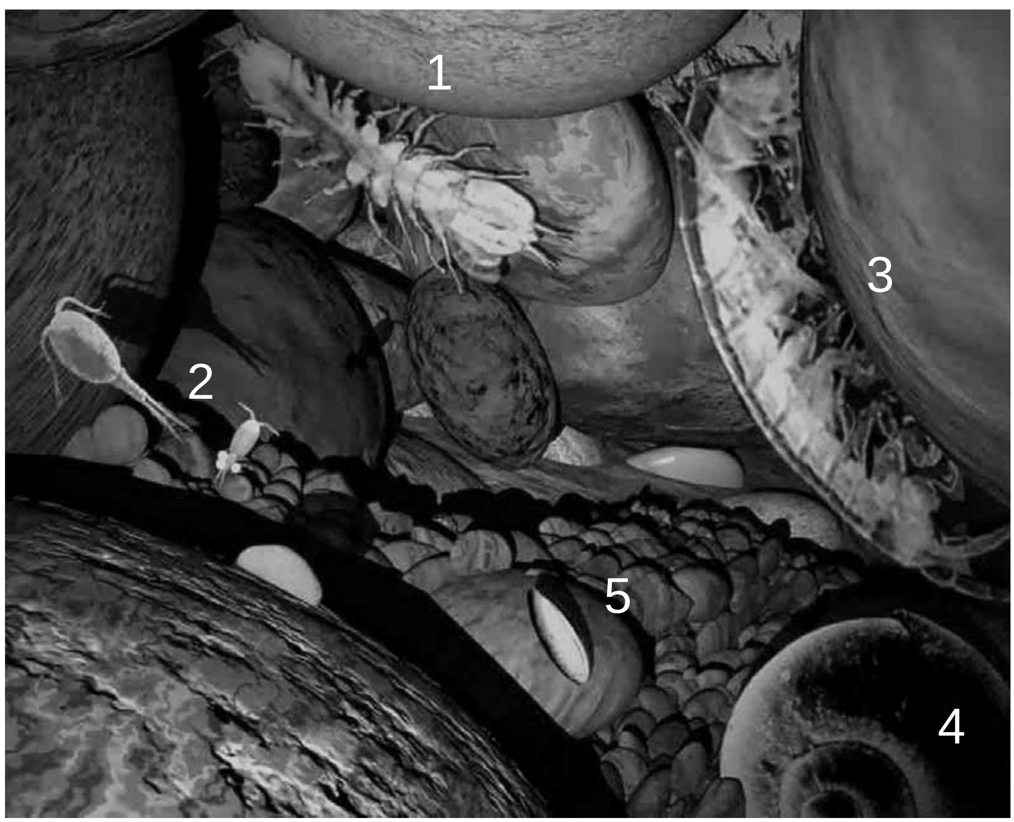


Fig. 1: An ecologist's view of life in the porous aquifer (picture produced by P. Pospisil; (1) Isopod, (2) Copepods, (3) Amphipod, (4) Gastropod, and (5) Ostracod.

by organisms during starvation and are unable yet to estimate the relation between food web structure and carbon sources, all the more since there has been virtually no study so far which accounts for biogeochemical features, microbial and metazoan diversity and abundances at the same time and place. In conclusion, we lack adequate data sets for experimenting with carbon budget models.

No microbial taxon endemic to aquifers has been found so far (Griebler & Lueders 2009), whereas in groundwater fauna, endemicity is huge (Sket 1999). This has implications for developing assessment systems. And time is putting us under pressure here, because legislation begins to ask for appropriate criteria to assess the ecological status of groundwater systems. Isn't it bizarre that without having a detailed functional ecosystem understanding, we try to distil indicator species which provide information on ecosystem health (Steube et al. 2009; project funded by the German Federal Environment Agency UBA)?

Our colleagues at the Institute of Groundwater Ecology at the Helmholtz Center in Munich, Germany, developed a common vision to address these challenges. Hydrologists, geochemists and biologists have contributed to the development of a conceptual and mathematical groundwater ecosystem model. To fill some of the "empty boxes" in the ecosystem model, an experiment in a large indoor flow-through sediment system is being performed in the framework of the EU ITN project GOODWATER. Several Ph.D. students collaborate on (i) organic contaminant transport and biodegradation, (ii) identification of microbial key players, (iii) the iron and sulphur cycle, (iv) environmental proteomics, and (v) stable isotopes as tracers in chemical reactions. A postdoctoral fellow will combine the concepts and results and develop a reactive transport model. In the EU IEF project WATERBUGMODEL, biological data derived from this project, among others, will be used to parameterize functional biofilm models. Together these efforts will enable us to estimate natural resistance, resilience and recovery potential with respect to human impacts.

References:

Danielopol, D.L. and Pospisil, P. 2000. Biodiversity in groundwater: a large scale view. Trends Ecol. Evol. 15: 223-224.

Griebler, C. and Lueders, T. 2009. Microbial biodiversity in groundwater ecosystems. Freshw. Biol. DOI:10.1111/j.1365-2427.2008.02013.x.

Sket, B. 1999. The nature of biodiversity in hypogean waters and how it is endangered. Biodiversity and Conservation 8: 1319-1338.

Steube, C., Richter, S. and Griebler, C. 2009. First attempts towards an integrative concept for the ecological assessment of groundwater ecosystems. Hydrogeol. J. 17: 23-35.

Christian Griebler and Susanne I. Schmidt,
Groundwater ecologists
Helmholtz Center Munich
Institute of Groundwater Ecology
Ingolstaedter Landstrasse 1
D-85764 Neuherberg
Germany
E-mail: christian.griebler@helmholtz-muenchen.de

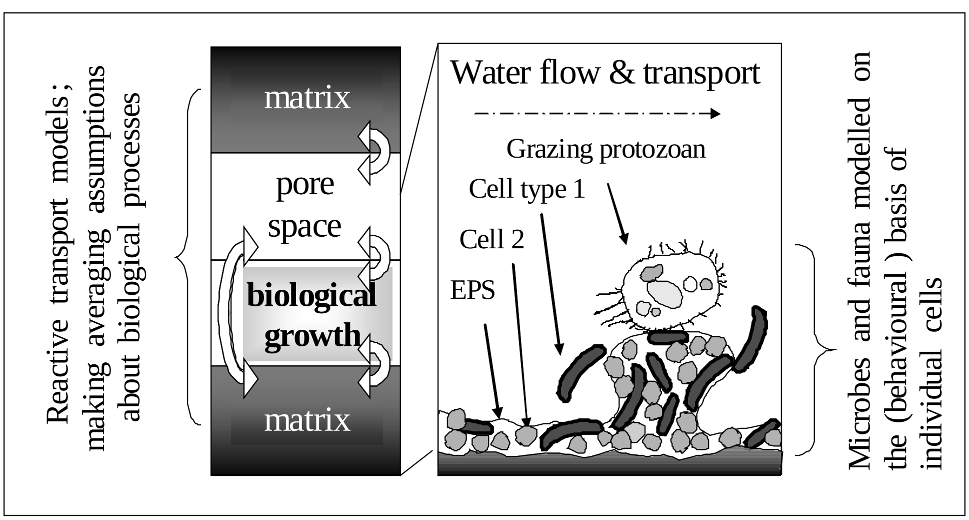


Fig 2. Conceptual overview of the coupling of the bioreactive transport models and the functional biofilm model of the microbial and faunal community, taking into account the interplay between different taxa.

Regional Limnology Spain

Snapshots on recent advances in Microbial Diversity and Ecology in Iberian Freshwater Ecosystems, Spain.

Plant-Microbe Interactions and Nitrogen Cycle in Wetlands

The nitrogen cycle and the implication of microorganisms governing it in natural environments are of critical importance in many ways. Microbial transformations of nitrogen may be a desired activity (i.e. nitrogen removal from wastewater or the increase of available nitrogen in crop soils) and the reason for many complaints in relation to global warming (i.e. production of greenhouse effect gases). The understanding of how bacteria transform nitrogen is essential in wetlands, mainly through nitrifications and denitrification, but also through DNRA and ANAMMOX. These processes are being described in Natural and Constructed Wetlands of the Spanish coast (Marismas de Doñana and Aiguamolls de l'Empordà), in particular how macrophytes affect the diversity and activity of nitrifying and denitrifying microorganisms (Ruiz-Rueda et al. 2009). The stimulation of bacterial nitrogen removal by plants is rather complex in "natural" systems, and defining appropriate vectors for these relationships is not an easy task. Plant-microbe interactions are being tested as new tools to promote microbial isolation.

Lluís Bañeras,
Institute of Aquatic Ecology,
University of Girona
E-mail: lluis.banyeras@udg.edu
http://www.udg.edu

Ecology and Biology of Novel Freshwater Archaea

The study of freshwater planktonic archaea is a fast growing and promising area of research (Casamayor and Borrego 2009). Archaea represent a considerable fraction of the picoplankton (between 1 and 37%) in freshwaters. From their ubiquity and abundance it can be envisaged that these microorganisms might have a large impact on biogeochemical cycles and global energy fluxes. However, the lack of pure cultures has strongly limited progress to understand their physiology and functional role within the ecosystem. We are currently studying the biology and ecological roles of several lineages of lacustrine archaea in both freshwater stratified lakes (Banyoles Karstic System, Girona, Spain) (Figure 1) and oligotrophic high mountain lakes (Limnological Observatory of the Pyrenees, LOOP]) (Fig. 2). In mesotrophic stratified lakes, anoxic water layers harbor a very rich archaeoplankton community, which will undoubtedly resolve in a larger metabolic diversity than previously assumed (Llirós et al., 2008). The archaeal lineages that prevail in these habitats (MCG *Crenarchaeota*) are distantly related to those prevailing in high mountain lakes or in the open ocean where Marine Crenarchaeota Group I dominates. In surface waters of Spanish Pyrenean lakes in particular, archaea reached >30% of total cells and the hydrophobic surface film at the air/water interphase (neuston, Fig. 2) appeared as a "hotspot" for uncultured crenarchaeota (Auguet and Casamayor 2008). Using lakes as model ecosystems we pursue to identify distribution patterns, environmental drivers and ecological thresholds for freshwater Archaea, and establish the links between archaeal community composition and biogeochemical cycling. Last but not least, we are combining advanced biochemical and analytical techniques with innovative cultivation systems to enrich and further isolate members of the main archaeal lineages that predominate in freshwater environments.

Figure 1. Sunset at Lake Banyoles, the main waterbody of the Banyoles Karstic System (Girona, Spain). Picture by C. Borrego.

Figure 2. Left: Panoramic view of the lake Vidal d'Amunt (2684 m.a.s.l.) in the Limnological Observatory of the Pyrenees (LOOP). Right: Members of the CEAB-CSIC team collecting samples from the hydrophobic surface film at the air/water interphase (neuston) in a Pyrenean lake in the Aiguestortes National Park. Pictures by E.O. Casamayor.

Carles Borrego,
Institute of Aquatic Ecology, UdG
E-mail: carles.borrego@udg.edu
http://www.udg.edu

Emilio O. Casamayor
Centre d'Estudis Avançats de Blanes (CEAB-CSIC)
E-mail: casamayor@ceab.csic.es
http://nodens.ceab.csic.es/ecogenomics

Functional Studies in Stratified Lakes

Nutrient limitation in upper layers during stratification occurs in both oligotrophic and mesotrophic lakes. This limits phytoplankton growth and allows penetration of selective light wavelengths to the metalimnion. There, dense populations of light-adapted phototrophic microorganisms take advantage of nutrient availability (Miracle et al., 1992). These commonly are cyanobacteria and cryptophytes, chrysophytes or sulphur phototrophic bacteria, or both (Camacho, 2009), depending on the type of lake. Several groups of researchers are now trying to determine the role of these populations on nutrient cycles, as well as their contribution to lake overall primary production, their mechanisms for nutrient acquisition and buoyancy regulation, and the microbial interactions among different lake layers. Nutrient transport to upper layers mediated by zooplankton migration is a mechanism of high relevance for the trophic functioning of oligotrophic lakes. In particular, deep planktonic populations in the maritime Antarctica shift their prevalence to benthic primary producers, and create "life oases" close to the bottom of the lakes. Nutrients are later transported to upper layers by means of metazooplankton migration. Current research in these Antarctic lakes is related to catchment-scale processes that influence lake functioning, as well as the interactions between the different components of the microbial food webs of these lakes (Camacho, 2006) and the effects of climate change on the functioning of these ecosystems.

Antonio Camacho,
Institut Cavanilles,
University of Valencia
E-mail: antonio.camacho@uv.es
http://www.uv.es/~biodiver/e/index.htm

Saharan Dust Storms: Lake Fertilization and Microbial Dispersal Vector

Massive airborne plumes of Saharan dust are regularly exported to the Mediterranean region (Fig. 4). These dust inputs are a significant source of mineral nutrients (Morales-Baquero et al. 2006) and organic nutrients (Mladenov et al. 2008) to inland waters, stimulating directly bacterial growth particularly in phosphorus-limited ecosystems (Reche et al. 2009). In addition to nutrient inputs, viable bacteria can be transported long-distances and be inoculated into these pristine waters (Hervàs and Casamayor 2009). Current research is based on loading (frequency and intensity) of airborne bacteria, and their viability and colonization success (*i.e.* competitive ability against indigenous bacteria) in waters of high mountain lakes from Sierra Nevada, Pyrenees and Alps that represent a gradual influence of Saharan dust inputs. Very closely related *Acinetobacter* spp. were found in Mauritanian sandy soils and dust collected over Sierra Nevada and Pyrenees, indicating these species are a frequent and viable airborne bacteria with potentiality to develop in alpine lakes (Hervás et al. 2009). This research reports processes associated with global change, as desertification and land use change, are promoting a net increase in dust content in the atmosphere with potential effects on bacterial worldwide dispersion.

Isabel Reche,
Departamento de Ecología,
Facultad de Ciencias, Universidad de Granada,
E-mail: ireche@ugr.es
http://www.ugr.es/~ireche
http://www.ecosensor.org

References

Auguet JC, EO Casamayor (2008) A hotspot for cold Crenarchaeota in the neuston of high mountain lakes. Environmental Microbiology 10: 1080-1086

Camacho A (2006) Planktonic microbial assemblages and the potential effects of metazooplankton predation on the food web of lakes of the maritime Antarctica and Subantarctic Islands. *Rev. Environ. Sci. Biotechnol.* 5: 167–185.

Camacho A. (2009) Sulfur Bacteria. *In*: Gene E. Likens, (Editor) *Encyclopedia of Inland Waters*. Volume 3, pp. 261–278 Oxford: Elsevier.

Casamayor EO, CM Borrego (2009) Archaea. In “Encyclopedia of Inland Waters”, G. Likens (ed.), Academic Press, Elsevier Oxford, UK, vol. 3 pp: 167-181

Hervàs A and EO Casamayor (2009) High similarity between bacterioneuston and airborne bacterial community compositions in a high mountain lake area. *FEMS Microbiol Ecol* 67: 219–228.

Hervàs A, L Camarero, I Reche and Casamayor EO (2009) Viability and potential for immigration of airborne bacteria from Africa that reach high mountain lakes in Europe. Environmental Microbiology 11: 1612-1623

Llirós M, EO Casamayor and C Borrego (2008) High archaeal richness in the water column of a freshwater sulphurous karstic lake along an inter-annual study. *FEMS Microbiol. Ecol.* 66: 331–342.

Miracle MR, E Vicente and C Pedrós-Alió (1992) Biological studies of Spanish meromictic and stratified lakes. *Limnetica* 8: 59–77.

Mladenov N, E Pulido-Villena, R Morales-Baquero, E Ortega-Retuerta, R Sommaruga and I Reche (2008). Spatiotemporal drivers of dissolved organic matter in high alpine lakes: the role of Saharan dust inputs and bacterial activity. *J. Geophys. Res. Biogeosciences* 113, G00D01, doi:10.1029/2008JG000699.

Morales-Baquero R, E Pulido-Villena and I Reche (2006) Atmospheric inputs of phosphorus and nitrogen to the southwest Mediterranean region: Biogeochemical responses of high mountain lakes. *Limnol. Oceanogr.* 51: 830–837.

Reche I, E Ortega-Retuerta, O Romera, E Pulido-Villena, R Morales-Baquero and EO Casamayor (2009) Effects of Saharan dust inputs on bacterial activity and composition in Mediterranean lakes and reservoirs. *Limnol. Oceanogr.* 54(3): 869–879.

Ruiz-Rueda O, S Hallin and L Bañeras (2009) Structure and function of denitrifying and nitrifying bacterial communities in relation to plant species in a constructed wetland. *FEMS Microbiol. Ecol.* 67: 308–319.

Figure 3. Setting up the in situ incubation system for dark carbon fixation experiments in Lagunillo del Tejo, a stratified karstic lake in Cañada del Hoyo (Cuenca, Spain). Picture courtesy of Marc Llirós.

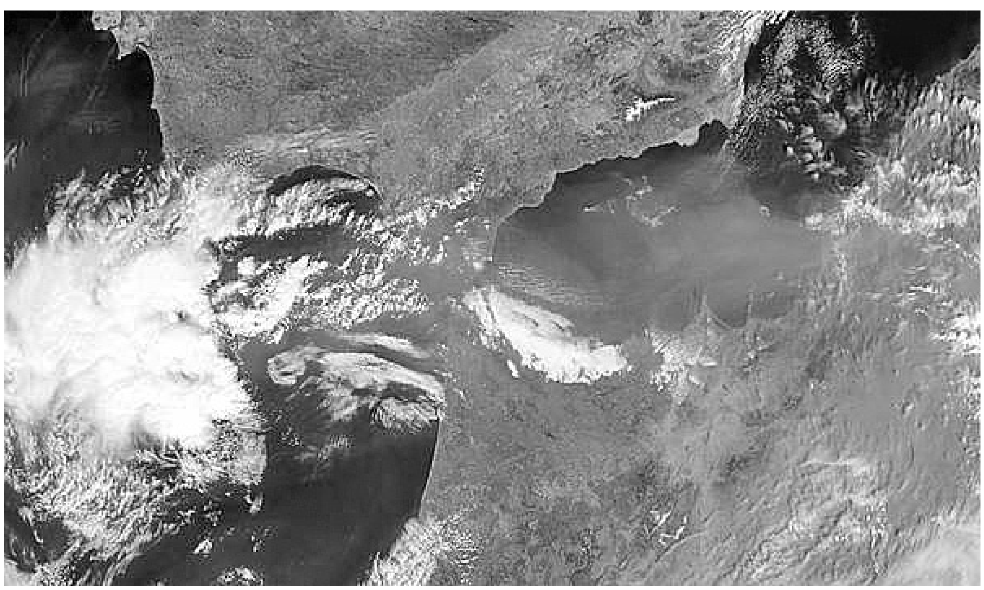


Figure 4. Satellite image of an African dust storm reaching Southern Spain where Sierra Nevada is located. Credit Provided by the SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE.

Ten years of research in the Fuirosos: the ecology of a forested Mediterranean stream (near Barcelona, Spain)

The research in the Fuirosos is a joint effort of several research groups from the University of Barcelona (UB), the University of Girona (UdG) and the CEAB-CSIC at Blanes. Several researchers of the different groups were inspired by the genius of Ramon Margalef and had their formation period at the Ecology Department of the University of Barcelona. Collaboration and interaction have been constant between them through all of these years. This has been translated in a continued research in the Fuirosos stream, the findings can illustrate the behaviour of an undisturbed Mediterranean-like systems in the world.

The Fuirosos is a typical Mediterranean stream whose catchment lies in the middle of the Montnegre-Corredor Natural Park, nearby Barcelona (NE Spain). The hydrological regime of Mediterranean streams is result of warm, dry summers, mild winters and rainfall events mostly in spring and autumn. The stream flow may highly vary along the hydrological year -- from flood periods to complete drought. The intensity and frequency of floods and droughts in the Fuirosos exhibit a remarkable inter-annual variability.

The phreatic dynamics and its relationship to the riparian vegetation were among the first issues studied in the Fuirosos, as part of the European project *Nitrogen Control by Landscape Structures* (NICOLAS), in the late 90s (Butturini et al. 2002, Sabater et al. 2003). The relevant role of vegetation on the nitrate depletion through the phreatic, the low denitrification occurring in the dry topsoil, and the intrusion of the stream water to the riparian compartment during the recovery of the summer drought, were the most relevant findings during that project. Later, the links between hydrology and biogeochemistry were largely explored. The calibration of the INCA (Integrated Nitrogen in CAtchments) model in Mediterranean systems produced a huge data set (Bernal et al., 2004). Recently, efforts have focused in studying the effect of seasonal and interannual variability on the Dissolved Organic Carbon and Nitrogen (DOC and DON) and on the nutrient uptake (Vázquez et al. 2007; von Schiller et al. 2008).

The functional ecology of communities has been explored from many different perspectives. The role of biofilm and its interaction with the faunal compartment, including protozoans, meiofauna and macroinvertebrates, have been explored through descriptive and manipulative approaches. The links between the environmental variations and stream metabolism, organic matter dynamics, algal, meiofaunal and macroinvertebrate dynamics, stoichiometry, trophic relationships, stable isotopes signatures, etc have been investigated in detail (e.g. Acuña et al. 2005; Artigas et al. 2009). Several *in situ* experiments have been carried out in the Fuirosos to test for the relevance of one of several of these factors. Amongst these, nutrient additions (Romaní et al. 2004), sand and leaf litter colonization (Gaudes et al. 2009) and stream warming (in progress) have shed light on the functioning of these systems. These experiments have shown the extremely relevant role of hydrology, but also the existence of pulses of light and nutrients that make the system to shift temporally from heterotrophy to autotrophy and back.

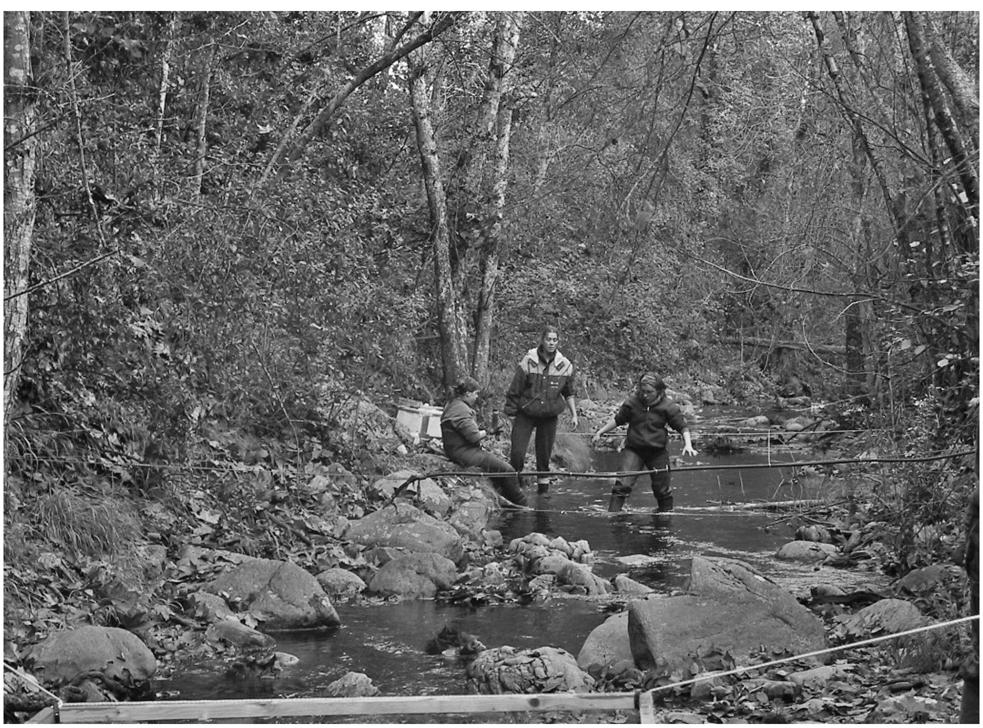


Fig.1. Working at the Fuirosos during fall 2006

The results obtained during the 10 years of collaborative effort can fit together to provide a whole-ecosystem point of view. The study has also been productive in terms of Master and Ph.D. theses that it has generated, e.g. those of Susana Bernal, Vicenç Acuña, Daniel von Schiller, Joan Artigas, Elisabet Tornés, Eusebi Vázquez, Marta Álvarez, Irene Ylla, Isis Sampera, Esther Mas and Ainhoa Gaudes.

References

Acuña V., I. Muñoz, A. Giorgi, M. Omella, F. Sabater, and S. Sabaterl. 2005. Drought and postdrought recovery cycles in an intermittent Mediterranean stream: structural and functional aspects Journal of the North American Benthological Society, 24: 919-933.

Artigas J., A. M. Romaní, A. Gaudes, I. Muñoz, and S. Sabater. 2009. Organic matter availability structures microbial biomass and activity in a Mediterranean stream. Freshwater Biology, doi:10.1111/j.1365-2427.2008.02140.x.

Bernal S., A. Butturini, J.L. Riera, E. Vázquez, and F. Sabater. 2004. Calibration of the INCA model in a Mediterranean forested catchment: the effect of hydrological interannual variability in an intermittent stream. Hydrology Earth System Sciences, 8: 729-741.

Butturini A., S. Bernal, S. Sabater, and F. Sabater. 2002. The influence of riparian hyporheic groundwater on the hydrological responses in a intermittent stream. Hydrology Earth System Sciences, 6: 515-525.

Gaudes A., J. Artigas, A.M. Romaní, S.Sabater, and I. Muñoz. 2009. Contribution of microbial and invertebrate communities to leaf litter colonization in a Mediterranean stream. Journal of the North American Benthological Society, 28: 34-43.

Romani A.M., A. Giorgi, V. Acuña, and S. Sabater. 2004. The influence of substratum type and nutrient supply on biofilm organic matter utilization in streams. Limnology and Oceanography, 49 (5): 1713-1721.

Sabater, S., A. Butturini, J.C. Clement, T. Burt, D. Dowrick, M. Hefting, V. Maître, G. Pinay, C. Postolache, M. Rzepecki, F. Sabater. 2003. Nitrogen removal by riparian buffers under various N loads along a European climatic gradient: patterns and factors of variation. Ecosystems 6:20-30

Vázquez E., A.M. Romani, F. Sabater, and A. Butturini. 2007. Effects of the Dry–Wet Hydrological Shift on Dissolved Organic Carbon Dynamics and Fate Across Stream–Riparian Interface in a Mediterranean Catchment. Ecosystems, 10: 239-251.

Von Schiller D., E. Martí, J.L. Riera, M. Ribot, A. Argerich, P. Fonollà, and F. Sabater. 2008. Interannual, Annual, and Seasonal Variation of P and N Retention in a Perennial and an Intermittent Stream. Ecosystems, 11: 670-687.

See the complete list of references on Fuirosos in: http://fuirosos.blogspot.com/

Ainhoa Gaudes,
Ecology Department,
University of Barcelona
E-mail : agaudes@ub.edu

Limnology in Italy: What Future?

The kick-off of limnology in Italy took place only six years after the founding of the discipline by Forel in 1901, with the publication in 1907 of the first limnology textbook in Italian. Despite this, the study of inland waters in Italy continued to be driven mostly by practical issues, such as fishery and fish farming. In 1921 the Central Laboratory of Hydrobiology was founded in Rome to promote fish production but with an eye for inland waters quality assessment. The interest in limnology grew thanks to Rina Monti's research on comparative limnology, to the point that the 4th SIL Congress was held in Italy in 1927 and celebrated with the mintage of the medal shown in the figure. The golden age of Italian limnology began in 1938, when the *Istituto Italiano di Idrobiologia* (now part of the *Institute of Ecosystem Study - CNR*) was founded in Pallanza. In this institute, directed successively by Edgardo Baldi, Vittorio and Livia Tonolli, Italian limnology developed from the prevailing taxonomy oriented studies for fish production, to a truly ecological approach, addressing ecosystem conservation and management. The interdisciplinary approach and the international contacts were strongly encouraged. A lot of research was done on alpine and subalpine lakes as well as on lakes all around the country. These studies provided the theoretical background, which subsequently proved its practical importance. One example is the liming of Lago d'Orta that allowed to completely recover this environment in the 1990s, after it had been polluted for about 30 years. In 1968 the *Istituto di Ricerca sulle Acque - CNR* started, and addressed studies on waste water treatment techniques and protection and management of water resources. Other pivotal places of limnological research were established in the past century. One is the *Museo Tridentino di Scienze Naturali*, working on alpine lakes, rivers and springs of the south-eastern Alps. Among the Environmental Science Department active in limnological research the one belonging to Parma University is to be mentioned for its works on mountain lakes in Apennines, on the Po river and on transition environments of its delta. Roma University conducted many studies on temporary water bodies and on volcanic lakes in central Italy. In Palermo and Sassari universities, in regions at high risk of desertification, a lot of effort is being made to study the limnology of Mediterranean and man-made water bodies.

Bronze medal coined for the 4th SIL Congress (Rome 1927) and offered to participants. The motto "bene urbis auspicetur flumen" expresses the wish that "the God River [Tiber] promotes the good of the city [Rome]"

The present: a critical situation.

Altogether, there are about 80 limnologists in Italy and only 10% of them are below 40 years old due to discouraging policies for research of the recent Italian governments. Most of the Italian limnologists are SIL, AIOL (Italian Association for Oceanography and Limnology), and SItE (Italian Society for Ecology) members, publishing in 2007-2008 about 158 papers in ISI journals. In Italy less than 0.02% of the GDP is allocated for ecological research and there are no research funding agencies to which one can submit basic research projects. Therefore, money for limnology must be sought from institutions (local administrations and EU projects) that are mainly monitoring oriented . The Ministry of Education and Research gives funds for small projects for basic research, but in 2008 none involving limnology was funded.

In conclusion, Italian limnology seems to be carried out by middle-aged scientists and supported by very limited funds. On the other hand, these people appear active, as highlighted by the presence of five LTER sites devoted to lakes and inland waters in the Italian LTER network. The success of the publishing activity of the "*Journal of Limnology*" (IF 2.375 in 2007) indicates the continuing healthy tradition of the past "*Memorie dell'Istituto Italiano di Idrobiologia*" (first issue dating back to 1942). These are good perspectives for the colleagues attending the 33rd SIL Congress in Turin in 2016.

Web References

Istituto Italiano di Idrobiologia: www.iii.to.cnr.it. An ebook of historical images is downloadable from: www.ise.cnr.it/ebooks/istituto-idrobiologia-storia.pdf (7MB)

Institute for Ecosystem Study (CNR ISE): www.ise.cnr.it

Water Research Institute (CNR IRSA): www.irsa.cnr.it

Trentino Nature & Science Museum: www.mtsn.tn.it

Department of Environmental Science, Parma University: www.dsa.unipr.it/

AIOL (Italian Association for Oceanography and Limnology): www.aiol.info

SitE (Italian Society for Ecology): www.dsa.unipr.it/SITE/

LTER Italia: www.lteritalia.it

Journal of Limnology: www.jlimnol.it

33rd SIL Congress in Turin. www.silitaly.it/candidatura/candidaturaweb.htm

Roberto Bertoni,
Roberto.bertoni@isi.cnr.it

Aquatic plants as indicators of radioactive contamination of the Yenisei River (Siberia), Russia

The Yenisei is one of the largest rivers on this planet. It crosses Eurasia in the geographic center of Russia. The Yenisei flows into the Kara Sea, and annually discharges about 625 km^3 of water. The Yenisei has the second largest catchment basin (2580 thousand km^2) among Russian rivers and it is the third longest river (4 000 km) in Russia.

In 1958, a nuclear facility for production of weapons-grade plutonium – the Mining-and-Chemical Combine (MCC) – was constructed 80 km downstream of the city of Krasnoyarsk (56° 0'N, 92° 47'E), on the right bank of the Yenisei. The MCC included a reactor plant and a radiochemical one. Two of the three reactors have been shut down but one is still operating. The MCC has been a source of radioactive contamination of the Yenisei River for many years. For the last 20 years, the Radioecology Laboratory of the Institute of Biophysics at Krasnoyarsk (Siberian Branch of the Russian Academy of Sciences, Krasnoyarsk) has been performing radioecological studies at the Yenisei River in cooperation with a number of Russian and foreign laboratories. The studies comprise both monitoring and laboratory experiments with aquatic organisms and show that the river floodplain and sediments are contaminated by artificial radionuclides, including transuranium elements (isotopes of plutonium, americium, neptunium, and curium) over a stretch of 2000 km downstream of the MCC (Bolsunovsky & Bondareva, 2003, 2007; Bolsunovsky et al., 2007). The Yenisei floodplain soils and sediments have been found to contain high-activity ("hot") particles of reactor origin (Bolsunovsky & Tcherkezian, 2001).

The radioactively contaminated Yenisei parts abound in aquatic vegetation, mostly represented by submerged macrophytes. The greatest species diversity is observed among potamogetons: *Potamogeton lucens* L. dominates in terms of biomass in the river stretch between the MCC and the Angara River mouth. Other characteristic plants in this part of the river are *Elodea canadensis* Mich., *Batrachium kauffmanii* (Clerc) V. Krecz., *Myriophyllim spicatum* L., *Potamogeton pectinatus* L. and *Fontinalis antipyretica*, etc. (Zotina, 2008).

Owing to the ability of submerged macrophytes to accumulate radionuclides in their biomass, they are universally used as bioindicators in monitoring of radioactive contamination. Researchers of the Radioecology Laboratory every year record a wide range of artificial radionuclides (up to 30) in the biomass of Yenisei macrophytes. These include several relatively short-lived activation radionuclides (^{24}Na, ^{32}P, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{58,60}Co, ^{59}Fe, ^{65}Zn, ^{152,154,155}Eu, ^{239}Np, etc.) and long-lived fission radionuclides (^{90}Sr, ^{134,137}Cs, ^{238,239,240}Pu, ^{241}Am, etc.). The highest activity concentrations of most of these radionuclides were registered in the biomass of the water moss *Fontinalis antipyretica* (Bolsunovsky, 2004).

Fig. 1. Sampling trip at the Yenisei River: researchers of the Radioecology Laboratory of the IBP SB RAS and the boat crew.

Fig. 2. Potamogeton lucens L. the most abundant macrophytes in the radioactively contaminated part of the Yenisei River.

Fig. 3. Potamogeton lucens – the dominant macrophyte species in the Yenisei River in the radioactively contaminated part of the Yenisei

Calculation of the exposure dose to aquatic plants due to biomass-bound radionuclides (internal), and due to the nuclides in the river water and sediment (external), showed that at 50 km downstream of the MCC the internal dose rate was an order of magnitude higher than the external dose rate (Bolsunovsky et al., 2005 a). In the vicinity of the MCC discharge site, artificial radionuclides contribute mainly to the internal dose rate, which is an order of magnitude higher than the dose rate due to natural radiation. Both farther downstream and upstream of the MCC, the main contributor to the dose rate is ^{40}K – a natural radionuclide. The impact of radiation on aquatic plants is observed at also at the cellular level. A cytogenetic examination of aquatic plants of the Yenisei River shows that chromosomal aberrations in the cells of the roots of *Elodea,* growing in the radioactively contaminated part of the Yenisei, occur 3-5 times more frequently than in the control plants upstream of the MCC discharge site (Bolsunovsky et al., 2009). Cytogenetic studies on other macrophyte species are also in progress.

Researchers of the Laboratory use sequential chemical extraction techniques to study if radionuclides bound to biomass of plants growing in the radioactively contaminated part of the Yenisei are in exchangeable or non-exchangeable forms (Bolsunovsky & Bondareva, 2007; Zotina & Bolsunovsky, 2007).

Mechanisms of accumulation and distribution of transuranium radionuclides in plant biomass are being studied in laboratory, i.e. to determine the rates of accumulation and release of ^{241}Am and ^{99}Tc by *E.canadensis* shoots (Bolsunovsky et al., 2005 b; Bolsunovsky & Bondareva, 2008). Other recent studies have addressed the distribution of ^{241}Am in cell compartments and biochemical components of the biomass of *F.antipyretica* (Zotina et al., 2008) and *E.canadensis* (Zotina et al., 2009). They confirmed that ^{241}Am taken up by macrophytes from the water is mainly found in cell wall polysaccharides.

The largest sink for long-lived artificial radionuclides in an aquatic ecosystem is the Yensei River sediment, which has been found to contain ^{60}Co, ^{90}Sr, ^{137}Cs, Eu isotopes, and transuranium elements ^{239}Np, ^{238,239,240}Pu, ^{241}Am, ^{243,244}Cm (Bolsunovsky et al., 2007; Bolsunovsky & Bondareva, 2007). Plants can take up radionuclides not only from the water but also from the sediments. Artificial radionuclides (^{60}Co, ^{137}Cs and ^{152}Eu) were recorded in submerged macrophytes rooted in the sediment. Mobility of artificial radionuclides located in the sediments of the Yenisei River was determined using sequential, chemical extraction techniques (Bolsunovsky & Bondareva, 2007).

The last reactor is to be shut down within the next few years, and, hence, short-lived activation radionuclides will not be released into the river any more. Nevertheless, deposits of long-lived artificial radionuclides will continue to persist in the river sediments and floodplain soils. Thus, the primary challenge will be to study mobility of radionuclides deposited in the river ecosystem. Assessing the consequences of radioactive contamination for submerged plants and other aquatic organisms will continue to be a topical issue.

References

Bolsunovsky, A.Ya., 2004. Artificial radionuclides in aquatic plants of the Yenisei River in the area affected by effluents of a Russian plutonium complex. Aquat. Ecol. 38: 57-62.

Bolsunovsky, A.Ya. & L.G. Bondareva, 2003. Tritium in surface waters of the Yenisei River basin. J. Environ. Radioactiv. 66 (3): 285-294.

Bolsunovsky, A. & L. Bondareva, 2007. Actinides and other radionuclides in sediments and submerged plants of the Yenisei River. J. Alloy. Compd. 444-445: 495-499.

Bolsunovsky, A. & L. Bondareva, 2008. Accumulation and release of Tc-99 by a macrophytes of the Yenisei River (*Elodea canadensis*) in laboratory experiment. J Radioanal. Nucl. Ch. 277 (3): 631-636.

Bolsunovsky, A., Ermakov, A. & A. Sobolev, 2007. New data on transuranium elements in the ecosystem of the Yenisei river floodplain. Radiochim. Acta 95 (9): 547-552.

Bolsunovsky, A., Muratova, E., Sukovaty, A. & M. Kornilova, 2009. The effect of radionuclide and heavy metal contamination of the Yenisei River on cytogenetics of aquatic plant *Elodea canadensis*. Radioprotection. (In press)

Bolsunovsky, A.Ya. & V.O. Tcherkezian, 2001. Hot particles of the Yenisei River Floodplain, Russia. J. Environ. Radioactiv. 57: 167-174.

Bolsunovsky, A., Sukovaty, A. & E. Pankov, 2005 a. Radioactive contamination and exposure dose rates of aquatic organisms of the Yenisei River. Proceedings of the 6th International Conference on radioactivity in the Arctic and Antarctic. 2-6 October, 2005 a. Nice, France. NAPR, Osteras, Norway. P. 138-141.

Bolsunovsky, A., Zotina, T. & L. Bondareva, 2005 b. Accumulation and release of Am-241 by a macrophyte of the Yenisei river (*Elodea canadensis*). J. Environ. Radioactiv. 81: 33-46.

Zotina, T.A., 2008. The biomass of macrophytes at several sites of the upper reaches of the Yenisei River. Journal of Siberian Federal University. Biology. 1 (1): 102-108.

Zotina, T. & A. Bolsunovsky, 2007. Role of aquatic plants in migration of artificial radionuclides in the Yenisei River. In: Y.Zhu et al. (Eds.) Biogeochemistry of trace elements: environmental protection, remediation and human health. Tsinghua Univ. Press, Beijing. P.457-458.

Zotina, T.A., Kalacheva, G.S. & A.Ya. Bolsunovsky, 2009. Accumulation and distribution of ^{241}Am in the biomass of freshwater plant *Elodea canadensis*. Radioprotection. (In press)

Zotina, T.A., Kalacheva, G.S., Bolsunovsky A.Ya. & A.G. Degermendzhy, 2008. ^{241}Am distribution in the biomass of freshwater macrophytes. Doklady Biological Sciences, 421: 254-256.

Alexander Bolsunovsky, D. Sc.,
Head of the Radioecology Laboratory,
Institute of Biophysics SB RAS

Tatiana Zotina, Ph. D.,
Research Scientist,
Institute of Biophysics SB RAS

Ping River of North Thailand: Diversity of Benthic Diatoms and their Use for Biomonitoring of Water Quality

Thailand is located in South-East Asia at latitude between 5º 27' and 21º 27' N and longitude 97 º 21' and 105 º 37' E. Ping River is the major river in Northern Thailand, which runs through 5 provinces: Chiang Mai, Lamphun, Tak, Kamphaeng Phet and Nakorn Sawan. It is about 750 km long with catchment area around 34,885 km^2 and it flows into the Chao Phraya River, the biggest river of Thailand (Figure 1). The activities of people who live along the river not only affect physical and chemical properties of the water but also aquatic organisms inhabiting the river. Benthic diatoms are useful in the biodiversity studies because they are found in many substrates in the water, being tolerant to different environments. However, the studies on diatom flora in South-East Asia are not well-documented in terms of diversity, distribution patterns and ecology.

Applied Algal Research Laboratory (AARL) has been studying freshwater benthic diatoms for more than 10 years in both lentic and lotic ecosystems, in particular biodiversity of diatoms and their bioindicator value. Our previous studies on benthic diatoms not only provided new knowledge of aquatic benthos in a Thailand river but also the potential for using benthic diatoms to monitor water quality. In this communication, we discuss the water quality and indicator species of benthic diatoms in Ping River during December 2004 to December 2005.

Physical and chemical conditions of Ping River such as water temperature, conductivity, pH, dissolved oxygen (DO), BOD_5, alkalinity, ammonium nitrogen, nitrate nitrogen and soluble reactive phosphorus (SRP) were measured (Greenberg et al. 2005). The trophic status of water was evaluated from several parameters (conductivity, DO, BOD_5, alkalinity, ammonium nitrogen, nitrate nitrogen and soluble reactive phosphorus) according to Lorraine & Vollenweider (1981), Wetzel (2001) and Peerapornpisal et al. (2004). The benthic diatom samples were collected following Renberg (1990) and species were identified according to Krammer & Lange-Bertalot (1986, 1988, 1991a, 1991b).

The Ping River was moderately clean and oligo-mesotrophic. In the upstream area, the water quality was good to moderately good with oligo-mesotrophic status whilst in downstream region the water quality was moderate; the water was mesotrophic depending on the environmental status around the sampling sites. Benthic diatom diversity seems be rather rich, with 159 species of benthic diatoms recorded. The majority of benthic diatoms were pennate diatoms (97%) and the remaining 3% were centric diatoms. The dominant species of benthic diatoms in Ping River were *Gomphonema parvulum* (Kützing) Grunow, *Achnanthidium minutissimum* (Kützing) Czarnecki and *Nitzschia palea* (Kützing) W. Smith. Six indicator species were found for example *Cymbella turgidula* Grunow, *Gomphonema lagenula* Kützing and *Navicula symmetrica* Patrick for oligo-mesotrophic status and *Nitzschia palea*, *Nitzschia* sp., *Synedra ulna* var. *aequalis* (Kützing) Hustedt for mesotrophic status (Figure 2). Since Ping River is essential for people living along its course, the water quality should be monitored continuously.

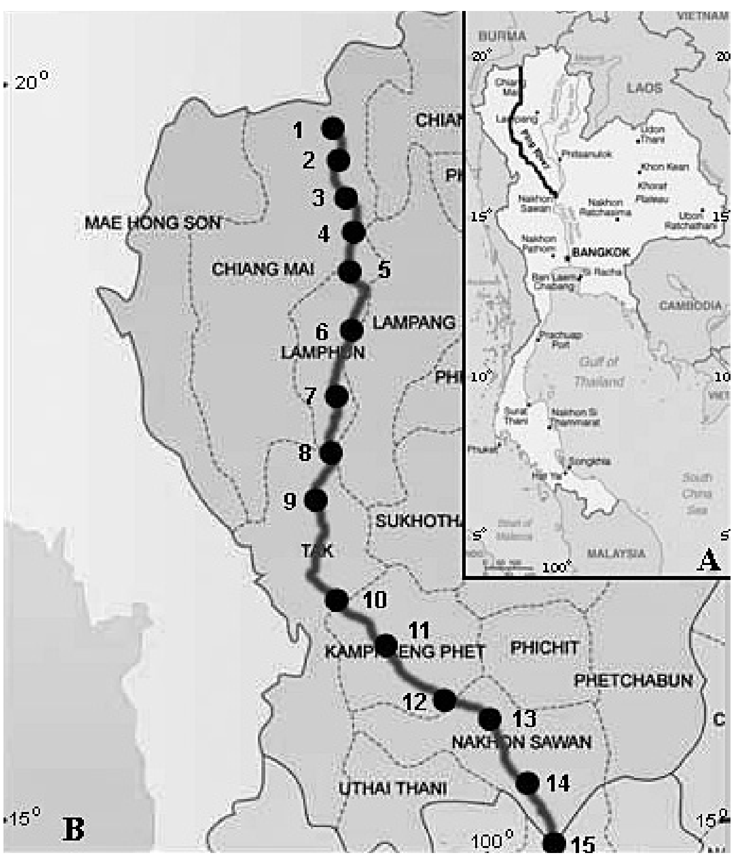


Fig. 1 . Map of Thailand and Ping River watershed (A) and 1-15 sampling sites along the Ping River (B).

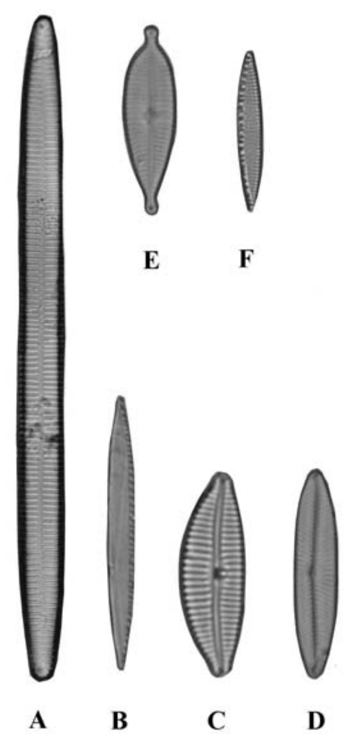


Fig. 2. Benthic diatoms as indicator species in the Ping River from December 2004-December 2005. (Scale bar = 10 m) (A) Synedra ulna var. aequalis, (B) Nitzschia palea, (C) Cymbella turgidula, (D) Navicula symmetrica, (E) Gomphonema lagenula, (F) Nitzschia sp.

References

Greenberg A.E., Clesceri L.S. & Eaton A.D. (2005). Standard Methods for the Examination of Water and Wastewater, 20th edition, American Public Health Association (APHA), Washington DC, 1325 pp.

Krammer K. & Lange-Bertalot H. (1986). Bacillariophyceae: Teil 1. Naviculaceae. Süβwassweflora von Mitteleuropa, Bd. 2, berg. Von A. Pascher. Gustav Fisher Verlag, Stuttgart, 876 pp.

Krammer K. & Lange-Bertalot H. (1988). Bacillariophyceae: Teil 2. Epithemiaceae, Surirellaceae. Süβwassweflora von Mitteleuropa, Bd. 2, berg. Von A. Pascher. Gustav Fisher Verlag, Stuttgart, 596 pp.

Krammer K. & Lange-Bertalot H. (1991a). Bacillariophyceae: Teil 3. Centrales, Fragilariaceae, Eunotiaceae. Süβwassweflora von Mitteleuropa, Bd. 2, berg. Von A. Pascher. Gustav Fisher Verlag, Stuttgart, 576 pp.

Krammer K. & Lange-Bertalot H. (1991b). Bacillariophyceae: Teil 4. Achnanthaceae. Kritische Ergünzungen zu Navicula. Süβwassweflora von Mitteleuropa, Bd. 2, berg. Von A. Pascher. Gustav Fisher Verlag, Stuttgart, 437 pp.

Lorraine L.J. & Vollenweider R.A. (1981). Summary report, the OECD cooperative programme on eutrophication, National Water Research Institute, Burlington, 381 pp.

Peerapornpisal Y., Chaiubol C., Pekkoh J., Kraibut H., Chorum M., Wannathong P., Ngernpat N., Jusakul K., Thammathiwat A., Chuananta J. & Inthasotti T. (2004). The monitoring of water quality in Ang Kaew Reservior of Chaing Mai University by using phytoplankton as bioindicator from 1995-2002. *Chiang Mai Journal of Science*. 31(1):85-94.

Renberg I. (1990). A procedure for preparing large sets of diatom slides from sediment cores. *Journal of Paleolimnology*. 4: 87–90.

Wetzel R.G. (2001). Limnology: Lake and River Ecosystems, Academic Press, New York, 1006 pp.

Yuwadee Peerapornpisal* and Pongpan Leelahakriengkrai
Environmental Science section,
Department of Biology, Faculty of Science,
ChiangMai University,
Chiang Mai 50200, Thailand

*Author for correspondence, e-mail: scboi017@chiangmai.ac.th

The Legacy of James G. Needham

A Century of Limnology at Cornell University : The legacy of James G. Needham and the first course on limnology in the U.S.

**This article is published simultaneously in the Bulletin of the American Society of Limnology and Oceanography and the News Letter of the Societas Internationalis Limnologae*

James G. Needham taught the first limnology course at Cornell University during spring semester 1908. On April 18, 2009, Cornell limnologists celebrated this event with a day-long symposium of talks and posters presented by former faculty, and former undergraduate students, graduate students and postdocs who have gone on to successful careers of their own in limnology.

By exploring Needham's archived letters, papers and photographs in the Rare and Manuscript Collection of the Cornell University Library, we have reconstructed the details of his arrival at Cornell, and the early days of the limnology program. In the process, we became reasonably certain that his course was also the first in limnology taught in the United States and indeed in the Western Hemisphere. It is possible that it was also the first formal limnology course taught anywhere in the world, but we will return to that thought later.

James Needham obtained his PhD degree working with the entomologist, John H. Comstock, at Cornell University in 1898. He arrived from Knox College, Illinois, where as an undergraduate student he was already fascinated by aquatic insects, holding extended correspondence about odonates with some of the best known academics, nationwide, in this field. The summer before arriving at Cornell for graduate study, Needham spent a month visiting Charles Hart at the Illinois State Laboratory of Natural History (later the Illinois Natural History Survey). The "Survey" was directed at that time by its founder Stephen A. Forbes, who a decade earlier had written his seminal paper "The Lake as a Microcosm[1]," and it may have been during this brief visit that Needham first got a taste of a broader perspective on freshwater science. Limnology was a young but growing field at the turn of the last century with A.-F. Forel in the process of publishing his three-volume monographic work on Lake Geneva (1892 - 1904)[2], and E. A. Birge at the University of Wisconsin, Madison, engaged in his early and fundamental studies of the Cladocera[3] and after 1905 his influential research on the physical and chemical properties of lakes with Chauncy Juday[4]. It was in this climate that Needham obtained his degree and took his first faculty position at Lake Forest College, Illinois.

James G. Needham with limnology students ca. 1925. The student diversity, both gender and ethic, in the group is striking. At least eleven women obtained advanced degrees (four MS and seven PhD) working with Needham. Photo from the Rare and Manuscript Collection, Cornell University Library.

Needham stayed at Lake Forest College for eight years teaching primarily introductory biology, but he clearly chafed at this work and on the back of a letter that Comstock had sent to him in 1905, he penciled a note to himself: "Discuss my getting ready for something new in limnology." In the winter of 1906, he acted and wrote to Comstock: "Is it not time that Cornell University had a professorship in limnology, or freshwater biology? I am suffering for a chance to undertake university work of that sort." He went on to say: "There can be no doubt that limnology is a proper subject for university instruction. A general course would have culture value equal to any other general science course. What wonderful beauty and interest its material offers! Ecology is at its best pedagogically in this subject." Comstock replied to Needham that spring saying that his "limnology proposition was extremely well received" by the Cornell administration and by summer Needham was hired. He began as an Assistant Professor at Cornell in the spring term of 1907, when based on some accounts he may have first taught limnology. More certain is the fact that "Course 19. General Limnology… Assistant Professor Needham" was first listed in the Cornell University course catalog for second term 1907-1908.

Needham brought enormous energy to his position, establishing the "first permanent limnological station for research and investigation"[5] on the shores of Cayuga Lake. In 1916, he and his assistant, J. T. Lloyd published the first English language limnology text "*The Life of Inland Waters*"[6] with a subhead of "*An* *elementary text book of fresh-water biology for American students*", described by E. A. Birge in a review in *Science*[7] as "… a very good and very useful book … well planned, well executed and well illustrated" though "the emphasis on insects will seem somewhat disproportionately large to students of other groups." The latter is perhaps not surprising given Needham's passion for insects and the fact that his course was offered through the Department of Entomology and Limnology. Nevertheless, the book was broader and contained major chapters on "The Nature of Aquatic Environments," "Types of Aquatic Environment" and "Inland Water Culture." It is unfortunately ingrained in numerous sources that Paul Welch's 1935 text "*Limnology*"[8] was the first American limnology text. For example, McIntosh[9] in his history of ecology gave Welch this credit despite the fact that he cited the Needham and Lloyd (1916) book in another context. McIntosh seems not to have understood that he was holding a limnology text in all but title: complete, in addition to its emphasis on the adaptations of organisms to their aquatic habitat, with extended discussion of such limnological phenomena as light penetration, thermal structure and mixing, dissolved gasses, the reactions of inorganic carbon.

Both during his 26-year career at Cornell and after his retirement in 1935, Needham contributed thoughtful commentary, often in the journal Science, on the state of limnology, biology and the scientific endeavor nationally. In a 1930 review of the teaching of hydrobiology for the U.S. National Research Council, he pointed out that although there were courses at 16 universities in the U.S. and Canada the situation was far from perfect since in nearly every case the courses were taught by individuals "voluntarily in addition to other teaching or administrative work that is required of them"[10]. On biological nomenclature, he wrote objecting to the practice of creating new genera, subfamily and family names apparently for the primary purpose of having the author's own name enshrined for the future: "A name is a name and not a memorial inscription"[11]. He had a healthy skepticism about the value of report writing, noting that Comstock, as chair of the Department of Entomology at Cornell, "… didn't ask for reports at stated intervals; he asked only for reasonable accomplishment."[12] and elsewhere he commented that the value of reporting depends upon the reason for the report: "There are reports and reports. For the making out of reports merely to comply with governmental red-tape, I do not care to train [students]… And as to the training needed for making reports of the results of investigation, it is often training in restraint that is most needed." He went on to point out that for writing up research he "set but three requirements before students in [his] own laboratory: (1) clear analysis of the subject matter, (2) simple drawings, (3) good English – and not too much of it."[13]

Until he retired in 1935, Needham taught General Limnology with the catalog description: "An introduction to the study of the life of inland waters. Aquatic organisms in their qualitative, quantitative, seasonal and ecological relations." Following Needham's retirement, the course was taught by at least four different people between 1935 and 1948. David Chandler was hired to teach it in 1949, and when he left for the University of Michigan in 1953, Clifford Berg replaced him. In 1965, the administrative structure of biology was reorganized at Cornell and Jack Vallentyne, who had been teaching Evolutionary Biology in the old Zoology Department, took over teaching "Limnology" with a new faculty member, Donald Hall, as a part of the newly formed Section of Ecology and Systematics within the Division of Biological Sciences. It was during this period that Hall with colleagues William Cooper and Earl Werner carried out their remarkable experimental ecosystem study using Cornell's replicate ponds. Vallentyne and Hall, and then Hall by himself, gave the limnology course a more distinctly ecosystem perspective, while Berg continued to teach a more organismally orientated course with the title "Aquatic Entomology and Limnology."

Gene Likens moved to Cornell in 1969 after both Vallentyne and Hall left for positions at other institutions. Likens strengthened the ecosystem, physical and biogeochemical perspective of the limnology position and he and his students carried out many of the well-known whole-ecosystem studies at the Hubbard Brook Experimental Forest and Mirror Lake in the White Mountains of New Hampshire while he was on the faculty at Cornell. At the same time, Likens grew the limnology course to its largest enrollment of over a hundred and twenty-five students during the 1970s. It was during this period that Berg retired and was replaced by Barbara Peckarsky, whose research focus on stream insect ecology redirected Berg's former course offering to "Stream Ecology" and "Freshwater Invertebrates" within the Department of Entomology (Limnology having been dropped from the department's name in the 1970s). In 1983 Likens left Cornell to found the Institute of Ecosystem Studies in Millbrook, New York, becoming the first Director and President. Cornell's limnology course was taught by Charles A.S. Hall while Likens was leave in 1975 and by David Strayer (PhD with Likens) and Paul Murtaugh in the two years immediately following Likens' departure. Nelson Hairston, Jr. joined the faculty of Ecology and Systematics in 1985 and continued the ecosystem perspective of the limnology course, but also brought his organismal and evolutionary interests to its instruction.

The number of faculty members at Cornell whose research interests were directly focused on limnology greatly increased from a single faculty member from Needham's time though the early 1960s to nine tenure-track faculty by 2005. A large number of other faculty on campus have had research interests in limnology or related to limnology (broadly defined), and additions to this faculty group came through hires not only in the Section of Ecology and Systematics (now Department of Ecology and Evolutionary Biology) and Entomology, but in other departments including, Agronomy (now Earth and Atmospheric Sciences), Civil and Environmental Engineering, Biological and Environmental Engineering, and especially in Natural Resources. The Cornell Biological Field Station on Oneida Lake grew from its establishment in 1955 to the present into a significant site of limnological research and instruction for faculty, graduate students and undergraduate interns through the efforts of a succession of visionary directors from J. Forney to E. Mills and now L. Rudstam.

The First Limnology Course?

Was Needham's limnology course the first in the world? There would seem to be only three other serious candidates in the United States and the Americas more broadly. The course at the University of Wisconsin was first taught in 1909 by Chauncey Juday[14]. EA Birge was heavily involved in administration as Dean and University President. Stephen Forbes as Director of a state laboratory apparently did not teach any formal course, including limnology. Paul Welch, author of the text "Limnology" in 1935 did not begin teaching limnology at the University of Michigan Biological Station until 1922[15].

In Europe, F.-A. Forel taught medicine at the University of Lausanne, Switzerland, and there is no record of his having taught a formal course in limnology. Einar Naumann in Sweden was only 17 years old when Needham first taught limnology. In Germany, Otto Zacharias began "Ferienkurse" (vacation courses) on "life in fresh waters" at the Biological Station at Plön in 1899, but this was continuing education for high school teachers[16], not college students. August Thienemann obtained his PhD degree in 1905, and was put in charge of a hydrobiological station in Munster in 1907 before becoming Director of the hydrobiological station in Plön in 1917[17]. It seems unlikely that he taught a limnology course as early at 1908, but this remains uncertain at present. The Freshwater Biological Association laboratory in the English Lake District was not established until 1929. Are there other candidates? The authors would welcome any additions to, or corrections of, the information they have accumulated. For now, however, we claim precedence for James Needham and his prescient insistence that Cornell University hire a limnologist.

Literature Cited:

[1]Forbes, S.A. 1887. The lake as a microcosm. *Bulletin Science Association of Peoria, Illinois*, 1887, 77-87.

[2]Forel, A.-F. 1892, 1895, 1904. Lac Léman: monographie limnologique. Vol.1-3. Lausanne, Rouge

[3]Birge, E.A. 1898. Plankton studies of Lake Mendota. II. The Crustacea of the plankton from July 1894, to December 1896. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 11:274-451.

[4]Birge, E.A. and C. Juday. 1914. A limnological study of the Finger Lakes of New York. *Bulletin of the U.S. Bureau of Fisheries*. 32:523-609.

[5]*Cornell Alumni News* 13 Nov. 1907

[6]Needham, J.G. and J.T. Lloyd. 1916. The life of inland waters: An elementary text book of fresh-water biology for American students. Comstock Pub. Co. 438 pp.

[7]Birge, E.A. 1916. Review of "Life of Inland Waters." *Science* 44:683-684.

[8]Welch, P.S. 1935, Limnology. McGraw Hill. 538 pp.

[9]MCintosh, R.P. 1985. The background of ecology: Concept and theory. Cambridge Univ. Press. 383 pp.

[10]Needham, J.G. 1930. The teaching of hydrobiology and agriculture in American universities. *Science* 71:265-266.

[11]Needham, J.G. 1930. Scientific names. *Science* 71:26-28.

[12]Needham, J.G. 1946. The lengthening shadow of a man and his wife – I. *The Scientific Monthly* 62:140-150.

[13]Howard, L.O, and J. G. Needham. 1919. Methods of securing better cooperation between government and laboratory zoologists in the solution of problems of general or national importance. *Science* 49:454-458.

[14]Beckel, A.L. 1987. Breaking new waters: A century of limnology at the University of Wisconsin.
Transactions of the Wisconsin Academy of Sciences, Arts and Letters, Special Issue, 122 pp.

[15]Eggleton, F.E. 1961. Paul Smith Welch 1882-1959. *Hydrobiologia* 17:259-261.

[16]Lampert, W. personal communication, and archival document.

[17]van Oye, P. 1958. Prof. Dr. August Thienamann 75 Years. *Hydrobiologia* 11: 182-183.

Nelson G. Hairston, Jr.,
Department of Ecology
and Evolutionary Biology,
Cornell University, Ithaca, NY 14853;
E-mail: ngh1@cornell.edu

Gene E. Likens,
Cary Institute of Ecosystem Studies,
Millbrook, NY 12545,
E-mail: likensg@caryinstitute.org

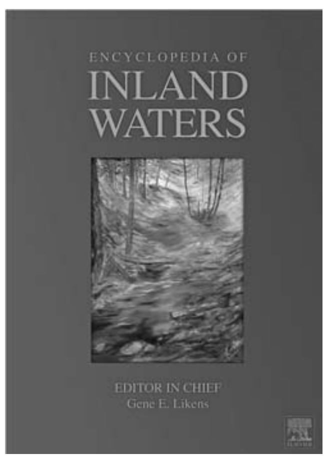
News: Book Reviews/Journals

Encyclopedia of Inland Waters

Encyclopedia of Inland Waters, Three Volume Set. Editor-in-chief Gene Likens. Hardbound, 6492 pages, ISBN-13: 978-0-12-088462-9 ISBN-10: 0-12-088462-3; Elsevier & Science Direct.

Dedicated to Prof. Robert G. Wetzel, hopefully this massive reference will be an inspiration and a resource for all those working on and interested in the inland waters of the world.

Limnology began as a formal discipline in Europe in the late 1800s and in the United States in the early 1900s. This month (March 2009) a major reference work for limnology, the Encyclopedia of Inland Waters was published. This 3-volume encyclopedia contains 264 chapters and is available both in hard copy and electronically from Elsevier. Quoting from the marketing material that I wrote,"The Encyclopedia of Inland Waters provides a comprehensive resource on the essence, complexity, diversity and importance of the inland waters (lakes, ponds, rivers, streams and wetlands) of the Earth. This major reference work attempts



to summarize current knowledge and to capture the excitement about inland waters …"

Talented and dedicated Section Editors assisted me in bringing this project to fruition. Section Editors included: Mark Benbow, Thomas M. Burton, John A. Downing, Ramesh Gulati, Dag Hessen, George M. Hornberger, Robert Howarth, Jack Jones, Tim Kratz, Winfried Lampert, William Lewis Jr., Gene E. Likens, Andreas Lorke, Sally MacIntyre, Richard Merritt, Michel Meybeck, Michael Pace, Judit Padisák, Morten Søndergaard, Kenton Stewart, Frieda Taub, Ellen Van Donk, Ian J. Winfield and Thomas C. Winter.

Gene Likens,
Editor-in-Chief **,**
Encyclopedia of Inland Waters

PS: Prof. Gene Likens kindly agreed to my request to personally announce the publication of this *Encyclopedia* for the *SILnews* readers. (Ramesh D. Gulati, SILnews Editor)

New Books Received: Brief Reviews

POLUNIN, NICHOLAS V.C. (Ed.). Aquatic ecosystems: trends and global prospects. 2008. ISBN: 978-0-521-83327-1 Cambridge University Press: Cambridge. 482 p.

I scanned through different chapters of my copy of this new book very recently, and got the impression that both the book Editor Professor Polunin, a leading marine environmental scientist at Newcastle University, and the chapter authors have critically examined how the increase in human populations, urbanization and industrial development are going to further affect the aquatic ecosystems during the next 15 years or so. The take-home message of the book is gloomy but probably quite realistic because many of the ecosystems have already been seriously damaged, and there is a sharp increase in the rate at which our aquatic ecosystems are being destroyed further. Drawing on the expertise of more than hundred eminent ecologists, and some new works, Professor Polunin has succeeded to examine the trends and perspectives of our aquatic ecosystems. The conclusions based on 21 different ecosystems, including lakes, rivers, tropical seas and Arctic waters, are rather bleak. We are warned by the world's leading marine and freshwater scientists of the consequences of direct human impacts: these are devastating lakes, rivers and coastal seas, i.e. already before climate change takes full effect. Dr Polunin says (I quote an excerpt '…the demise of fish stocks through fishing and decline of rivers through excessive off-take are just two dramatic examples of how people are directly changing aquatic ecosystems and threatening the natural services that they deliver.'

Ramesh D. Gulati.
Editor, *SILnews*

CARGILL, M., O'CONNOR, P. (EDS.). Writing Scientific Research Articles: Strategy and Steps. 2009. Hardcover. ISBN-10: 1-4051-9335-2; ISBN-13: 978-1-4051-9335-1. Wiley-Blackwell, Sussex, UK. 173 p.

The new book is a guide for authors to write scientific articles such that their chances increase to have the articles published in international, peer reviewed journals. The book is intended for scientists both who use English as a first language and as an additional language. These include both research students and those who train them to improve their writing skills. It is organized into 5 Sections and 19 chapters in all. The approach in this book, as the editors themselves say, is practical in order to help developing scientists "writing skills" with three criteria: first, to develop a strategy of understanding what editors and reviewers want to publish and why; second point is to develop a story, i.e. an understanding of what makes a compelling article in a certain discipline; the third criterion is 'language', i.e. to developing writing techniques in order to communicate effectively with who read the article.

Chapter 15 essentially summarizes some of aspects described in the preceding chapters, i.e. how to proceed with preparing a manuscript. It presents a set of steps from data collection, to preparation of a draft paper, etc. The checklist for such a draft starts with how the Title reflects the paper contents, and how Introduction narrows down to the main topic after describing big issues, including how it highlights gaps and states hypotheses to be tested and what the study aims are. It proceeds with all necessary sections from Methods to Results and Discussion and Conclusions, and based on the findings how to revert to and prepare Abstract, Key-words.

In short the book is a welcome addition to the scanty information that exists for successful scientific writing (such a book should help the SIL 'mentors' to help their younger colleagues, who are relatively inexperienced in the art of writing scientific papers).

Ramesh D. Gulati,
Editor, *Silnews*

Book Review

SCHIEMER F., SIMON D., AMARASINGHE U.S., MOREAU J. (eds.). Aquatic ecosystems and development: comparative Asian perspectives. *Biology of inland waters series,* Backhuys Publishers, Leiden, The Netherlands/ Margraf Publishers, Weikersheim, Germany, 2008, 508 pp, 181.90 EURO (incl. VAT)

This article is published with open access at Springerlink.com. Published online 28 January 2009.

This publication is the result of fruitful collaborative project FISHSTRAT funded by the EUs INCO-DC programme. This project may be regarded as the continuation of an earlier tropical limnology project, the famous Parakrama Samudra reservoir project (Schiemer 1983), which studied this beautiful, ancient reservoir in the north-east of Sri Lanka more than 25 years ago. The results of this study and hypotheses emerging from these, inspired a whole generation of tropical limnologists. As for the Parakrama Samudra project, the idea for FISHTRAT project came from three prominent members of the earlier Pakrama Samudra team: Nan Duncan (Holloway College, UK), Fritz Schiemer (University of Vienna, Austria) and Upali Amarasinghe (Kellaniya University, Sri Lanka). They originally wanted to limit the project to Sri Lanka, but because the EU rules stipulated three countries in the same region, they included Thailand and Philippines as well.

The book is dedicated to late Annie (Nan) Duncan, who coordinated the FISHSTRAT project until she became ill. This ambitious project had the aim to gain via multi-disciplinary and system-oriented research a better insight into the complex interrelationships in freshwater systems for formulating sustainable development policy recommendations for tropical water bodies. Research was carried out during 19982002 in five water bodies (four reservoirs and one lake) and their catchment areas in Sri Lanka, Thailand and the Philippines. This system-oriented approach integrated, limnology, fish ecology, fisheries, aquaculture and socio-economics conditions of the riparian fishing communities. To facilitate comparisons, the same methods, tools, gear and research strategy were used for all water bodies. This north south partnership involved researchers from five European and three Asian countries. In total, 33 authors from 16 institutions were involved in writing the 23 book chapters.

Limnology, including fish ecology, dominates 14 chapters, whereas fisheries and socio-economics are each represented by three chapters. Aquaculture with one chapter is clearly under represented. The whole effort is remarkable, taking into account the huge difficulties of coordinating the large number of people with different cultures and perceptions.

This 23-chapter book has six sections. The first section (chapters 24) provides a general description of physical, hydrological and catchment characteristics of the water bodies. The second section (chapters 59) compares different aspects of the ecosystems. It focuses on phytoplankton community structure and factors governing phytoplankton primary production. Role of bacterial activity in the detrital food chain, seasonality, biomass and production of zooplankton populations are also discussed. The third section (chapters 1014) focuses on fish ecology, use of hydro-acoustics for assessing fish stocks, feeding ecology of fish assemblages, diet predictions on basis of ecomorphology and selective feeding of small zooplanktivorous fish; modelling approaches are used to assess daily feeding patterns and food consumption. The fourth section (chapters 1517) addresses fisheries and aquaculture, analysing capture fisheries, population dynamics of non-exploited and underexploited fish species, population dynamics of commercially important species. The fifth section (chapters 1820) examines the socio-economic aspects of aquaculture, fisheries and fish trading. Chapters 2123 form the last section where the principal findings and conclusions from each disciplinary area are collated for a holistic analysis.

Limnology that is regarded as the scientific basis for aquatic resource management receives a great attention. Rightly, the ecosystem-oriented limnological approach employed here greatly helps to understand aspects such as the habitat conditions for the fish assemblages, the carrying capacity of the resource base, food web structure and the efficiency of its utilization by the fish, and unfilled niches versus untapped resources. The ecosystems of the three countries show both differences and similarities. As expected, the large and deep (max. depth 198 m) crater lake, L. Taal (Philippines), differs from the Sri Lankan and Thai reservoirs in many respects. Areal zooplankton production in Lake Taal is very high relative to the chlorophyll concentration per unit volume. This is because the mixing depth of the lake is ca. 100 m, with zooplankton inhabiting the upper 80-m layers. In the shallower Sri Lankan reservoirs Minneriya and Udawalawe in Sri Lanka and in Ubolratana reservoir in Thailand, nutrient and chlorophyll concentrations are high at the end of the dry season when water level is low, which demonstrates the importance of internal nutrient loading. In the Sri Lankan reservoirs, but not in Lake Taal in the Philippines, high flushing rates at the start of the dry season reduce chlorophyll levels and primary production.

Fish studies were based on both traditional gill netting, beach seining and use of acoustics (Simrad EY 500 split beam echo sounder, Chapter 10). This last technique offers several advantages over the other techniques. The acoustics enable to search a large volume of water in a relatively short time and give a better insight into the spatial distribution of the fish and allows accurate estimates of their size distribution and biomass. A major drawback, however, is that it is not easy to identify all fish species so that the acoustics had to be supplemented by experimental fishing. The overall size distribution of the fish communities was similar in all the waters studied. Small-sized fish comprised both the highest numbers and biomass, because of this and their high P/B ratios (chapter 21), small fish play a pronounced role in the food web. The fish communities in the three countries also differ: Thailand with 75 fish species had the highest biodiversity and Sri Lankan reservoirs with 31 species the lowest. The trophic structure of the fish communities differed markedly: whereas herbivores (tilapia, small carps) dominated in all Sri Lankan reservoirs, zooplanktivorous clupeids dominated in Lake Taal (Sardinella tawilis) and Ubolratana reservoir (Clupeichthys aesarnensis). Except for Lake Taal, zooplanktivorous fish in Sri Lanka and Thailand mainly feed on adult chironomid midges rather than on zooplankton.

The fisheries studies revealed several surprises. Despite the ancient tradition (ca. 2,000 years) of reservoir construction in Sri Lanka, inland fishery is a recent practice in this country. It has developed mainly due to the migration of coastal marine fisher families to the reservoirs after tilapia (Oreochromis mossambicus) was introduced in the early 1950s. The tilapia species, which form the main fishery in Sri Lanka, feed on lower trophic levels so that their annual yield is relatively high, much higher than the yield in Ubolratna, where the exploited fish populations feed higher in the food web. The fishery in Ubolratana and Lake Taal is very diverse probably because of the large size of the water bodies and greater fish diversity. Whereas in Ubolratana the yield is dominated by benthivorous fish species in Lake Taal, the pelagic zooplanktivores dominate the fish yield. Total fish yields are the highest in the Philippines and the lowest in Thai reservoirs. The income of fishermen varies markedly, being the highest in Sri Lanka where it is also well above the average poverty line and the lowest at Ubolratana in Thailand.

Aquaculture was only important in Lake Taal with some 10,000 cages (chapter 18). It increased production of total lacustrine fish substantially and offered a good income to the investors. However, the dense aggregations of cages in certain areas of the lake led to deterioration of water quality (anoxic conditions), causing fish kills in the both lake and cages.

Surprisingly, the FISHSTRAT researchers did not find a correlation between the resource potential and its utilization by the fishermen. In other words, the limnological conditions could not explain the differences in fish yields among the studied water bodies. Most likely, the choice of which species to target is predominantly influenced by social and economical factors. This is because the operation of capture fisheries in these water bodies mainly depends on tradition and the availability of gear rather than insight into the fish stocks. As a result, fisheries in all studied water bodies are restricted to a relatively small number of fish species, and only a small part of the available fish production is actually harvested. Thus, there are untapped resources that are not utilized by the fishery. This is an important revelation, especially for Sri Lanka where minor carps dominate the fish production but the fishery is concentrated on two tilapia species only. It is even clearer in Thailand where only a small number of the 75 species is harvested. The editors conclude that the interactions among managers, stakeholders and researchers need to be improved to optimise utilization of the resources; they recommend (chapter 23) establishing a co-management forum for all exploited water bodies in the three Asian countries. This, indeed, seems to be the only rational solution, since an optimal resource use includes ecological, environmental, economical as well as social sustainability.

The book is carefully edited and generally reads quite well. The diverse contributions are well integrated as the book chapters are very well crossreferred to one and other, and the last section (chapters 21, 22, 23) integrates the most important information. The book presents a large collection of interesting information and richly contributes to present knowledge and understanding of system dynamics in tropical lakes and reservoirs. The bottom-line: it is a good value for money for the fundamental limnologists/aquatic ecologists and the inland fisheries biologists. However, considering the central question addressed in this book, i.e. formulating appropriate sustainable development policy, for improving management and to increase the fish yields and the income of the fishermen, the whole FISHSTRAT project is obviously a bit biased. Somewhat exaggerated emphasis in the book is laid on limnology and fish ecology, and consequently this has taken its toll on the more essential issues as aquaculture and socialeconomical aspects of this study.

I would recommend this book to graduate students and researchers alike in tropics in the fields of limnology, fish community ecology and inland fisheries and to researchers engaged in multi-disciplinary and system-oriented studies for understanding the complex interrelationships in freshwater systems, especially if the study aims are to improve resource management.

I am highly grateful to my colleague Koos Vijverberg for his constructive criticism of an earlier version of this review.

Open Access

This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

Reference

Schiemer F (ed) (1983) Limnology of Parakrama Samudra Sri Lanka. A case study of an ancient man-made lake in the tropics. Dr. W. Junk Publishers, The Hague, p 236

Ramesh D. Gulati,
Editor, *Silnews*

Book Review

TELESH, I., POSTEL, L., HEERKLOSS, R., MIRONOVA, E. AND SKARLATO, S. "Zooplankton of the Open Baltic Sea: Atlas" by BMB Publication No. 20 – Marine Science Reports 73. Warnemünde: IOW, 2008. 251 pp., with 290 color photographs and 33 line drawings (http://www.io-warnemuende.de/documents/mebe73_2008-telesh-lpostel.pdf).

A renaissance of the research on diversity of living organisms can be observed today, after a long period when this scientific realm had been nearly consigned to oblivion and the both public awareness and finances were re-directed from the basic floristic and faunistic research to applied ecology. This is because, firstly, molecular geneticists studying phylogenetic relations and animal evolution became interested in species identifications made by taxonomists. The scantiness and uncertainty of results of many molecular-genetic analyses to solve all species identification problems by the DNA nucleotide sequencing only led to a revival of interest in classical methods in systematics, based on morphological characteristics. In addition, the ecologists today understand that the ecosystem resilience to the external regular and catastrophic impacts depends on species diversity and polymorphism of organisms in populations and aquatic communities. Thus, biodiversity alterations are to be monitored permanently, which is impossible without assessing the species composition routinely. Finally, the invasive species have recently become an international issue of importance, requiring specialists with professional knowledge of taxonomy, regional biodiversity and general ecology.

In August 2008, a new book in the series of zooplankton atlases of the semi-closed, brackish-water Baltic Sea was published by Dr. Irena Telesh and co-workers, members of the Baltic Marine Biologists (BMB) Working Group No. 29 "Zooplankton Diversity" (Telesh et al., 2008). Similarly to the first two books in this series that describe the Baltic estuarine Rotifera, Cladocera and Copepoda (Telesh, Heerkloss, 2002, 2004), the "Zooplankton of the Open Baltic Sea: Atlas" is an illustrated guide which can serve as a valuable addition to textbooks and classical identification keys to regional planktonic fauna of NW Europe.

Zooplankton atlas of the open Baltic Sea was published by a well known German research institution, Leibniz Institute for Baltic Sea Research in Warnemünde (IOW). This volume is also a BMB Publication No. 20, by which the members of the BMB WG "Zooplankton diversity" (convener – Dr. Irena Telesh) celebrated the 40-ieth anniversary of BMB. Currently, the full-text PDF-file of the atlas is available at the IOW web portal (http://www.io-warnemuende.de/research/mebe.html).

This new book deals with all zooplankton groups that inhabit the open Baltic Sea. In fact, this atlas is the first complete annotated and exhaustively illustrated zooplankton inventory of the central basin of the Baltic Sea. Following the general structure of the series, the atlas also contains an introductory part where the authors briefly describe the zooplankton communities of the open Baltic Sea, methodology of sampling and analyze the zooplankton collections, and make a rather unconventional subdivision of the sea area, which is always a challenging task in large water bodies with complicated geomorphology and hydrology. The original, easy-to-use photo-key of major high zooplankton taxa is one of the special features of this atlas.

A special chapter on planktonic ciliates of the Baltic Sea is another exclusive part of the book. This section contains a detailed description of the Baltic ciliate assemblages and an impressive annotated checklist of 786 valid Latin names of ciliates with synonymous names, which is a complete summary of the Baltic ciliate diversity to-date. The illustrative part of this chapter, however, is rather short and covers only ca. 5% of the total ciliate diversity in the sea.

The chapter on mesozooplankton and macrozooplankton of the open Baltic Sea briefly describes and provides information on general morphology of larger planktonic invertebrates: Cnidaria, Ctenophora, Turbellaria, Rotifera, Phyllopoda, Copepoda, Chaetognatha and Copelata, as well as meroplanktonic larvae of Polychaeta, Mollusca, Cirripedia, Bryozoa and Echinodermata. This section of the atlas is very extensively illustrated by ca. 300 original photographs of zooplankters.

The book provides a detailed illustrated survey of both, marine, brackish and freshwater (euryhaline) planktonic fauna that inhabit the open Baltic Sea. Because the book is freely accessible in the Internet it will be in great demand by students and researchers on biodiversity and aquatic ecosystems alterations in the Baltic Sea.

To my opinion, this atlas is a good example of a new generation of hand-books, which enable self-training. In Russia, such type of literature has not been published for ca. 30 years ago. Thus, there is an urgent need of such an Atlas Series for the university departments of general hydrobiology, regional ecology and applied ecology in all countries around the Baltic Sea. Therefore, I eagerly look forward to the publication of the second (improved and extended) edition of the zooplankton atlas of the open Baltic Sea, which is currently in preparation and is scheduled for publication by the same team of authors in mid-year 2009.

References

Telesh I.V., Heerkloss R., 2002. Atlas of Estuarine Zooplankton of the Southern and Eastern Baltic Sea, Part I: Rotifera. Hamburg: Verlag Dr. Kovač. 90 pp. (with CD).

Telesh I.V., Heerkloss R., 2004. Atlas of Estuarine Zooplankton of the Southern and Eastern Baltic Sea, Part II: Crustacea. Hamburg: Verlag Dr. Kovač. 118 pp. (with CD).

Telesh I.V., Postel L., Heerkloss R., Mironova E.I., Skarlato S.O., 2008. Zooplankton of the Open Baltic Sea: Atlas. BMB Publication No. 20 – Marine Science Reports 73. Warnemünde: IOW. 251 pp. (http://www.io-warnemuende.de/documents/mebe73_2008-telesh-lpostel.pdf).

Victor R. Alekseev,
Zoological Institute,
Russian Academy of Sciences,
Universitetskaya Emb. 1,
199034 Saint Petersburg, Russia,
E-mail: valekseev@yahoo.com

Book Announcement

PILLOT, M., HENK, K.M. Chironomidae Larvae II - Biology and Ecology of the Chironomini, Comprehensive guide to non-biting midges. The Netherlands : KNNV Publishing in cooperation with STOWA, 2009. 270 p., 16,5 x 24 cm, hardback, illustrated with b/w line drawings. ISBN: 978 90 5011 303 8. 69,50

Chironomid larvae play an important role in aquatic ecosystems and are used in the assessment of water quality. However, the species are difficult to identify and there is a lack of information about their biology.

This 2nd part of a series on Chironomidae larvae covers the most important tribes Chironomini and Pseudochironomini and presents a wealth of information for professionals and students for scientific and practical purpose.

Because the European Water Framework Directive requires from the authorities to ascertain the presence status of macro-invertebrates in surface waters, the work on Chironomids is gaining more attention.

The Chironomini larvae are the well-known red bloodworms. Almost all species in this group are coloured red by the presence of haemoglobin. They are the most important group of the Chironomidae family in stagnant water and can be very numerous, especially in polluted water. Many species are detritus feeders and play a part in the decomposition of organic material. Most species live in a tube of small particles, attached to the substrate.

The author has brought together a wealth of information on the biology and ecology of this group geared especially to water quality assessment. This collected knowledge is required in the interpretation of macro-invertebrate samples. An introduction gives background information on the influence of environmental factors on chironomid larvae.

This book takes a special place in the collection of KNNV Publishing because of its unique and helpful focus on this ecologically important group, useful for professionals or otherwise and especially important for its potential use in water quality management.

Previous in this series: Chironomidae Larvae I General ecology and Tanypodinae ISBN 978 90 5011 259 8.

More about the contents

Please contact Henk K.M. Moller Pillot, phone +31 (0)13-5425688, e-mail: henkmollerpillot@hetnet.nl

Review copies

Please contact KNNV Publishing, Kathrin Ohrmann, PO Box 310, 3700 AH Zeist, Netherlands. Phone +31 (0) 30-69 29 024 (direct) or +31 (0) 30-233 35 44, E ohrmann@knnvuitgeverij.nl

How to order?

Please contact KNNV Publishing, PO Box 310, NL 3700 AH Zeist, The Netherlands, phone + 31 (0) 30 233 35 44, fax + 31 (0) 30 236 89 07, e-mail info@knnvuitgeverij.nl or www.knnvpublishing.nl

Freshwater Reviews Update

In 2008, the Freshwater Biological Association (FBA) launched its new journal *Freshwater Reviews* (announced also in *SILnews52,* page 18). The new journal, edited by Professor Colin S. Reynolds, aims to provide authoritative and timely reviews on a wide range of topics in the freshwater sciences to a broad audience including academics, students, practitioners and teachers.

The first full volume of *Freshwater Reviews* was completed in December 2008 with articles published online first, and then two print issues compiled in March and December 2008. In total, 12 articles and three book reviews contributed to the first volume with authors hailing from Belgium, Hungary, Italy, Norway, Spain, Sweden and the UK. The full table of contents can be found below.

Contributed reviews are invited and may cover any topic within freshwater sciences and their application. Submissions should be made via the website. If you wish to discuss a submission please contact the Editor, Professor Colin S. Reynolds at creynolds@fba.org.uk.

Subscription rates remain very competitive and can be found on the website www.fba.org.uk/journals. *Freshwater Reviews* can also be ordered via your agent. Individual SIL members qualify for a 10% discount on online subscriptions when they quote the promotional code 'FR0609SIL'.

Volume 1, Issue 1 Contents

Volume 1, Issue 2 Contents

Book Reviews

Elliott, J.M. Biology and Management of Coregonid Fishes – 2005. Eds. Jankun et al.

Pentecost, A. Protistology. Third revised edition. Hausmann, K. et al.

Haworth, E.Y. Desmids of the Lowlands: Mesotaeniaceae and Desmidiaceae of the European Lowlands. Peter F.M. Coesel and Koos (J.) Meesters

Upcoming Meetings, Conferences and Reports

International School on "Alpine Ecology and Global Change"

4-8 October 2009
University Center Obergurgl (1,930 m a.s.l.), Tyrol, Austria

Organizers: Drs. R. Sommaruga and . U. Tappeiner

Background and objective: Alpine ecosystems are important on a global basis and are particularly susceptible to the effects of global change. At present, there is compelling evidence that different global changes (climate, land use change, biological invasions) are strongly affecting alpine ecosystems. Particularly, changes in climate, including the frequency of extreme events, will alter a wide range of characteristics of mountain ecosystems and mountain economies. The objective of this International School is to provide Ph.D. students and young postdocs with a state-of-the-art overview on the ongoing research on alpine ecosystems (both aquatic and terrestrial) and global change.

Program: Twenty one lectures (50 min each) will be given in English by members of the Alpine Ecology Research Focus from the University of Innsbruck, Innsbruck (Austria) and by guest scientists from Canada, Spain, UK, France and Switzerland. Some of the lectures will also include excursions and demonstrations on-site. Please see website for details.

Fee: Before 1st September 300 €, after this date 450 €. The fee includes accommodation, full-board, and course materials.

Application: http://c719-71-22.uibk.ac.at/ecoschool/

Contact: alpiner.raum@uibk.ac.at

Web: http://www.uibk.ac.at/obergurgl/index.html.en

Deadlines:
Submission of applications............ 1 July 2009
Notification of acceptance
to applicants........................... 10 August 2009
Confirmation by participant
and payment.......................1 September 2009

Australian Society for Limnology (ASL) Congress 2009

28th September to 2nd October2009
Alice Springs Convention Centre, Alice Springs, Northern Territory.

The call for papers and registration for the 2009 ASL Congress is now open. The theme of the congress is "Water in a dry land: sustaining arid zone rivers and wetlands."

For Congress information, a preliminary program and abstract submission please see the ASL web site (www.asl.org.au).

Simon Monk
Executive Director,
ASN Events P/L
PO Box 200, Balnarring Vic
Australia 3926

11th International Poster Session Conference on Ecosystems, Organisms, Innovations

Including Distant Participation
June 24, 2009
Moscow State University, Moscow

This is a series of International Poster Session Conferences started in 1999. Abstracts of the conferences are published where?.

Deadline: June 17, 2009. For submission by email of abstracts , posters (by mail) and for registration fees (please see details below). Please inform early if you intend to submit an abstract and/or a poster.

Details: Participants are not required to attend the conference in person (the posters sent by mail will be displayed/exhibited by organizers on behalf of the authors). Non-attendees can receive some feedback from other participants by email. The author of the best student poster (including those sent by mail) will receive an honorary diploma.

Contact: Abstracts submission: by email in .rtf or .txt format. Please send abstracts to the address: ar55[at]yandex.ru; saostro[at]online.ru. Posters: please send posters by conventional mail to: Dr. S.Ostroumov, Faculty of Biology, M.V.Lomonosov Moscow State University, Moscow 119991, Russia.

Fees in U.S. dollars: $50 for non-attendees and $30 for non-attendees students; please add a surcharge of $15 to fees received later than June 17, 2009. The fee those who attend the Conference is $400 ($200 for students). Please send an email prior to sending your fee to: Dr. D. S. Page, Professor, Bowdoin College Chemistry Department, 6600 College Station, Brunswick, ME 04011-8466 USA; Tel 207 725 3602; Fax 207 725 3017; dpage@bowdoin.edu, http://academic.bowdoin.edu/faculty/D/dpage/

We also invite nominations for ecologists to receive the honorary titles of *Aquatic Ecologist of the Year* and for *Ecologist of the Year*, with your rationale for your nomination. The process of nomination and selection of the finalists will be completed at the conference.

For more info please contact S.Ostroumov: ar55@yandex.ru, saostro[at]online.ru, http://sites.google.com/site/ostroumovsergei/conference-poster-session-2009 or http://www.limnology.org/links.shtml#meetings

Wetlands in a Flood Pulsing Environment: Effects on Biodiversity, Ecosystem Function and Human Society

1-5 February 2010, Maun, Botswana

HOORC will host the international symposium, *Wetlands in a Flood Pulsing Environment: Effects on Biodiversity, Ecosystem Function and Human Society in Maun, Botswana*, 1-5 February 2010 with international participation of the Olentangy River Wetland Research Park, Ohio State University, the Howard T. Odum Centre for Wetlands at the University of Florida, the Institute for Land, Water and Society (ILWS), Charles Sturt University, Australia, and the Global Wetlands Consortium.

The symposium will aim to provide an exchange of international scholars on the importance and effects of pulsing hydrologic cycles (floods, seasonal rainfall and stream-flow, for example) on the functioning of wetlands. Emphasis will be on inland wetlands with focus on the importance of pulsing in carbon and nutrient cycling, biological productivity, biodiversity and human livelihood, history and culture. Pre and post conference field trips to the nearby Okavango Delta will be arranged.

For submission of proposals for special sessions, papers and abstracts please see Conference Web site http://www.orc.ub.bw/floodpulse/index.html.

Contact persons: the undersigned, or the Conference Secretary, Lore Mosimi, Tel. +267 6817200, Fax. +267 6861835, e-mail. OkavangoConference@orc.ub.bw

Lars Ramberg,
Professor
Tel: +267-6817230,
Fax: +267-6861835

The VIII International Meeting of the Mexican Society of Planktonology: A Report

21-24 April, 2009
Mexico City, Mexico

The 8th International Meeting of the Mexican Society of Planktonology (SOMPAC) was held during 21-24 April, 2009 in the North Mexico City at the National Autonomous University of Mexico, Campus Iztacala, Tlalnepantla (State of Mexico, Mexico). About 150 participants attended the meeting, mostly from Mexico but there were also some international participants. There were about 140 presentations, including both oral lectures and posters; in addition, there were 4 invited, plenary lectures. A series of pre-conference workshops on various themes of plankton research were also conducted.

Despite the large number of participants and diverse themes on plankton, there were no parallel sessions, and the oral presentations were organized in a spacious cultural hall of the university campus. This provided the possibility of a good interaction among the planktonologists with diverse specializations. Although all the oral presentations except the 3 of the 4 invited talks were conducted in Spanish, the speakers answered in English for the questions raised by the non-Spanish speaking participants.

There were in total 10 oral sessions and 3 poster sessions. The presentation themes ranged from microbiology, toxicology, plankton cultures, evolutionary ecology and trophic interactions, phytoplankton, zooplankton and ichthyoplankton to alternative tools for the identification of planktonic organisms.

The plenary lectures, that had a duration of one hour each, were thought-provoking and were open even to non- registered participants. The first such talk "The symbioses and organelle retention in marine planktonic protists" was given by Prof. Diane K. Stoecker (University of Maryland, USA), the second was by Prof. Santiago Fraga (Centro Oceanográfico de Vigo, Spain) on "Toxic microalgae as an engine in basic science". The third talk "A birdwatchers approach to plankton ecology" was given by Prof. Thomas Kiørboe (Technical University of Denmark, Denmark). The fourth and last invited lecture was delivered by Prof. Nelson G. Hairston, Jr. (Cornell University, USA) on "How rapid contemporary evolution affects plankton dynamics". There was a general discussion after each talk, and the speakers also interacted with the participants during the coffee breaks.

Except for Prof. S. Fraga, the other invited speakers visited our research laboratory and showed great interest in demonstrations on live cultures of species of rotifers, cladocerans and copepods, all of which are routinely and meticulously maintained by Prof. S. Nandini. In addition, there was also an exchange of electronic reprints between our laboratory and the invited guests.

In order to encourage student participation, special prizes were awarded for the best presentations. On the last day of the meeting, we had the bad news of H1N1 virus outbreak in Mexico and by the order of the Federal Health Ministry, our university was closed immediately. Consequently, the technical sessions programmed for the last day were condensed and organized in a meeting hall in a hotel.

As during the previous meetings of SOMPAC, the proceedings of the present symposium will be considered for publication in international journals—*Journal of Plankton Research* and *Journal of Environmental Biology*—both of which are the standard and indexed journals; the choice between these two journals was left to the authors because of large number of manuscripts are expected to be submitted.

Unfortunately, at the present meeting there was inadequate emphasis on applied aspects in planktonology, e.g. including ecotoxicology, lake biomanipulation and aquaculture. Despite the growing importance of both phytoplankton and zooplankton for use as diet in aquaculture globally, there were only a few works that considered these aspects. The use of rotifer *Brachionus* for mariculture by Rimber and co-workers and the use of parthenogenetic harpacticoid copepod *Elaphoidella grandidieri* by Nandini & Sarma as live feed in freshwater aquaculture are among the few works that considered aquaculture aspects of zooplankton. We hope that our next planktonology meeting (programmed for 2011 in La Paz City, Baja California Sur, Mexico) will attract more diverse planktonologists.

S.S.S. Sarma,
Member, Organizing Committee & Guest Editor of the Proceedings
National Autonomous University of Mexico
Campus Iztacala
Tlalnepantla, Mexico.
E-mail: sarma@servidor.unam.mx

Call for Proposals to The Edward B. and Phyllis E. Reed Endowment

The Department of Invertebrate Zoology at the National Museum of Natural History is pleased to request proposals for grants to pursue research on freshwater copepods of North America. Funding for the grants is made available from The Edward B. and Phyllis E. Reed Endowment at the Smithsonian Institution.

Grants are for one year duration and are limited to no more than $6,000. U.S. citizens and foreign nationals are eligible. Funds are disbursed in US dollars. Proposals should include: (1) a statement of proposed research of no more than 3 double-spaced pages; (2) a budget page; (3) CV's of all participants. Proposals from undergraduate and graduate students also must include a letter of support from the primary faculty advisor explaining the student's funding needs and describing the student's academic and research accomplishments.

Proposals may address any aspect of the biology of freshwater copepods of North America, although specimen-based research on taxonomy, poorly surveyed habitats, zoogeography, invasive species, or phylogeny is of particular interest. Funds cannot be used to attend meetings. Awards for work at the Smithsonian Institution will be made as travel plus stipend; awards for all other research will be made as a reimbursable contract. In either case, grantee will deliver a final report on the results of the research within six months after the completion date. We also ask that reprints (paper or electronic) of publications resulting from the research should be made available to the Charles Branch Wilson Copepod Library, Dept. of Invertebrate Zoology [MRC – 534], Smithsonian Institution, 4210 Silver Hill Rd., Suitland, MD, 20746, USA, and to the Monoculus Library, Deutsches Zentrum fuer Marine Biodiversitaetsforschung, Forschungsinstitut Senckenberg, Suedstrand 44, D-26382 Wilhelmshaven, Germany

Proposals are due by June 1, 2009. Send electronic proposals to ferrarif@si.edu (MS Word, WordPerfect, or PDF) or paper proposals to Dr. Frank D. Ferrari, Dept. of Invertebrate Zoology [MRC – 534], Smithsonian Institution, 4210 Silver Hill Rd., Suitland, MD, 20746, USA. Proposals will be evaluated by a standing committee, Ferrari chairman. All applicants will be notified by the end of August, 2009.

Attention: Manufacturers of Limnological Equipment and Publishers

SILnews accepts advertisements for equipment and publications that will be of interest to SIL members.

SILnews is distributed twice a year to more than 3,000 SIL members and libraries world-wide. If your company is interested in acquiring advertising space in *SILnews,* please contact Ramesh D. Gulati (r.gulati@nioo.knaw.nl) or Ms. Denise Johnson (denisej@unc.edu) the Editorial Office for rates, or use the mailing address indicated on the front page.

A complimentary copy of *SILnews,* in which your advertisement appears, will be sent to you once it has been published. *SILnews* is posted on the SIL web site at http://www.limnology.org after it has been published .

Limnology Jobs and Studentship Notices

Notices on the availability of limnologically-oriented jobs and graduate student opportunities are now accepted for publication in the *SILnews* and displayed on the SIL web site at http://www.limnology.org. There is no charge for the service at this time, which is available to both SIL members and non-members.

Persons submitting notices should note the four month lead-time for the print edition of *SILnews;* those advertisements with short deadlines should be directed to the web site only.

Submissions should include:

- a short title describing the position (job or studentship);
- location and duration of the position;
- closing date for applications;
- a short paragraph describing the position, including any citizenship, educational or employment prerequisites; and,
- information on where potential applicants may obtain further information, including names of contact persons, telephone numbers, fax numbers, e-mail addresses, and web site addresses, where appropriate.

Submissions may be edited for length and clarity. Those deemed inappropriate to the SIL mandate will be rejected at the discretion of the *SILnews* Editor or the Webmaster. Submissions for the print edition of *SILnews* should be sent to the editor at the address on the cover of this issue.

Submissions for the SIL web site should be sent by e-mail to webmaster@limnology.org or by fax to the attention of Gordon Goldsborough at: +1 (204) 474-7618.

Are you moving?

Please send your change of address to:

Dr. Morten Søndergaard
c/o Ms. Denise Johnson
SIL Business Services Coordinator
University of NC at Chapel Hill, CB 7431
GSGPH, 135 Dauer Dr., ESE, 148 Rosenau Hall
Chapel Hill, NC 27599-7431 USA U.S.A.
Work: 336-376-9362; Fax 336-376-8825
E-mail: denisej@email.unc.edu

The International Society of Limnology (formerly International Association of Theoretical and Applied Limnology; Societas Internationalis Limnologiae, SIL) works worldwide to understand lakes, rivers, and wetlands and to use knowledge gained from research to manage and protect these diverse, inland aquatic ecosystems.

SIL Officers

PRESIDENT

Prof. Dr. Brian Moss
School of Biological Sciences
Biosciences Building
The University of Liverpool
P.O. Box 147
Liverpool L69 3BX
Great Britain
E-mail: brmoss@liverpool.ac.uk

GENERAL SECRETARY-TREASURER

Prof. Dr. Morten Søndergaard
Freshwater Biological Laboratory
University of Copenhagen
51 Helsingørsgade
DK 3400 Hillerød
E-mail: msondergaard@zi.ku.dk

EXECUTIVE VICE-PRESIDENTS

Prof. Dr. Judit Padisák
Veszprém University
Limnological Research Group
P.O.B. 158, H-8200 Veszprém
Hungary
E-mail: padisak@tres.blki.hu

Prof. Dr. Ellen Van Donk
NIOO/Centre for Limnology
P.O. Box 1299 3600 BG Maarssen
Netherlands
E-mail: e.vandonk@nioo.knaw.nl

Prof. Dr. Brij Gopal
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi 110067
India
E-mail: gopalb00@rediffmail.com

EDITOR, *SIL NEWS*

Ramesh D. Gulati
NIOO/Centre for Limnology
Post Box 1299
3600 BG Maarssen
The Netherlands
Fax: +31.294.232224
E-mail: r.gulati@nioo.knaw.nl

For Your Information

SILnews is now on the SIL web site in PDF format. The newsletter is created in Adobe Acrobat, Version 5. To open, use Adobe Acrobat Reader.