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SILnews

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In This Issue

Material for the December 2010 issue should be sent to the Editor by:

1 OCTOBER 2010

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

Come to Cape Town. Be Part of History

There are lots of reprints, even whole runs of journals, that are now being pulped for paper recycling. Shelves are getting full, offices in new buildings are getting smaller, and a laptop gives you access to a vast literature in a small space. But there are some books and papers that are impossible to part with. For me these include a battered copy of the translation of Ruttner's 'Fundamentals of Limnology', perhaps the clearest –written text book on limnology ever produced, and a couple of reprints of G.E. Hutchinson. I acquired these when the University of Bristol threw out a collection of reprints put together between the 1920s and 1960s by Penelope Jenkin, one of the first women limnologists, who sampled the East African lakes on the rather grandly titled 'Percy Sladen expedition to rift valley lakes in Kenya in 1929'. The entire expedition comprised Miss Jenkin, an old Ford car and a rowing boat.

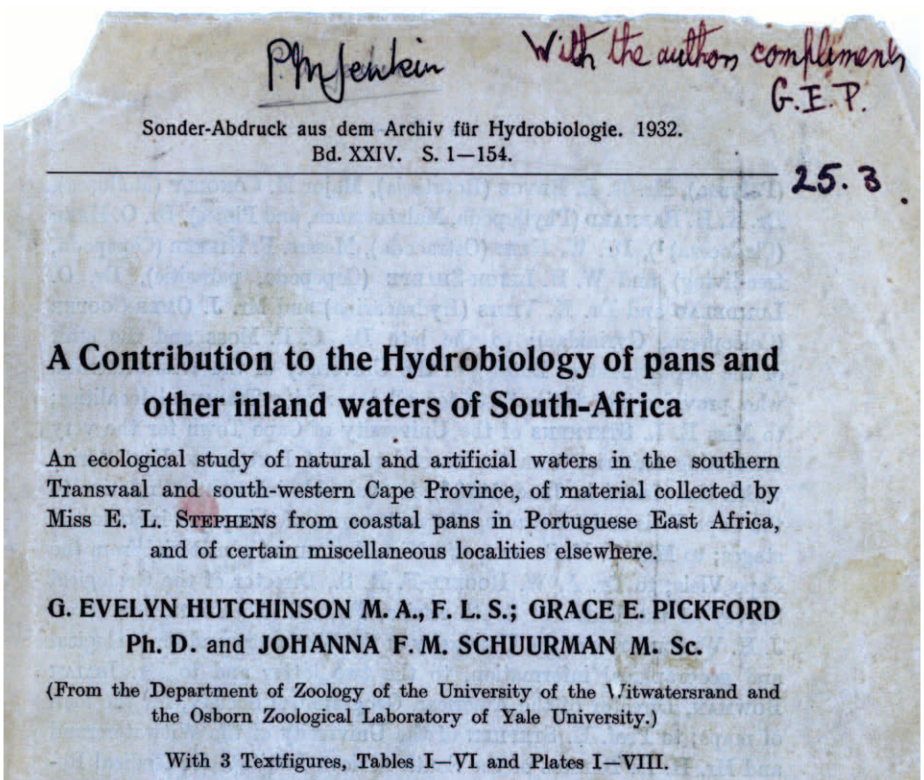
Brian Moss and a small child somewhere in Uganda, Africa.

She built a very comprehensive library of limnology, probably nearly complete for its time, and all the famous names, all the early classic papers, were there, often inscribed by their authors. It was a small and friendly and cosy world and I regret not reading through much more of it. It was how I learned a lot of limnology. There were papers that were really inspiring. One remains with me. It is the lengthy account Hutchinson published in 1932 on South African pans (see Hutchinson et al. 1932; Title page of reference is reproduced here). He had become interested in pools that dry out, and in a lady named Grace Pickford, who had also, and not entirely coincidentally, been in South Africa at the time. Hutchinson never returned to work in Africa, but what remained from his travels was a comprehensive interest in a worldwide limnology that fed the breadth of intellect that is his lasting legacy.

Africa cradled mankind, the most astounding of ecosystems and significant ideas in limnology. It is a continent that has suffered immensely from exploitation, not least now from the effects of climate change. But its people battle on. South Africa has the largest group of limnologist in Africa, but the number is tiny compared with the numbers of limnologists in even the smallest American state. They have been working hard to mount our Congress is Cape Town and they need our support. People from the host country dominate numbers at most Congresses. But there are few in even the entire continent of Africa, and so the Congress needs as many of us as possible from elsewhere to make it a success. In going, and staying for a few days travel, you can experience wonderful landscapes and coasts; you can enjoy a Congress that will not be so huge that it becomes anonymous; and you can be a part of history. For at this Congress we will launch our new Journal, to be called, following popular acclaim, *Inland Waters. Journal of the International Society of Limnology.* It will primarily be electronic, though print versions will be available. And perhaps in the first issues will be something that, like Hutchinson's paper on pans for me, someone, much later this century, will treasure as an early inspiration.

Hutchinson, G.E., Pickford, G.E. and Schuurman, J.F.M. (1932) A contribution to the hydrobiology of pans and other inland waters of South-Africa. Archiv fur Hydrobiologie, 24, 1-154.

Jenkin, P.M. (1932) Reports on the Percy Sladen expedition to some rift valley lakes in Kenya in 1929. I Introductory account of the biological survey of five freshwater and alkaline lakes. Annals and Magazine of Natural History. Series 10, Vol.9, 533-553.



P M Jenkin With the author compliments G.E.P.

Sonder-Abdruck aus dem Archiv für Hydrobiologie. 1932.
Bd. XXIV. S. 1—154.

25.3.

A Contribution to the Hydrobiology of pans and other inland waters of South-Africa

An ecological study of natural and artificial waters in the southern Transvaal and south-western Cape Province, of material collected by Miss E. L. Stephens from coastal pans in Portuguese East Africa, and of certain miscellaneous localities elsewhere.

G. EVELYN HUTCHINSON M. A., F. L. S.; GRACE E. PICKFORD Ph. D. and JOHANNA F. M. SCHUURMAN M. Sc.

(From the Department of Zoology of the University of the Witwatersrand and the Osborn Zoological Laboratory of Yale University.)

With 3 Textfigures, Tables I—VI and Plates I—VIII.

Front page of an 'inspiring paper' by Hutchinson et al. (1932) from Brian Moss Collection.

SIL2010 Cape Town, South Africa

The countdown has begun and what seemed as an eternity suddenly became a reality–SIL IS COMING TO CAPE TOWN AND AFRICA.

We are excited at the prospect of welcoming you to South Africa and all indications point to a congress that should not be missed. We managed to put together some fantastic Pre- and Post Congress Excursions ranging from 3 to 7 days. A recent new hominid species discovery at the Cradle of Humankind claims to have found the "missing link" and this will be part of the Cradle to Cradle Corridor tour. Of course, Kruger National Park is very special as well as visiting the Namaqualand wild flower early spring bloom, which rates amongst the seven natural wonders on earth. The Cape region and Garden Route covers some of most beautiful scenery in the world and exposes the traveller to some of the most biologically diverse areas imaginable, not forgetting whale watching during this time of the year.

Scientifically the congress will deliver and the varied special sessions, keynote plenary lectures, workshops and papers will satisfy the curiosity needs of SIL's members. All this will happen at the Cape Town International Convention Center, where the majestic Table Mountain forms the backdrop. As *Organizing Committee* we are aware that many delegates will have to travel long distances, but we are certain that the effort will be worth the while. The congress will deliver scientifically, but important delegates will experience something of Africa, re-unite old friendships and make new ones, and all that hopefully over a glass or two of some of our excellent Cape Wines.

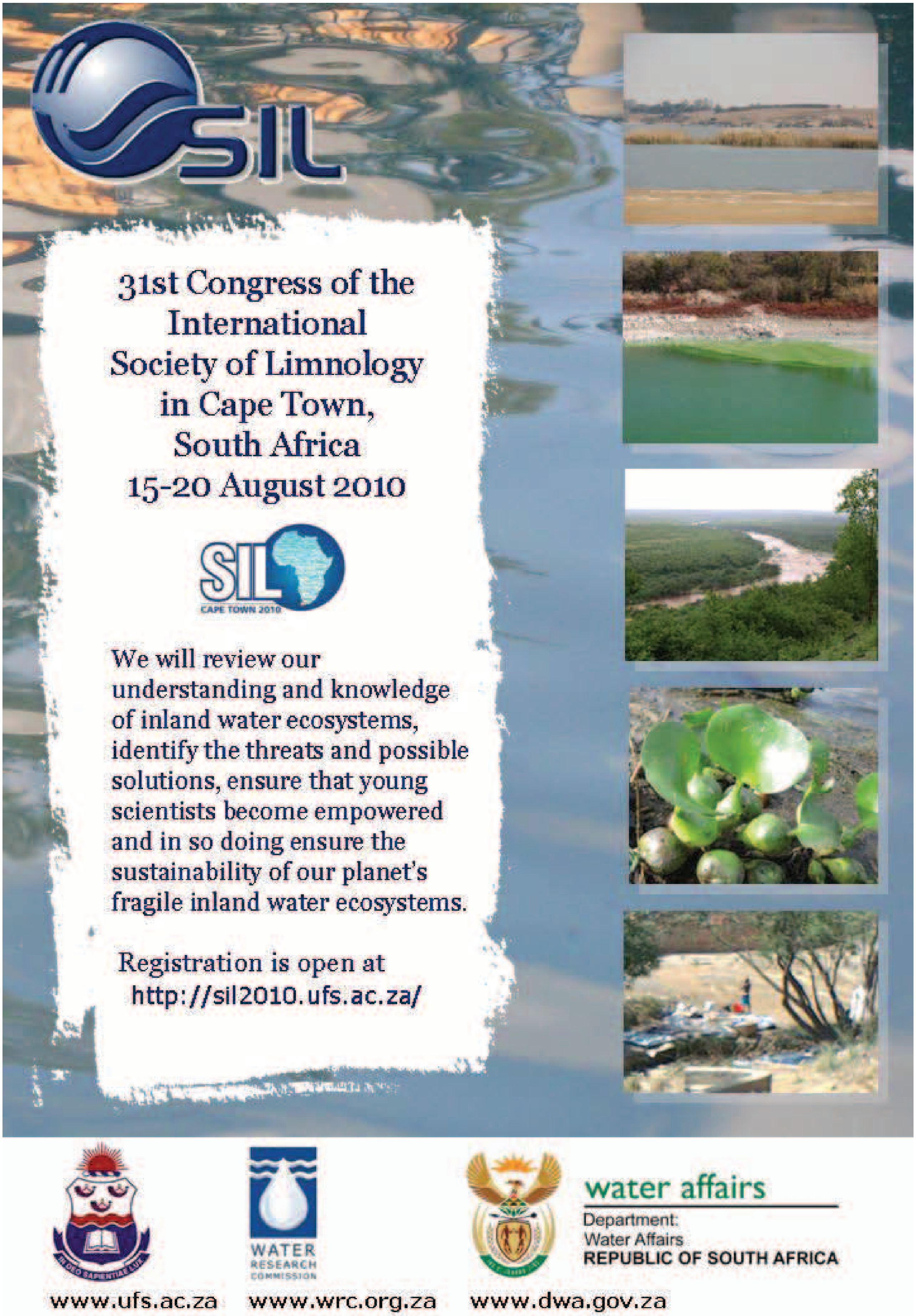
Prior to SIL2010, South Africa is hosting this year the FIFA Worldcup and delegates will benefit from the upgraded infrastructure, increased security, and spirit of *Ubuntu* made famous by President Mandela and Archbishop Desmund Tutu. For those of your already registered, you will have an experience of a lifetime and for those who still planning to make the trip to Africa, now is the time.

Till we meet in Cape Town,

Johan Grobbelaar (LOC)
grobbeju.sci@ufs.ac.za

From the Editor

This summer issue of this SIL newsletter has a special significance, because it will appear about two months before the 31st triennial SIL Congress starting on 15 August 2010 in Cape Town, S. Africa. The newsletter carries on the front page a welcome message from the SIL President Prof. Brian Moss to the SIL members, using the catchphrase *Come to Cape Town*. In the photo (Brian with a child in Uganda) that I inserted with the *call,* Brian- looking fondly at the child- seems to be cheerfully gripped with the SIL's future, which probably lies more in Africa and other countries facing the consequences of climate change (see major article in this newsletter) than anywhere else. This is followed by a call from Dr. Johan Grobbelaar, Chairman of the Local Organising


SIL
31st Congress of the International Society of Limnology in Cape Town, South Africa
15-20 August 2010
SIL
CAPE TOWN 2010
We will review our understanding and knowledge of inland water ecosystems, identify the threats and possible solutions, ensure that young scientists become empowered and in so doing ensure the sustainability of our planet's fragile inland water ecosystems.
Registration is open at
http://sil2010.ufs.ac.za/
WATER RESEARCH COMMISSION
water affairs
Department:
Water Affairs
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www.wrc.org.za
www.dwa.gov.za

Committee of the SIL in S. Africa. I think Johan and his team are very sanguinely engrossed with giving last touches to the preparations of this major event. I wish the organisors a great success with the upcoming meeting.

On this special occasion, I think it is apt to look up to some of our legendary laboratories and scientists: Prof. Colin Reynolds kindly agreed to pay tribute to the Windermere Laboratory and its great scientists. Also, Dr. Arthur S. Brooks provides a life-time biography of Prof. Dr. Clifford H. Mortimer (Biological Sciences and the Centre for Great Lakes Studies at the University of Wisconsin-Milwaukee) who turned 99 years on 27 February, 2010 (See more in the main article following this editorial).

The main substance on Limnology in this *newsletter* concerns the current issue of C*limate Change Effects* on water-level fluctuations in lakes and rivers and their impacts on the ecosystem structure and functioning. I am happy that we could acquire some basic information on this theme from all the continents. I thank all the invited authors for their encouraging response. It will be perhaps equally interesting to discuss the distressing problems related to the acute water shortages that are already affecting more than half the world's human population: China, India and Pakistan, in that order, are the countries most seriously concerned, in addition to the adverse effects on plant and animal life in general.

I hope that lectures and poster presentations at the SIL Congress in S. Africa, and the excursions that both precede and follow the Congress, will be as interesting and exciting as the FIFA World Cup Championship that will be probably be already underway in S. Africa when this newsletter appears on the SIL Internet Site. Hopefully, the Cape Town SIL Meeting will go down in the history as a memorable one.

Ramesh D. Gulati
Editor *SILnews*
12 May 2010

Homage to All-time Greats In Limnology

Biographical Sketch of Distinguished Professor Emeritus, F.R.S. Clifford H. Mortimer

Clifford H. Mortimer at age 90, 2001.

Clifford H. Mortimer, FRS, Distinguished Professor Emeritus of Biological Sciences and the Center for Great Lakes Studies at the University of Wisconsin-Milwaukee, took the day off from his writing on February 27th 2010 to celebrate his 99th birthday with family and friends.

Biographical sketches generally start with a listing of one's degrees and early publications and work forward in chronological order. In this case I will start with the remarkably productive 9th decade of a distinguished nonagenarian and work toward the beginning. Another reason for taking this tact is that the more recent years are those most familiar to me. I arrived at the Center for Great Lakes Studies as a Postdoctoral Fellow in 1972 and joined the faculty a year later. I have maintained a close friendship with Professor Mortimer over the past 38 years and feel honored to have been asked to prepare this note.

Full citations to works cited below, a full bibliography and a 2009 radio interview with Professor Mortimer are available online at: www.uwm.edu/glwi/profiles/chmortimer.

Professor Mortimer's current writing is focused on a manuscript dealing with the physics governing the density variations of fresh water as influenced by temperature, pressure and chemical composition. He includes an historical review of previous work to develop density tables for pure water and examines in detail the variables that influence water density in lakes. The manuscript will be submitted for review by mid-2010.

In 2006 a publication by C.H. Mortimer appeared in Limnology and Oceanography (51:1914-1955) titled, *Inertial oscillations and related internal beat pulsations and surges in Lakes Michigan and Ontario,* that was based upon data collected in 1963 that had waited for a time in retirement when the analysis could be conducted quietly without interruption. All the calculations were done on a hand calculator with the figures also drawn by hand, but scanned and properly lettered to satisfy the editor. This paper was preceded in 2005 by, *Internal seiche dynamics in Lake Geneva,* co-authored by U. Lemmin, and E. Baeuerle (L&O 50:207-216).

What might normally be the crowning achievement of one's career before retirement, a book titled, *Lake Michigan in Motion: Responses of an Inland Sea to Weather, Earth-Spin, and Human Activities*, was published by the University of Wisconsin Press in 2004, 28 years after Professor Mortimer's retirement. With over 300 pages and 187 illustrations, the book chronicles three centuries of observations of the Great Lakes by native peoples, early explorers and contemporary scientists. The physical geography and geology of the basin is covered along with chapters on sediment and water chemistry, ecology, human influences, and of course, the internal motions of waves and currents.

Much of the 1990's was spent preparing materials for "the book" and work on the papers cited above published in the new millennium. The American Society of Limnology and Oceanography bestowed the "Lifetime Achievement Award" upon Professor Mortimer at the 1996 annual meeting of the Society in Milwaukee, at which a special symposium was held in his honor.

The 1980's were very productive years with eleven publications and reports.

Never one to be left behind by technological advancements, Professor Mortimer took a leap into space spending several weeks at the Goddard Space Flight Center in Maryland reviewing National Aeronautics and Space Administration (NASA) tapes of images taken by the Coastal Zone Color Scanner satellite over Southern Lake Michigan. This research resulted in the publication of, *Revelations and testable hypotheses arising from Coastal Zone Color Scanner images of Southern Lake Michigan,* in 1988. (L&O. 33:203-226).

In 1987 he was granted an Honorary Docteur degree at Ecole Polytechnique Federale de Lausanne and in 1985 he was awarded an Honorary Degree of Doctor of Science by the University of Wisconsin-Milwaukee. In 1981 he retired for the second time, but this time it was from his academic role and he was granted Distinguished Professor Emeritus status. His first retirement was from the directorship of the Center for Great Lakes Studies, which was mandatory for administrators reaching age 65. Concurrently, he was awarded "Life Membership" by the American Society of Limnology and Oceanography. Work continued with European and British colleagues on the internal motions and biology of Swiss lakes (four publications), and a paper examining water motions in Green Bay, Lake Michigan using numerical models developed by former student, E. J. Fee, the present journal editor of Limnology and Oceanography.

The oxygen content of fresh waters was addressed in 1981 (Mitt. Int. Verein. Limnol. 22: 23pp). A review of 15,000 pages of court documents from a law suit over the pollution of Lake Michigan resulted in a 156 page scientist's assessment of the court proceedings. The judge's final decision was viewed to be based more on the personalities of the witnesses than the testimony they provided. (*The Lake Michigan Pollution Case: A Review and Commentary on the Limnological and Other Issues*). The decade began with the publication of a review and analysis of data collected during the 1972 International Field Year on the Great Lakes (IFYGL), (Center for Great Lakes Studies Special Report No. 37, 1980).

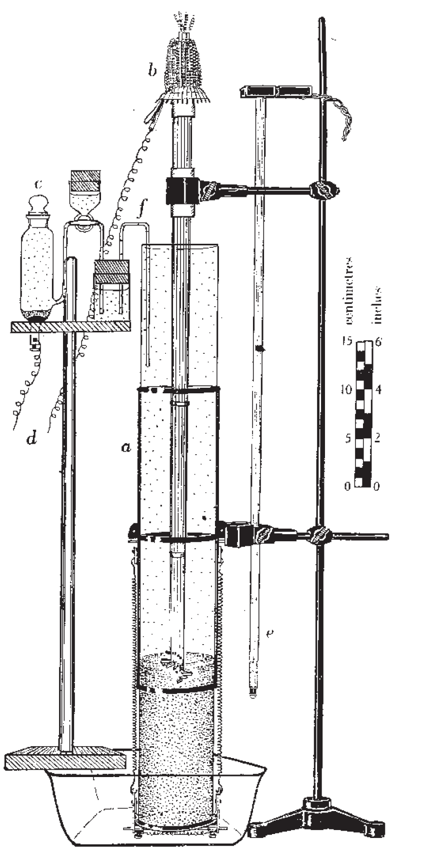


Figure 1. Apparatus used to investigate the distribution of redox potential and electrical conductivity in surface mud cores. (a) sampling tube from Jenkins water/sediment corer); (b) redox electrode bundle; (c) calomel electrode; (d) leads to potentiometer; (e) conductivity electrode; (f) KCL-agar bridge. (Mortimer, C.H. 1942. The Exchange of Dissolved Substances Between Mud and Water in Lakes: parts III and IV. J. Ecol. Vol. XXX No. 1.)

An American-Soviet symposium on the use of mathematical models in1978 lead to a paper on the importance of model verification (EPA Rpt. 600/9-78-024). The symposium also included a trip to Lake Baikal. Another paper in 1979 with W.H. Graf, examined *Strategies for coupling data collection and analysis with dynamic modeling of lake motions*.

There was a flurry of activity in the 1970's with graduate students and post doctoral fellows collecting data on IFYGL cruises and performing analysis of physical processes in Lakes Ontario and Michigan. There were 8 papers published during the decade relating to the IFYGL program as well as others that focused on continuing Lake Michigan research. Professor Mortimer's classic paper, *Lake Hydrodynamics,* was published in 1974 (Mitt. Internat. Verein. Limnol. 20:124-197). The illustrations developed for this paper have appeared in several textbooks and have helped many students understand the dynamics of internal motions in lakes. A 1971 paper, *Chemical exchanges between sediments and water in the Great Lakes –speculations on probable regulatory mechanisms* (L&O. 16:387-404) harkened back to his earlier research on sediment – water exchanges in English lakes.

The 70's were also busy with service to professional associations. He was elected President of the International Association for Great Lakes Research in 1973 and served as President of the American Society of Limnology and Oceanography in 1970.

The 1950's and 60'saw major changes in Professor Mortimer's research focus and geographical location. The former was strongly influenced by his wartime duties, more on that later, and the latter by opportunities that arose serendipitously. In 1966 he was offered a position as Distinguished Professor of Zoology at the University of Wisconsin-Milwaukee and the Directorship of a newly formed Center for Great Lakes Studies. Acceptance of that position lead to his resignation as Director of the Scottish Marine Biological Station at Millport Scotland, where he had served since 1956, and a move to Milwaukee, Wisconsin USA. Seeds for this move were sown in 1962-63 while on a Brittingham Visiting Professorship at the University of Wisconsin-Madison, arranged by Professor A.D. Hasler, and a prior visit to that campus in 1953 at the invitation of the American Society

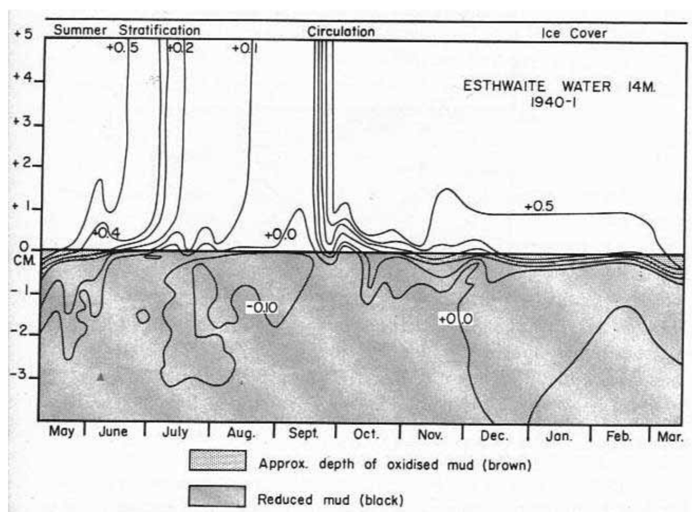


Figure 2. The distribution of redox potential above and below the mud surface during 1940 in Esthwaite Water 14m (E7 in volts). (Mortimer, C.H. 1942. The Exchange of Dissolved Substances Between Mud and Water in Lakes: parts III and IV. J. Ecol. Vol. XXX No. 1.)

of Limnology and Oceanography (ASLO) to address the annual meeting there. He was also asked to prepare material for a biography of E. A. Birge that resulted in an essay, *E. A. Birge an explorer of lakes,* a chapter in *E.A. Birge, a memoir,* by G. C. Sellery, University of Wisconsin Press 1956. Following his time in Madison, ASLO organized a three month lecture tour of limnological and marine stations across North America. During these visits to Wisconsin Professor Mortimer discovered temperature records at domestic water intakes in Lake Michigan that enabled him to deduce internal motions in the lake and to produce the research papers concerning these motions in the volumes noted above. Nearly 30 papers were published on lake motions and related methodology during the 1950's and 60's. Some focused on the English lakes, others on Lake Michigan.

Two noteworthy awards were bestowed on Professor Mortimer during this period. In 1958 he was elected to the Fellowship of the Royal Society of London and in1965 he was awarded the Naumann Medal of the International Association of Limnology (SIL).Among the accolades he received upon becoming a Fellow of the Royal Society (F.R.S.) was one letter that I will include here.

Istituto Italiano di Idrobiologia
Verbania Pallanza
May 8

Dear Mortimer

I have just been looking over recent numbers of Nature, and have so learnt of your election to the Royal Society. Please accept my congratulations; I am delighted both for your sake and for the recognition due to limnology.

Sincerely
(signed)
Evelyn Hutchinson
[Professor of Zoology at Yale University, on leave at Pallanza]

The 1940's were a tumultuous time for the world and the career path of Professor Mortimer. However, for him the decade ended as it began at the Freshwater Biological Association (FBA) on Lake Windermere in the English Lake District. His time at the FBA was interrupted by a secondment to the Royal Naval Scientific Service, Oceanographic Group at the Admiralty Research Laboratory from 1941-46. Duties with the Oceanographic Group included studies of waves and tides in the English Channel and shore patrols with other scientists, including Francis Crick.

Upon his return to Windermere with a new-found interest in physical limnology and miles of war-surplus electrical cables and other equipment, he set about to study the internal oscillations of Windermere and other lochs through the deployment of strings of thermistors to monitor temperature fluctuations about the thermocline. These investigations led to several publications that appeared in the early1950's .

Professor Mortimer's initial appointment with the FBA in 1935 was with the condition that he continue the chemical analysis of lake water begun by Professor W.H. Pearsall, F.R.S. These studies drew his attention to the sediment-water interface and the importance of oxidation-reduction potential gradients that influence seasonal processes in lakes. Two papers written before his naval secondment have become classics on the subject and are cited in numerous textbooks and research papers. (*The exchange of dissolved substances between mud and water in lakes.* J. Ecol. 29:280-329 and J. Ecol. 30:147-201). These papers were published well before most of the readers of this sketch and the author were born!

In 1946 he was awarded the degree of Doctor of Science (D. Sc) by his Alma Mater, the University of Manchester, having received his B.Sc degree in Zoology there in 1932.

Post-graduate research was conducted at the Kaiser Wilhem

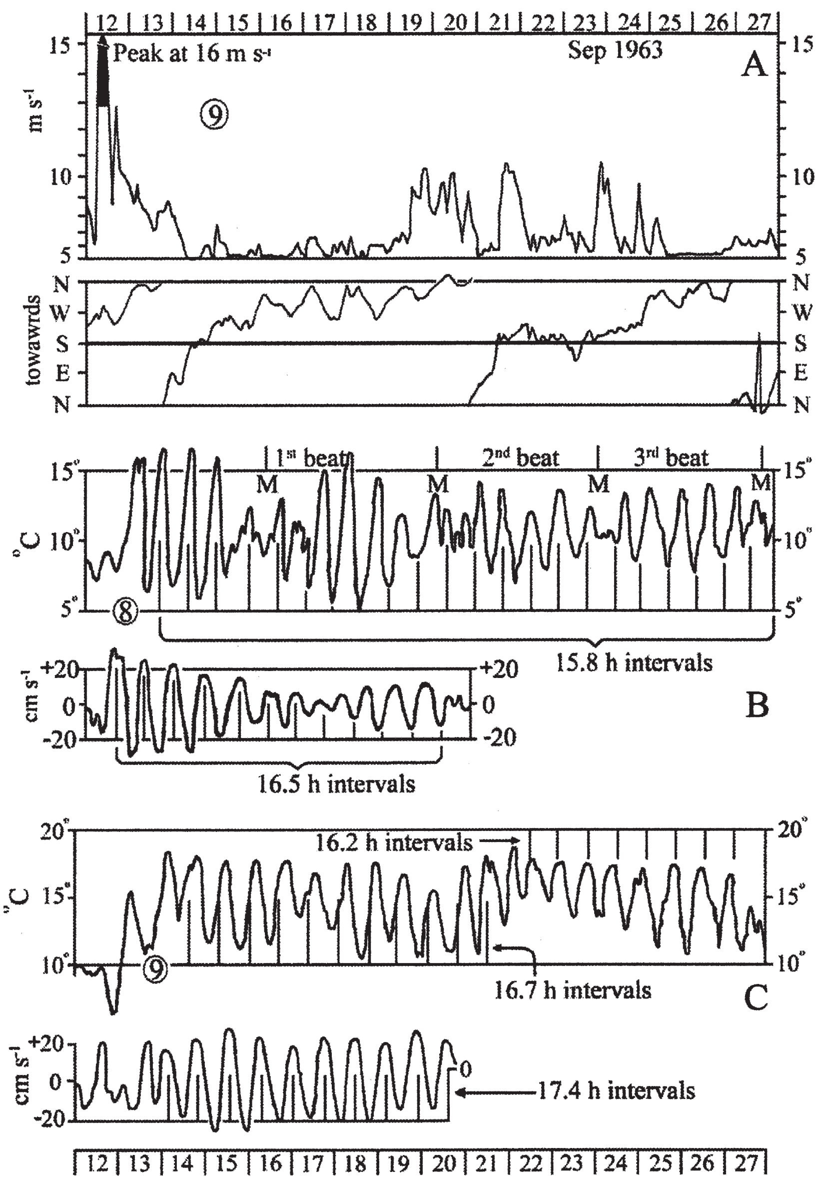


Figure 3. Lake Michigan, 12 to 27 September 1963. (A) Midpoints of 3-hourly envelopes of wind speed at Sta. 9 (squared scale to simulate wind stress) and direction; (B) temperature (Co) at 15-m depth at Sta. 8 and NS component of current; (C) as for (B) but for Sta. 9. Equally spaced vertical lines estimate mean oscillation periods. (Mortimer, C.H. 2006. Inertial Oscillations and Related Internal Beat Pulsations and Surges in Lakes Michigan and Ontario. Limnol. Oceanogr. 51:1914-1955).

Institut für Biologie, Berlin-Dahlem, on the cytology and the environmental control of parthenogenesis in Cladocera. He was awarded a Doctor of Philosophy degree from the University of Berlin in 1935. Three papers were published detailing his cytological and genetics research on Cladocera in 1935-36.

Thus began the multiple careers of a truly distinguished scientist. Beginning with Cladoceran cytology and genetics, the geochemical studies of sediment-water interactions and continuing to date with the physical limnology of large lakes. Throughout his career, not only did Professor Mortimer distinguish himself as a research scientist and academic Professor, but he also was an adept administrator who understood the needs of the scientist for whom he was responsible. Having conducted research in most areas of the discipline, he could discuss the details of colleagues' work, contribute helpful suggestions, and provide them with the facilities and support required of their research.

The breadth and depth of his limnological and oceanographic knowledge has been demonstrated to me many times at seminars covering a wide range of topics. Distinguished Professor Mortimer would almost always ask the first question of a speaker, pointing out something he had done or observed decades earlier that was right to the point of the lecture at hand. At age 99-plus he is still vigorously writing, trying to meet the deadline for his next paper.

Arthur S Brooks
abrooks@uwm.edu

P.S.: It is shocking to inform our readers that while I had just finished preparing the final draft of this Newsletter, I received an email from Dr. Arthur Brooks, the author of the above Biosketch, informing "that Clifford (Mortimer) died this afternoon (12 May 2010) while he was chatting with a friend when she noticed he had stopped breathing and he was gone". It is very sad for Limnology, that he did not complete the well-deserved century. Probably, I will come back to this in the next SILNews letter with an Obituary of this legendary limnologist.

Ramesh Gulati, Editor

Phytoplankton Ecology – Homage to the Pioneers at Windermere

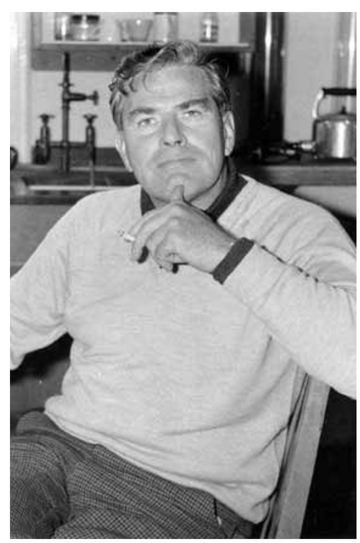
The sixtieth anniversary of the publication of John Lund's classical work[1] on the dynamics of the planktic diatom, *Asterionella formosa*, in Windermere (English Lake District) is sufficient an excuse to celebrate the remarkable legacy that his work has bequeathed to modern science. His founding studies were ably supported by those of several contemporaries at The Ferry House Laboratories of the Freshwater Biological Association and John Lund would insist on their acknowledgement. The scholarship represented by their collective contributions is not claimed to be unique - there are older and no less famous laboratories in the world, where important innovative and pioneering studies were undertaken by eminent biologists whose advances in developing our science are similarly revered. All practised in a glorious age of relative enlightenment, when national institutions, advised by established experts, would appoint young scientists of promise and potential to carry out and lead research, very often seeking answers to their own curiosity-led questions. The financial support was probably modest, the laboratory facilities quite basic but, in the case of the FBA, at least, they did run to the provision of technical assistance and the services of boatmen, instrument makers and handymen. The point that cannot be overemphasised to today's scientists is that not one jot of the original work was commissioned by any government agency or specified by any overarching EU framework. Then, the responsibility to devise scientifically rigourous and reproducible techniques and to present the robust conclusions recruited to knowledge and understanding of the world around us was discharged wholly by the scientists themselves.

In this way, several of the foundations of modern work on phytoplankton, and even the role of the oceans in the geochemical cycling of carbon, oxygen and other elements, can be traced back to the Freshwater Biological Association and to the work of John Lund and his colleagues in particular. John, a graduate of the University of Manchester, joined the FBA in 1945, when its laboratories were still located at Wray Castle, in what is now Cumbria. This is close to Windermere, some 4 km north of The Ferry House and also near to Blelham Tarn. This small Lake (0.1 km^2) was small enough to freeze over for several weeks in 1947, providing him an opportunity to make one of the first explorations of the buoyant behaviour of phytoplankton – and especially diatoms – when (supposedly) isolated from water movements[2]. The techniques and sampling strategies he employed were largely those that had already been developed as part

John Lund

Clifford Mortimer

Jack Talling



John Mackereth

of his investigation of *Asterionella* in the rather larger Windermere. He had been inspired, in part, by Pearsall's earlier recognition[3] that this was the most prominent phytoplankter in the lake, that it reached its greatest abundance in the spring, coinciding with the period of greatest availability of phosphate, nitrate and silicate in solution; it declined in abundance during the summer period of nutrient depletion. In order to test hypotheses about the control exerted by nutrients, Lund needed a method for quantifying algal concentrations that was quantitatively robust and adequately sensitive to temporal change. He devised a vertical column sampler that integrated variations in depth distribution[4], a non-disruptive way of preserving material on collection, and he tested and validated a reliable method for counting phytoplankton cells[5]. He soon realised that, in order to capture realistically the rates of population change, it was necessary to adopt a weekly sampling frequency. Lund also needed parallel information on water temperature and transparency and on the concentrations of dissolved nutrients[6], which, to give the appropriate sensitivity, also required Mackereth's adaptation of some existing methods of water analysis[7]. Before long, a vigourous sampling routine was established. Indeed, the pattern of Lund's programme has been emulated in so many subsequent investigations and in so many countries that it is regarded as a standard approach, applied in modern studies with little regard to its origins.

Extended to Blelham Tarn and to the nearby Esthwaite Water, and addressing all types of phytoplankton and zooplankton, the sampling was continued with little modification for many years. Despite reductions in sampling frequency in the 1980s and 1990s, the collection of these data, first by the FBA, then by the Institute of Freshwater Ecology and, ultimately, by the Centre of Ecology and Hydrology, continues to this day. As a result, an astonishing 65-year plankton record has been accumulated and, rather recently, digitised. Now that some important analyses of patterns and trends in these data have been published[8-10], with further work currently in hand, it is interesting to reflect on the fortuitous nature of their instigation.

What were the outcomes of Lund's studies and what has been their scientific contribution? Starting with the *Asterionella* story, it was demonstrated that the spring bloom was essentially the result of *in-situ* growth of an existing stock population: smaller lakes feeding into Windermere do support the same species of alga but it is the size of the overwintering standing crop that is crucial. Growth is possible through most of the year and there are ongoing mortalities (grazing, settlement); net increase in the spring is the consequence of accelerating rates of growth, responding principally to increasing day length; warming is slow but it is implicated through the progressive resistance of the water column to the penetration of wind-induced circulation. Growth proceeds at the expense of nutrients in solution, although, in the early days, the depletion of soluble reactive phosphorus to levels then chemically indetectable occurred very early in the process. Increase nevertheless proceeded, albeit at it diminishing rate, until slowing abruptly in late spring. Over several such cycles, this cessation coincided with the fall of the silica concentration to 0.5 mg SiO_2 L^{-1} (equivalent to ~ 0.23 mg SRSi L-1 or about 8 µmol Si L^{-1}). In this way, silicon reduction was recognised to control further growth and to determine the maximum crop achieved.

To an extent, both the demand for silicon and the limitation wrought by its near exhaustion were verifiable in laboratory cultures of the alga[11]. This concept of nutrient limitation of growth dynamics and yield has been greatly extended through the works of others. Lund was active in developing algal bioassays to test the fertility of lake water[12]. He also conducted verifying experiments in the field, moving from glass bottles suspended in the lake, to plastic cylinders and, eventually, to large, limnetic enclosures[13] (actually, the largest yet constructed!). Yet, ever the phycologist, John Lund remained closely in touch with taxonomic developments, publishing several papers describing new species. In those days, algae could best be identified against existing descriptions already published in a disparate literature. One of his most far-sighted services to his successors was to rescue F.E.Fritsch's embryonic Collection of Algal Illustrations and to supervise its steady growth to the remarkable resource of iconotypes that it eventually became. He assisted his wife, Hilda Canter, over many years, in reconstructing the life-histories and importance of fungal parasites of phytoplankton. Hilda's competence as a photographer became legendary; together, they co-authored the handsome book[14] that was to become a bible to almost all students of the freshwater plankton.

John Lund is always quick to acknowledge the extent of his collaboration with his contemporaries. Clifford Mortimer, John Mackereth and he must have engaged in imaginative and frequently spontaneous discussions about how to answer complex environmental concepts and to devise ingenious practical as well as scientific solutions to quantification. Clifford was among the early recruits to the FBA in 1935. Though a zoologist by training (his first degree was from Manchester; the topic of his doctoral dissertation, at the Kaiser-Wilhelm Institut für Biologie in Berlin, was the cytology of sex determination in *Daphnia*), Clifford's most remarkable contributions were on the chemical consequences of thermal stratification in lakes and the redox transformations of iron and of phosphorus that govern their exchange between sediments and waters[15]; his celebrated work on the physics of water movements[16] was to flourish after he moved to the Scottish Marine Biological Association and, especially, to the Center for Great Lakes Studies at the University of Wisconsin-Milwaukee, in 1966. Clifford had also shown great interest in the sediments themselves, allegedly stimulated by an unanswered question about the multiple traces produced by ship-borne echo-sounders, leading him to sample the mud with a rigid pipe and to reveal beautiful horizontal varves. From this simple expedient, colleagues at the FBA went on to devise bottom-sampling equipment and to create a new palaeolimnological discipline at Windermere, leading, eventually, to the penetrative studies of Winifred Pennington (Mrs T.G.Tutin) and several others on the late- and post-glacial development of the vegetation of the British Isles[17] . John Mackereth, a chemistry graduate from Manchester University who joined the FBA staff in 1946, was also to play a prominent role in the investigation of sediments, both in devising long- and then short-core airlift sediment samplers, as well as conducting his own innovative research on remanent palaeomagnetism in postglacial sediments and the variation in polar magnetic declination[18]. He led work on water- and sediment- chemistry and pioneered methods for measuring the chemical composition of organisms – including the silicon content of diatoms. He contributed the design of a submersible galvanic electrode to make instant measurements of in-situ oxygen concentration[19]. Perhaps John Mackereth is best remembered for his renowned ability to think laterally and to come up with ingenious solutions to many practical problems. His death in 1972, at the wretchedly early age of 50, was an enormous shock to all his colleagues and a tragic loss to science.

No account of the classic work on phytoplankton at Windermere could be complete without reference to the pioneering research of

Jack Talling on phytoplankton photosynthesis and production. Jack, a graduate of the University of Leeds, was appointed in 1950 by the FBA as a research student, where he quickly made the *in-situ* measurement of oxygen production, in clear and darkened bottles, into a practical and reliable technique. His early publications were profound in relating photosynthetic production to light and to the producer biomass present and, thence, to extrapolating integral assessments through the whole water column and to the effects of water movements[20, 21]. Before his eventual appointment to the staff, Jack was based in Khartoum, where he worked with Julian Rzóska on the Nile and on various lake systems, including those of the Great Lakes of East Africa. The sound, founding knowledge of plankton production he developed served as the starting point of important subsequent studies. His work back at Windermere included the development of a standardised measurement of algal chlorophyll concentration as a proxy of standing-crop biomass[22], which has been adopted worldwide, and of the electrochemical measurement of photosynthesis[23], which he applied in the diagnosis of photosynthetic carbon depletion[24]. Jack was also in charge of the FBA-Royal Society Project on Lake George, Uganda, for the International Biological Programme.

Many co-workers, assistants, research students and visiting scientists at Windermere benefited from the inspiration and instruction that was generated in those golden days. As one drawn in to the net at that time, I can attest to the heady atmosphere of learning and discovery that pervaded the laboratory. Looking back on those days and the many ideas infused and now deeply ingrained into modern aquatic science, I am reminded of a personal debt I owe – and one that, I suspect, is widely shared by many others – to the pioneers of Windermere!

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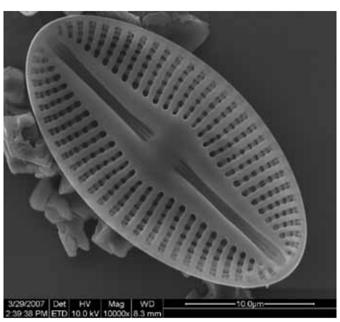
Climate & Water Level Fluctuations in Lakes and Reservoir Ecosystems

Reviving Diatom Resources in South Africa – Applications and Challenges

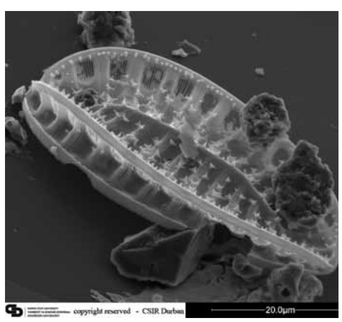
In recent years the use of diatoms for aquatic biomonitoring has increasingly become a mainstay of many monitoring protocols, as reflected in the mandatory inclusion of periphyton, of which diatoms form an important constituent in the European Water Framework Directive. With appropriate use, diatoms provide insights that other biological data, e.g. invertebrates, and chemical data simply cannot provide. They have proven to be particularly-useful as early indicators of eutrophication and acidification, both issues prevalent in South Africa. Additionally, their position at the base of the foodweb (primary producers) and their rapid response times allows them to act as indicators of change more quickly than higher plants.

Since 2004, a very small group of South African researchers has produced a composite set of tools that has underpinned the addition of diatoms as a proxy for water quality, or for the extraction of ecological inferences, to existing methods (conventional water quality analysis, vegetation, invertebrates and fish). This work parallels other similar efforts from the United Kingdom and elsewhere.

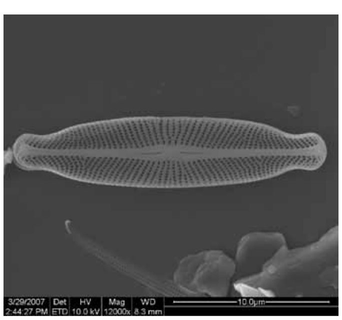
Development of the South African Diatom Assessment Protocol (DAP), led by Dr Bill Harding and funded by the Water Research Commission (WRC), is producing a useable index to determine aquatic health, with an emphasis on water quality. This was not a simple task: by the mid-1980s diatom research in South Africa was all-but dead; moreover, for the better part of a decade thereafter, there was little interest in diatom-based monitoring techniques. Equally, there was scant interest in diatom taxonomy, the second of two diatom research fields that have to go hand-in-hand. This was unfortunate for a country that, without doubt, has fostered some of the leading diatomists of all times (Bela Cholnoky, 'Archie' Archibald and Ferdinand Schoeman heading this list).



Diploneis sp. (internal view)



Surirella acanthophora



Adlafia sp.

Surirella chasei

Earlier research into many aspects of diatom biology, morphology and taxonomy conducted in South Africa, led to ground-breaking work investigating their use as water quality and ecological indicators. Only in the mid-1990s was this work to some extent revived and, subsequently, has gradually regained the acceptance of the aquatic monitoring community.

The DAP began by re-assessing the Cholnoky Collection, with the dual goals of making, first, diatom studies and monitoring techniques accessible to students, field operatives and water management agencies and, second, establishing a diatom index unique to South Africa. The first goal has been achieved with the production of a LUCID-based multi-access key to the common diatom species (Version 2 to be released shortly), that includes morphometric information and imagery for some three hundred species of diatom that occur commonly in South Africa. Coupled with this key is a hard-copy illustrated guide to common diatom species, serving as a useful aide-memoire for those engaged in routine analysis. Field and laboratory-based methodologies were also described in great detail in a special manual and are distributed with video clips demonstrating the relevant techniques. These tools have been requested from as far afield as South America, India and China. The reports are listed on the DHEC website (www.dhec.co.za) and are available from orders@wrc.org

Coupled to the production of guides and keys, there has been a strong capacity-building initiative, with a large number of students and other interested parties being trained in various aspects of diatom studies. Although reference material is very necessary, it cannot replace one-on-one mentoring and training.

The second goal of producing the index is currently nearing completion. Over 800 sites have been surveyed for both diatom communities and environmental parameters. This information will be used to determine the environmental requirements of South African diatom species, as well as to determine whether cosmopolitan diatom species react in the same way to environmental pressures in South Africa as they do elsewhere. Once this information has been obtained it will be possible to resolve it into indicator and tolerance values for individual species and then to include the species in an index.

Our greatest challenge, however, lies in training people to use the index. Our experience has shown that, provided the trainees are keen and receptive, recognition of the key characteristics of common diatom taxa is possible relatively quickly. It is our intention to conduct primary training using visual aids first, before switching to microscopy. We believe that the bulk of the fundamental, taxonomical, training can be imparted to relatively-large groups in a classroom setting, during which process we can also identify (pre-screen) those most likely to experience problems once in the laboratory environment.

Hand-in-hand with the development of the aforementioned tools has been the renewed curation of the Cholnoky Diatom Collection, one of the world's more important collections of a variety of diatom material. The Collection, essentially dormant and in storage since the mid-1980s, has recently been transferred to the aegis of the South African National Biodiversity Institute (SANBI), with the Collection itself being moved to the North-West University (NWU), under the curatorship of Dr Jonathan Taylor.

Regrettably, the South African Department of Water Affairs

(DWA), the primary user of the work and tools arising from this research, has recently (January 2010) declined to contribute financially to the research programme. This incomprehensible decision, coming at a time when diatom monitoring is now well-established in Europe and elsewhere, has led to the premature termination of the work at a crucial stage.

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Response of two impoundments to regional climate variability and climate change.

The Zambezi and L. Kariba

Scudder *et. al.* (1993) point out that in the two decades preceding 1993 the Zambezi river has delivered, at Victoria Falls, about half its long-term flow average for the preceding periods. Mazvidza *et al* (2000) grouped the precipitation records from a number of Zambian stations into decadal means between 1960 and 1990. Ten out of fifteen stations examined showed that the 1980-1990 decade registered the lowest means for the last forty years, while fifteen registered showed the lowest mean for the last thirty years in the same decadNobel Laureate 2007(IPCC)

Figure 1 is a time series analysis of the flow of the Zambezi River monitored at Katimamulilo, Zambia. Figure 2 shows lake level variation of Lake Kriba. These data show a diminishing hydrological income of the lake. Climate variation, superimposed on the hydrological trend, can result in critically low lake levels, with significant economic impacts (Desanker and Magadza 2001). Prior to the expansion of the generating capacity of the Kariba dam power stations, lake levels on Kariba were were regulated by annual spillage in anticipation of incoming flood. However, with the reducing flow of the Zambezi, and increased water demand from the power stations.

The Manayme River and Lake Chivero

Figure 3 shows the growth rate of Harare popolation, the capital of Zimbabwe. The doubling perion is 12 years. Figure 4 shows time

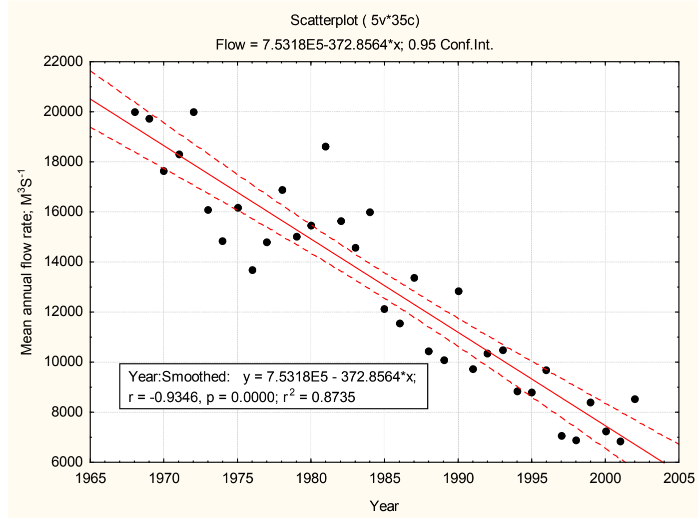

Figure 1. Reducing flow of the Zambezi River

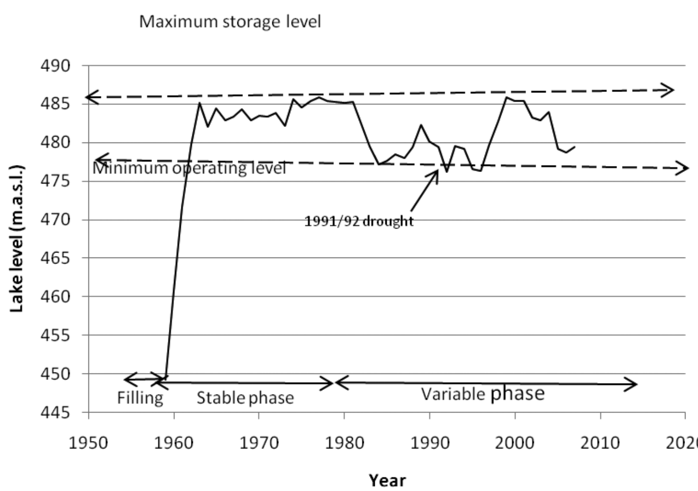

Figure 2. L. Kariba levels. Note high variability after 1980. High levels in the 2000 season due to maintanance work

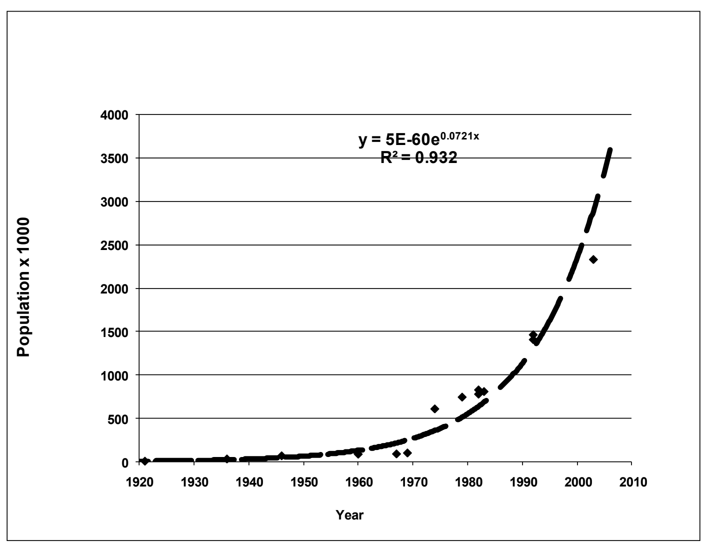

Figure 3. Reconstructed Harare population: (After Magadza 2009)

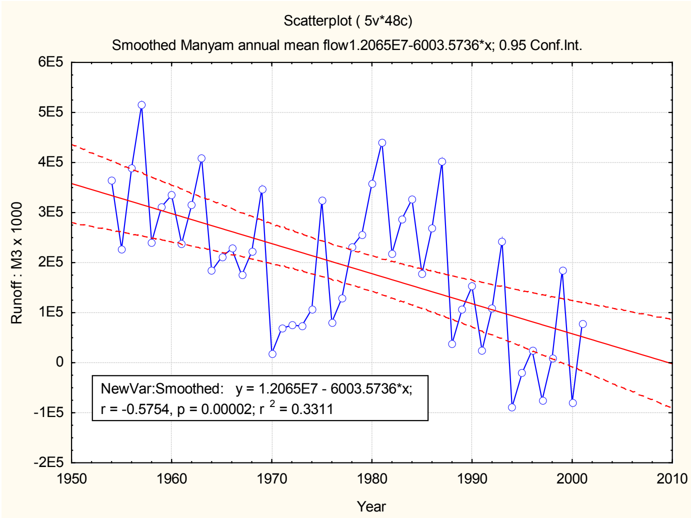

Figure 4. Reducing runoff of Manayame River, Harare's main water supply river.

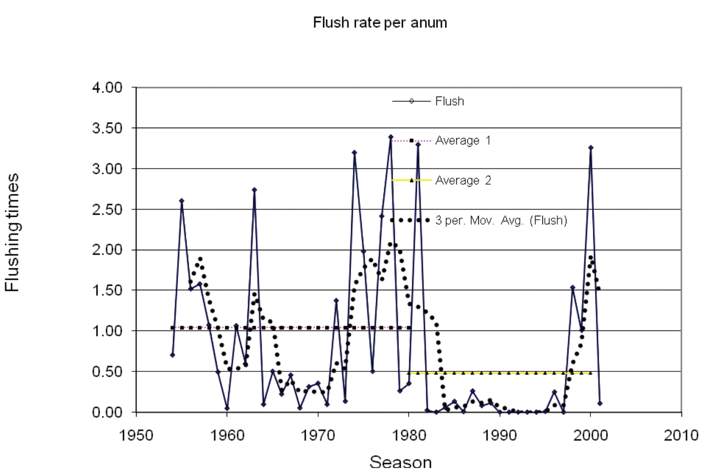

Figure 5. Flushing rate of Lake Chivero in the pre & post 1980 periods. Note that the post 1980 flushing period is nearly twice that of the preceding period

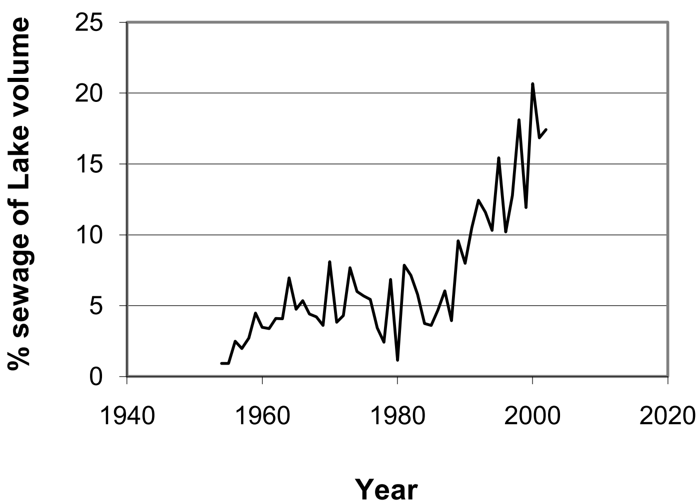

Figure 6. Proportion of Lake Chivero volume consisting of wastewater returns. In 2010, proportion of lake water from sewerage returns is expected to reach 50%.

series changes in the annual ruoff of the manayame river which enters Lake Chivero, the water supply reservoir for Harare, while Figure 5 shows the frequency of flushing the lake. The lake lies down stream to sewage effluent. The flushing period of the lake from runoff is now twice that in the thirty year period priod to 1980. The lake is now hyperuetrophic. Figure 6 shows the ratio of sewage effluent to precipitationl runoff in the lake. Was the precipitation runoff from the Lake Chivero decreases the cosumers of the Lake Chivero water will increasingly rely on recycled sewage. Figure 7 shows fishermen working on a raft of floating compacted water hyacinth in the spillway channel of Lake Chivero. This is due to reuced frequency of spilling from the lake. Figure 8 shows a weak spill at the spillway, of less than a cubic meter per second, when in normal pre 1980 period there would have been a spill of several hundred cubic meters.

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Figure 7. Fishermen working from platform of compacted floating water hyacinth in the L. Chivero spillway channel. The accumulation is due to lack of sufficient flow to clear the channel.

Figure 8. Lake Chivero spillway, showing small amount of water going over the spillway, insufficient to clear the water hyacinth weed.

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Future of the Nile Delta lakes: implications of their subsidence in relation to climate changes

Similar to other Deltas of the world, the Nile Delta is densely populated and its resources are overexploited not only by anthropogenic activities but also by natural stressors. The Nile is the main source of freshwater in Egypt, where agriculture is dependent on irrigation using Nile water released annually from Aswan High Dam (AHD), which was completed in 1964. Before Nile water finally flows into the Mediterranean Sea, lakes Mariut, Edku, Borullus and Manzalah are the last opportunity for Egyptians to use the Nile water (Figure 1). These Delta lakes also referred as delta coastal lagoons originally developed during the intense flooding period of the 19th century. The periodic advance and retreat of the shoreline has resulted in some of these lakes becoming directly connected to the Mediterranean Sea via narrow outlets (Hamza, 2006; 2009). The Nile delta lakes occupy a significant area (>1100 km^2), of the Egyptian Mediterranean coastal zone. The lake basins have also been affected by urbanization, agriculture, and highway construction. In fact, the northern Delta lakes now cover <50% of the area they occupied 35 years ago. In addition to the anthropogenic activities, the coastal zone of the Nile Delta, including the four coastal lakes, is undergoing major changes due to natural influences such as tectonic activity, climatic and sea level fluctuations. Despite the undeniable benefits of the AHD in sustaining the Egyptian agriculture and industry via the pollution-free provision of cheap hydroelectric power, the loss of sediments supply from the pre dam Nile flood is a significant problem aggravated by the erosion of the Nile delta. In a detailed study, Stanley (1996) showed that the Nile delta areal loss is also due to continued land surface subsidence at rates of 40-50 cm per century. He also warned that eustatic sea level rise, conservatively estimated at 4-8 cm during the next 40 years, and at least 50 cm by the year 2100, may compound the effects of delta subsidence and coastal erosion to submerge the delta region as far inland as 30 km from the present day coast. In this scenario, the Port Said-Northern Suez Canal – Lake Manzalah region, with a population of > two millions, would become particularly susceptible to flooding because it is located in one of the more rapidly subsiding parts of the delta. The estimated values of the Nile Delta subsidence, i.e. drop in its water level, and its coastal erosion will have further negative consequences not only on losing areas and lakes but also on different economic levels from land and job losses to the loss of world famous historic, cultural and archeological sites. In a recent declaration of the Egyptian government, coastal erosion and subsidence of the Nile Delta are the top priority of the strategic agenda. Furthermore, it announced a long term contingency plan to deal with the different scenarios of sea-level rise and the delta subsidence. It is important to mention here that, the Egyptian government is making different and very professional efforts to combat coastal erosion processes along headlands of the Egyptian Mediterranean coastal area, where a number of coastal protection structures such as jetties, groins, seawalls and wave breakers have been built to combat beach erosion and to reduce shoaling (Frihy, 2001). It is believed that the economic resources in Egypt will not be enough to face such natural impact on the delta of the longest river of the world. International economic support and mitigation plans have to be implemented in order to face any future consequences.

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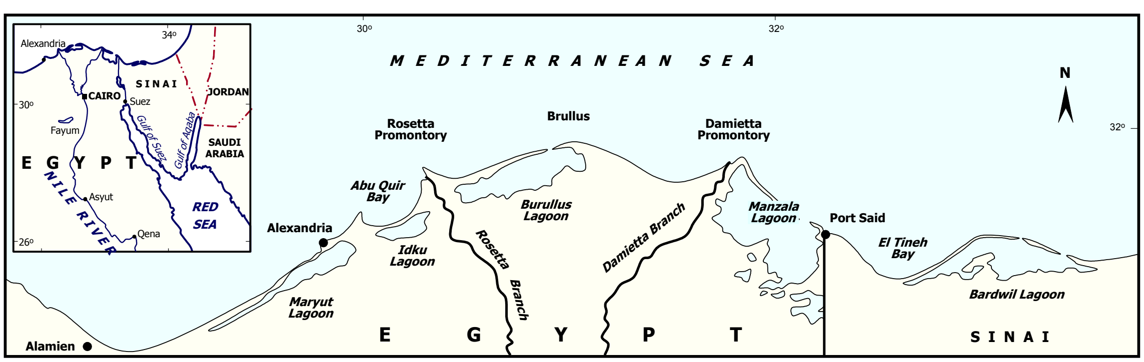

Figure 1, Nile Delta coastal lakes (lagoons) and their connections with the Mediterranean Sea

Drought, drawdown and algal blooms in Lake Hume, a large water storage reservoir, Australia

South-eastern Australia has been in the grip of a severe drought since about 1995. This has put substantial pressure on water stored in reservoirs in the region. This has resulted in some dams being drawn down to extremely low level, which in turn has resulted in a substantial decline in water quality. For example Lake Hume, Australia's 7th largest water storage (holding 3038 GL and covering 202.5km^2 at full supply level), has been drawn down to < 10% capacity in 6 of the last 10 years. Although cyanobacterial blooms are very rare in the lake, with only three reported blooms from the dams commissioning in the mid 1920's, until the mid – 1990's , there have been cyanobacterial blooms in the reservoir almost every year since 2000. In 2006 and 2007 we undertook a detailed study of the limnology of Lake Hume (funded by the Murray-Darling Basin Commission) to explore the relationship between drought, drawdown and water quality in the reservoir (Baldwin et al., 2008; Wilson & Baldwin, 2008; Boulding et al., 2008; Boulding & Baldwin, 2009; Baldwin et al., 2010).

Water quality parameters (temperature, dissolved oxygen, pH, conductivity, turbidity, total nitrogen, ammonia, NOx, total phosphorus, soluble reactive phosphorus, dissolved organic carbon, acid extractable iron and manganese, sulfate and chlorophyll a) were measured weekly during late (austral) spring and summer 2006-07, and biweekly during autumn 2007. Samples were taken from the Murray and Mitta Mitta Rivers (the two sources of inflow) before they enter the dam (surface water), in both arms of the lake and the dam wall (surface and bottom samples), and immediately downstream of the dam (Baldwin et al 2008 - Figure 1). Depth- integrated samples for algal community structure were taken at these sites as well as at Howlong (ca.100 river km downstream of the dam) and at Corowa (about 150km downstream - Baldwin et al, in press). In addition, thermistor chains (logging temperature every 30 min) were deployed at the Murray River arm station and at the dam wall, while a D-opto dissolved oxygen logger (recording dissolved oxygen and temperature every 30 minutes) was deployed approximately 1 m from the bottom at the Murray River arm station.

During the study period water levels in the reservoir fell from about 9% of full capacity in early November to a low of about 3% at the end of February 2007 before increasing slightly towards the end of autumn. During the period of extreme drawdown, the reservoir consisted of three separate but inter-related parcels of water. The warm surface mixed layer was about 6 metres deep. Inflows from the Mitta Mitta River (which accounted for 75% of the inflows into the dam) were up to 13 ^{o}C colder than the surface mixed layer (SML). These inflows undershot the SML in the Mitta Mitta arm of the reservoir and flowed along the bottom of the reservoir to the dam wall without substantial interaction with the SML. When inflows from the Murray River occurred (usually as discrete pulses) the temperature of these inflows was similar to that of the SML and the flows appeared to move within the SML towards the dam wall. These Murray River inflows were insufficient to promote total mixing of the surface and bottom waters. The Murray River arm of the reservoir became a 'hot spot' for nutrient production. Stratification and subsequent anoxic conditions promoted the release of nutrients – ammonium, organic N and total P – from the sediments into the overlying hypolimnion. Because the depth of the lake was relatively shallow due to the extreme drawdown, wind driven events led to a substantial deepening (turnover) of the thermocline allowing periodic pulses of nutrients into the warm surface layer (Baldwin et al., 2008). These nutrient pulses in turn stimulated cyanobacterial growth.

Algal community structure at sites upstream of the dam was dominated by green algae, and that in the dam by cyanobacteria. Much of the algal biomass found up to 150km downstream of the reservoir appeared to have originated in Lake Hume and was physically transported downstream. Load estimates showed that the lake was a net exporter of carbon, nitrogen, phosphorus and iron, a large proportion of this expert was as algal biomass (Baldwin et al, 2010).

Modelling undertaken by CSIRO has indicated that rainfall in the southern Murray-Darling Basin, which includes the lake Hume Catchment, will decline by up to 15% by 2030 as a result of climate change (CSIRO 2008). This translates to a loss of up to 40% of surface run off, which means that the extreme drawdowns that occurred during the current study are going to be more common in the future. This study has shown that extreme drawdown in a large reservoir can have substantial effects on the water quality and algal community structure both within the storage and large distance downstream, highlighting the ongoing need to balance between delivering water quantity and delivering water quality.

Figure 1 – Location map of Lake Hume sampling sites (stars). Grey area shows the lake's extent at full capacity; arrows indicate approximate extent of water during the sampling period.

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Water Level Changes in Asian Tropics and the Climate Change

Aquatic ecosystems experience seasonal water level changes caused by climatic and hydrological factors. Numerous studies in temperate regions and some tropical countries show that seasonal water-level changes invariably affect the physical and chemical characteristics of the aquatic ecosystems as well as the biotic communities and ecosystem processes (Cantrell 1988, van Geest et al. 2005, Cott et al. 2008, Wantzen et al. 2008, Layman et al. 2010). Water level changes in the tropical Asian region are of a far greater magnitude because of very high seasonal and inter-annual variability of monsoonal precipitation. The physiographic peculiarities of tropical Asia (numerous mountain ranges, especially the Himalaya) contribute to extreme spatial variability in precipitation regimes. Whereas extensive areas of tropical Asia are arid or semi-arid, severe floods and droughts are quite frequent throughout the region. The seasonal variability is reflected in enormous water level changes in the lakes and rivers as the river discharges increase manifold from a few $m^3 s^{-1}$ in the dry season to several thousand $m^3 s^{-1}$ during the rainy season (Gopal 2000). The lakes, mostly floodplain lakes, expand seasonally in their extent several fold; for example, Lake Tonle Sap (Cambodia) grows from 2500 km^2 in dry season to 15,000 km^2 in the wet season (MRC 2003). Also there are numerous seasonal streams and temporary water bodies that dry up completely for different periods each year.

Such large water level changes caused by the monsoonal variability greatly influence the aquatic biodiversity in tropical Asia (Gopal and Chauhan 2001). Most of the aquatic flora and fauna are well adapted to the extreme water level changes. The sexual, asexual or vegetative propagules, which develop quickly with the onset of dry conditions, exhibit prolonged dormancy and viability, and rapidly give rise to fresh populations when water levels increase. The aquatic vegetation shifts along the moving littoral zone – colonizing areas with the falling or rising water levels, though with significant differences in species composition. Species like water hyacinth, on the other hand, are favoured by stable water levels, and rapidly colonise the impoundments. Associated with these water level changes are also the changes in the habitat characteristics of both rivers and lakes, particularly those related to the fluvial transport and distribution of sediments. The organic matter gets readily decomposed and mineralized in seasonally exposed and dry habitats during the summer so that the nutrients turnover rapidly.

For centuries, the human response to the seasonal variability in rainfall has been confined largely to the construction of large and small reservoirs to meet water demands for domestic supplies and irrigation during the dry season. With the rapid increase in human population and the pressures of economic development, however, demands on water resources have also increased steeply for agriculture, industrial use, domestic supplies in urban areas and hydropower generation. Therefore, the diversion, abstraction and storage of water as well as shoreline modification (e.g., embankments along streams) have induced alterations in the timing, amplitude, duration and frequency of water level changes in all aquatic systems. Because the vast majority of lentic and lotic ecosystems in the tropics are rather shallow (1 to 5 m), the human-induced changes are relatively large.

Though specific studies from Asian region are very rare, the consequences of the human-induced changes are already loud and clear particularly in the changing community structure of aquatic/wetland vegetation, decline of species such as Tamarix and canes, spread of exotic invasive species such as water hyacinth, bush morning glory (*Ipomoea fistulosa)* and alligator weed. Human manipulation of water levels during the dry years in Keoladeo National Park (Bharatpur, India) has resulted in accelerated terrestrialization and invasion by *Prosopis juliflora* in the wetland areas. The decline in riverine fisheries is direct consequence of loss of their breeding and feeding habitats caused by decrease in water levels and changes in timing of floods. Lowered lean season water levels in streams and rivers have also affected the migration of fishes. Further consequences include a degradation of water quality and increased rate of eutrophication as was witnessed in Lake Kolleru (India). Many of these changes cannot be directly linked to water level alterations alone because of several other accompanying human influences.

The human influence on water level changes and its impact on aquatic ecosystem functions and services are likely to both spread and intensify with the climate change. The Climate Change is projected to further increase both spatial and temporal variability in precipitation along with an increased frequency of extreme events, causing more frequent floods and droughts (Solomon et al. 2007). It is likely that the human response to Climate Change will be to increasingly regulate the water resources. The aquatic systems will be under greater threat as the human societies become increasingly water-stressed.

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Lake Kinneret, Israel, is undergoing eutrophication-like processes without increased nutrient loads

Lake Kinneret, also known as the biblical Sea of Galilee or Lake Nazareth, is the only natural freshwater lake in Israel, supplying nearly half of the country's drinking water. This vital role led to the establishment of a dedicated research laboratory on the shore of the lake in 1969: the Yigal Alon Kinneret Limnological Laboratory, a branch of Israel Oceanographic & Limnological Research (Fig. 1).

The Kinneret Limnological Laboratory became a center of limnological research, in which research and monitoring are combined to enhance understanding of the functioning the Kinneret ecosystem, and provide managers with knowledgeable advice regarding its management. The monitoring program, on-going since 1969, has developed and expanded over the years to include a wide range of meteorological, physical, chemical, biological and health-related parameters measured routinely, as well as a series of synoptic and near real-time measurements taken automatically in the more recent years (Wagner et al. 2005). With its intensive database, now spanning 40 years, Lake Kinneret has always been an attractive study site for scientists from other research institutes in Israel and overseas. The result is that Lake Kinneret is probably the most studied Mediterranean/subtropical lake, with over 1000 scientific publications addressing it.

Lake Kinneret became famous within the Limnological community for its recurring spring dinoflagellate bloom (Pollingher 1986) and its high resilience to change (Berman et al. (1995), as Reynolds (2002) stated: "Kinneret provides one of the best-known and best-attested examples of year-to-year similarity in the abundance, distribution and composition of the phytoplankton."

This description held until the mid 1990s, when major changes started taking place in the previously stable ecosystem (Zohary 2004). While not quite a "regime shift" known from shallow lakes, the changes recorded on Kinneret are probably getting close to it. These changes manifested initially in the collapse of the Kinneret bleak fishery in 1993 (Ostrovsky & Walline 2001), followed by the lowest ever record of zooplankton abundance (Hambright 2008), and a year later the first ever invasion and intensive summer bloom of the N-fixing, toxin-producing cyanobacterium, *Aphanizomenon ovalisporum* (Pollingher et al. 1998, Banker et al. 1997). Since the mid 1990s the famous dinoflagellate bloom no longer occurred every single spring (Fig. 2), intensive dinoflagellate blooms developed only in high-rainfall winters (Fig. 3). In low-rainfall winters other species bloomed in spring, including the invasive filamentous chlorophyte *Mougeotia* sp., and the toxin-producing cyanobacterium *Microcystis aeruginosa*. Overall phytoplankton species diversity declined significantly, from 227 recorded species in 1978 to 147 in 2008.

Such changes are typical of an eutrophication process. However, in Lake Kinneret they were not triggered by increased nutrient loading, in fact, strict legislation and active measures taken to minimize inflows of domestic and agricultural (mostly dairy) effluents led to substantial reductions in nutrient loads since the mid 1980s, this trend is continuing (Markel 2005). Thus, reasons for these major ecosystem changes remained obscure for a while, but now – with another 15 years of monitoring data – we are starting to understand some of the processes leading to the changes.

Fig. 1. Lake-view of the Yigal Alon Kinneret Limnological Laboratory. Photograph was taken by Dr. Werner Eckert in 2003, when the water level was unusually high.

We attribute much of the changes to multi-annual water level drawdowns, combined with increased range of water level fluctuations. Prior to human intervention, the Mediterranean climate of wet winters and dry summers dictated natural water level fluctuations in Lake Kinneret of about 1.5 m between spring highs and autumn lows, excess water used to flow down the Southern Jordan River to the Dead Sea. In 1932 the Jordan River outflow was dammed, making it possible to draw down the water to below natural levels. Since then, Kinneret water levels were managed. Due to an ever-increasing demand for freshwater, over a series of low-rainfall years, more water was pumped out of the lake than was replenished, causing a gradual, multi-annual water level decline. Then, an exceptionally wet winter filled the entire volume deficit, raising the water level in a few months by 4-5 m, triple the natural amplitude. This sequence of events, of multi-annual water level decline followed by an abrupt re-fill in a single winter, has taken place already twice over the last ~25 years, with the current situation being back to exceptionally low water levels (Fig. 4).

Much research at the Kinneret Limnological Laboratory over the last decade focused on understanding the ecological consequences of declining water levels and increasing water level fluctuations. Those studies suggest that the impacts are initially via littoral and benthic boundary layer processes, which later cascade also to the pelagic zone, in both bottom-up and top-down pathways.

The bottom-up pathways dominate low-inflow years when water levels are declining, and revolve around the intensification of internal loading processes. Lake Kinneret is characterized by strong activity of internal waves (Lemckert & Imberger 1998), breaking internal waves (seiches) with amplitude of ca. 10 m swipe the benthic boundary layer

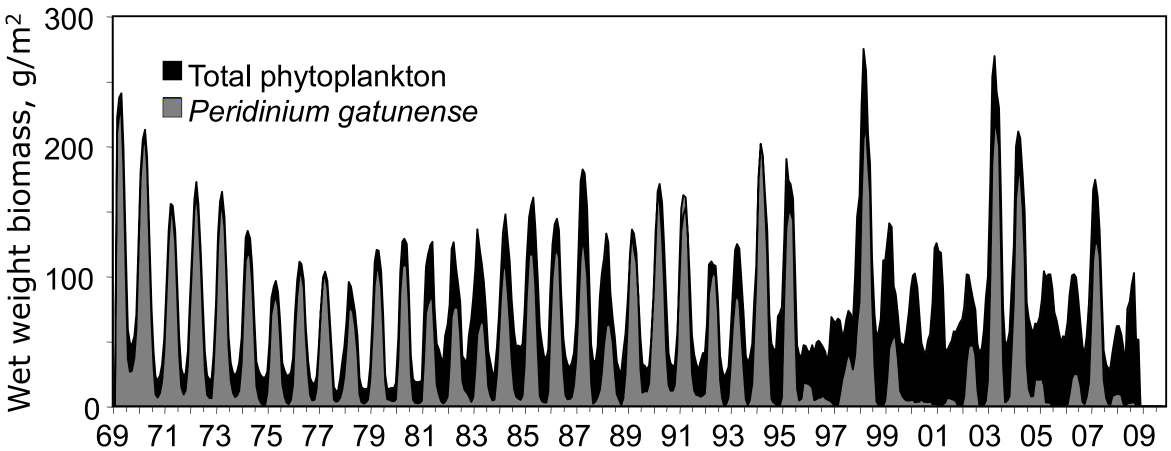

Fig. 2. A time series (1969-2009) of total phytoplankton wet weight biomass and the part of it due to the bloom-forming dinoflagellate Peridinium gatunense in Lake Kinneret, Israel. Data are 5-month running mean depth-integrated values, showing the repeatable dinoflagellate blooms till the mid-1990s. Since 1996 the bloom failed to develop in 8 out of 14 springs.

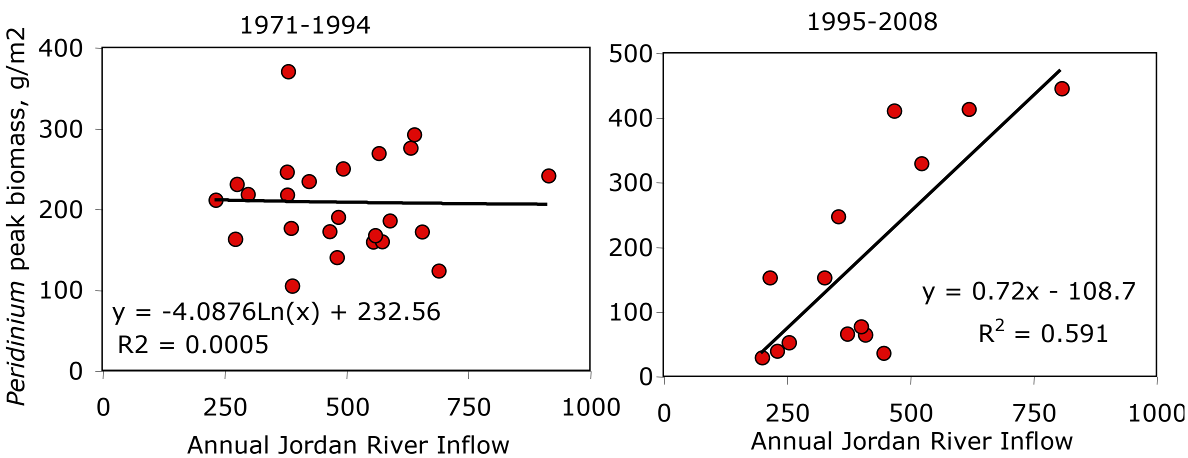

Fig. 3. The relationship between annual Jordan River inflow volume (hydrological year, Oct–Sep) and the annual peak Peridinium biomass obtained in Lake Kinneret, for 1970-1994 (left, no significant relationship) and 1995-present (right, highly significant relationship).

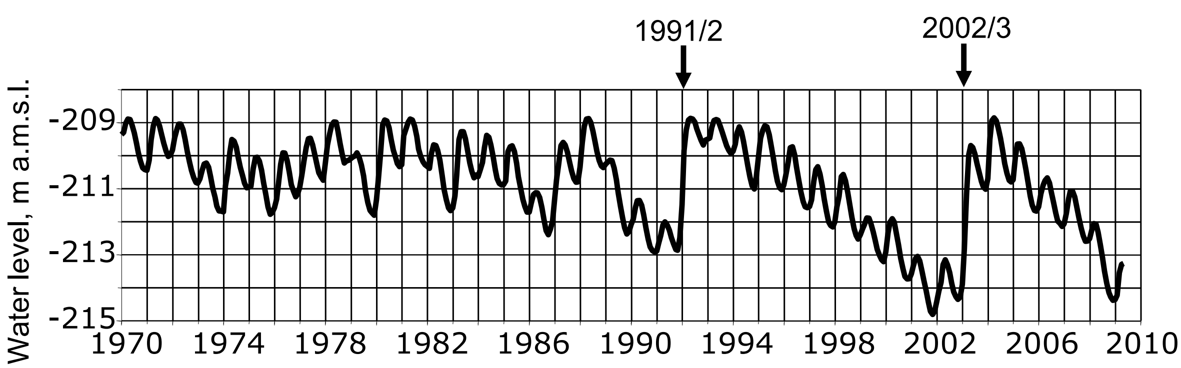

Fig. 4. Lake Kinneret water levels, 1970-2009. Typical seasonal fluctuations are evident with super-imposed multi-annual water level declines, followed by fill-up of the lake in a single winter. The 1991/92 and 2002/03 fill-up events are arrowed. Data courtesy of the Israel Hydrological Services.

of a sediment belt at around the depth of the thermocline, causing turbulent mixing and resuspension of the top sediment. As water levels decline from year to year, the resuspended sediment belt migrates deeper, exposing previously undisturbed nutrient-rich layers to this turbulent mixing (Ostrovsky et al. 1996). Current work by Werner Eckert and Ilia Ostrovsky is aimed at quantifying the fluxes associated with this process of internal nutrient loading.

Another interesting outcome of declining water levels is increased bubbling of methane gas from the sediments due to reduced hydrostatic pressure (Ostrovsky et al. 2003). The bubbles migrate to the surface, crossing the thermocline on their way up. Methane is a potent greenhouse gas and thus its enhanced ebullition is unwelcome. Furthermore, the bubbles may transport nutrient-rich water from the hypolimnion to the epilimnion, further increasing internal cycling of nutrients. Another current project attempts to quantify this nutrient flux.

The top-down pathway operates in response to exceptional high rainfall winters with un-naturally high amplitude water level rises, as occurred in the winters of 1991/92 and again in 2002/03 (Fig. 4). Routine acoustic surveys for quantifying fish densities demonstrated that those exceptional 4-5 m water level rises were followed by a huge increase in the total number of fish in the lake and particularly of the dominant species, the planktivorous Kinneret bleak (*Acanthobarama terraesanctae*). This pelagic fish lays its eggs in the littoral zone in winter when the water level rises, adhering its eggs to stones that were only recently covered with water (Gafni et al. 1992). The increased bleak population then exerts elevated predation pressure on zooplankton, the effects of which cascade down the food-web.

As climate change is progressing, with predictions that vast areas around the Mediterranean will become more arid, and more susceptible to extreme climatic events, there is an important lesson to be learnt from the long-term experience in Lake Kinneret: Mediterranean lakes are threatened with increased eutrophication resulting from extreme water level changes even without increased external nutrient loading.

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Overriding Effects of Water Level Fluctuation on Ecology of Mediterranean, Turkish Shallow Lakes

Water-levels in shallow lakes naturally fluctuate depending largely on regional climatic conditions (e.g. temperate, semi-arid and arid) and human activities (Coops et al. 2003). Water-level fluctuations (WLFs) emerge as the decisive element of hydrology especially in shallow lakes embedded in wetlands, which are particularly sensitive to any rapid changes in water level and inputs. Therefore, WLFs may have an overriding effect on the ecology, functioning and management of shallow lakes.

Turkey has ca. 900 natural lakes and ponds covering over 10000 km^2 area with a high level of endemism and species diversity of fauna and flora owing to habitat and climate diversity and lack of major disturbances. Mostly influenced by Mediterranean climatic conditions, water level in Turkish lakes fluctuates from <1 m to over 3 m or more (Beklioglu et al., 2006) following the drought and wet periods. Although the amplitude of variations depends on local climatic conditions, human water abstraction should also be taken into account. Many of the lakes are important as wetland due to high diversity of waterfowl and fish. However, because the lakes are mostly valued as source of water supply for agricultural and domestic purposes, their hydrology and ecosystem dynamics are seriously threatened.

Water level fluctuations have pronounced effects on submerged macrophyte growth, more so in warm lakes in arid and semi arid regions such as the Mediterranean basin (Coops et al., 2003; Beklioglu et al., 2007). A reduction in water level during the growing season may improve the light environment for the plants and may also increase the extent of the littoral area receiving adequate light for plant growth, as recorded in 5 Mediterranean shallow lakes of Turkey (Beklioglu et al., 2006). Associated with low water level and a shift to macrophyte dominated state, the ecological and conservation values of the lakes increase, because of a 10–15-fold increase in species diversity and density of water birds. A high density of waterfowl, especially coot (*Fulica atra*), has been recorded in all lakes at high submerged plant coverage. Consequently, these lakes were designated as Ramsar sites, A-class wetlands or Important Bird Areas (IBA). In contrast, a high water level in the growing season may impede submerged macrophyte growth depending on lake morphometry as extremely low water level in winter or summer may expose littoral zones to freezing or desiccation, which may reduce the regenerative capacity of the plants (Beklioglu et al., 2006).

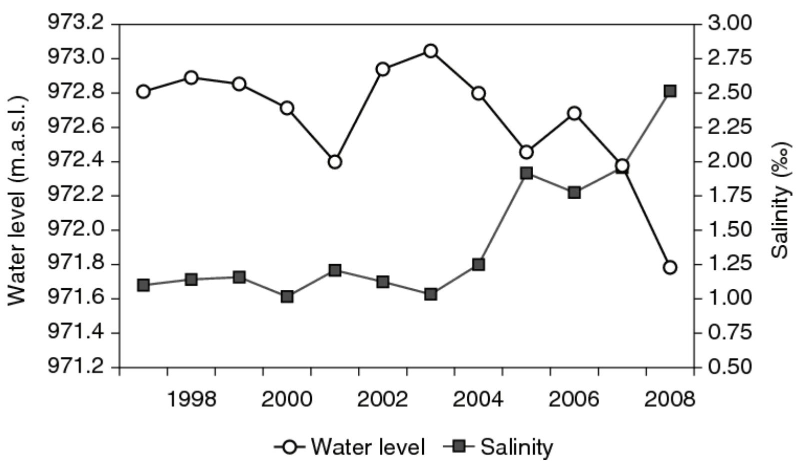

Figure 1: Changes in water level (m.a.s.l) and salinity (‰) in Lake Mogan from 1997 to 2008. Water samples were collected fortnightly in spring, summer, and autumn and at monthly intervals in winter, lake level being recorded daily from a fixed gauge (Beklioglu et al., in press).

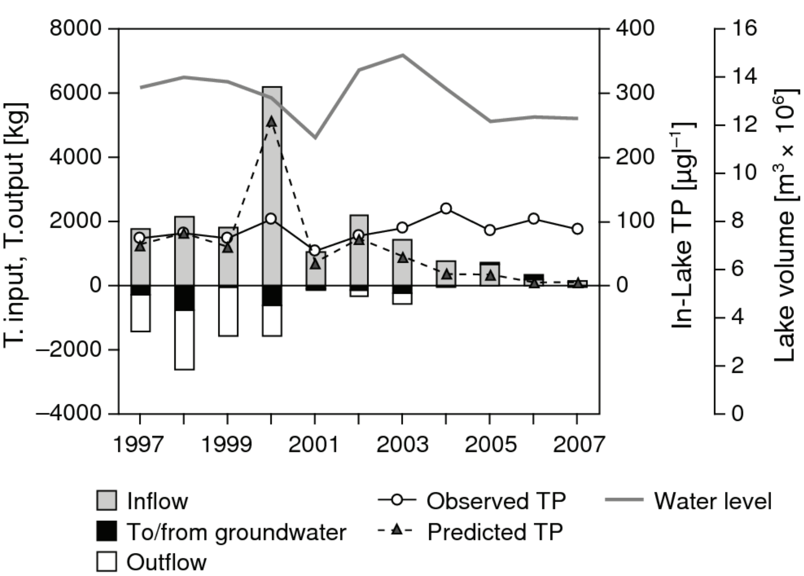

Figure 2: Mass balance of total phosphorus (TP) on Lake Mogan, showing annual input, output, and retention of TP as well as annual mean lake TP concentration and lake volume. The mass balance is based on water samples collected fortnightly in spring, summer, and autumn and at monthly intervals in winter. The lake level was recorded daily from a fixed gauge, flow rates were measured in inlet and outlet, and ground water was determined from input calculations. Taken from Jeppesen et al. (2009) J. Environmental Quality.

Hydrology is an important factor in major ions and nutrient mass balances, especially for shallow lakes located in Mediterranean climatic regions. As such, lakes are subjected to large seasonal variations in water level determined by changes in rainfall and groundwater discharge or recharge in alternating drought and wet periods (Beklioglu et al. 2007). Such changes in hydrology may have major implications for dynamics and retention of nutrients and major ions (Beklioglu et al., 2006, Beklioglu and Tan 2008; Özen et al. in press). Lakes Mogan and Eymir are two interconnected shallow lakes located in the Central Anatolia, 20 km south of Ankara, Turkey. The region has the Central Anatolian semi-arid climatic conditions, with most of the annual rain fall during late winter and spring and with hot and dry summers. A 5- to 10-fold increase in hydraulic residence time resulting from a major drop in the water level occurs during the dry periods due to low inflows and high evaporation, leading to major increase in salinity (1‰ to 2.5‰) from 2004 to 2008 (Beklioglu et al., unpublished data) (Figure 1). Furthermore, based on a 10-year mass balance, the concentrations of TP and DIN (ammonium as well as nitrate) increased in dry years despite lower external nutrient loading, which contradicts observations from cold temperate lakes (Figure 2) (Özen et al. in press). The mass balances clearly show that during the dry periods, in-lake TP becomes more dependent on internal processes (evaporation and internal loading) than on the external loading. This is supported by a comparative study of 10 shallow Turkish lakes showing an average eleven-fold increase in chlorophyll *a* concentrations during 2004-2007 (Beklioglu et al.,unpublished data). While inflows appear to be the major nutrient sources in wet years, precipitation and groundwater inputs are most important in dry years. It appears that the higher TP and DIN concentrations in the dry years destabilised the clearwater state in the lakes, leading to disappearance of the submerged plants, although we know that low water levels in dry years occasionally leads to higher macrophyte coverage (Beklioglu et al., 2006).

I suggest that climate warming will enhance the risk of salinization and eutrophication in shallow lakes in the Mediterranean climatic region in a future warmer and drier climate (Beklioglu et al., 2010).Therefore, it is recommended that in the arid zone, in future lower critical nutrient loading levels are needed for maintaining a clearwater state in shallow lakes along with restrictions on the human use of water particularly in irrigated agriculture, supplemented with reduced intensification of agriculture and drought control.

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Climate change and enhancement of water-level fluctuations in Mediterranean reservoirs: a sad fate for water quality?

The increase in annual average temperatures in the Mediterranean area, as observed during the last decades, has already led to increase in evapotranspiration rates, and this is likely to interfere with the hydrological balance of Mediterranean water bodies even in the absence of variation in the amount of precipitation (Barone et al. 2010). The increased water deficit will be certainly worsened by the increased water demand for agriculture and drinking water needs. Freshwater resources are also deteriorating in quality because of ongoing eutrophication processes. Thus, climate change and human impacts will adversely affect both water quality and quantity in the Mediterranean area. Here I address some aspects connected with water-level fluctuations and eutrophication in Sicilian reservoirs.

Sicily is the largest island (surface area 26.000 km^2) in the Mediterranean Sea and with about 6 millions inhabitants is among the most densely populated areas in the region. The average annual rainfall in Sicily ranges between 350 and 1200 mm y^{-1}. The average annual temperature ranges from 4 to 20 °C. Based on climate and temperature differences, the climate of the island ranges from semi-arid to humid; the humid area is located along the North coastal chain and on Mount Etna, the highest European volcano, while the more arid zones are located in western Sicily and along the southern coast of the island. Semi-arid climate characterizes most of the hilly and lowland parts of the island. In general, these areas are the most exploited for intensive agriculture. To fulfil irrigation needs and supply drinking water, 30 dam-reservoirs, impounding about 750 10^6 m^3, were built in the last 80 years. However, the lack of any plan to cut off nutrient loads to recipient water bodies (sewage diversion, buffer zones, etc.) has driven all of these aquatic ecosystems to eutrophication.

Several European countries have successfully responded to meet the global threat to water quality by managing human nutrient emission (low-P detergents, P precipitation at sewage treatment plants, decreased fertilizer application, erosion control, etc.). These steps have been strengthened by several Directives issued by the European Union, the most famous being the so-called "Water Framework Directive", aimed at protecting inland water and at setting quality standards for freshwater compatible with their drinking, recreation, industry or agriculture usage. Unfortunately, in Sicily almost all of its water bodies, both natural and man-made, are still suffering of the eutrophication effects , including structural and functional changes, a decrease in biodiversity, higher vulnerability to invasions, fish kills, cyanobacterial toxic blooms, oxygen depletion, etc. Such an inverse trend seems to be linked a particular set of socio-environmental relations characterizing this region since unification of Italy in the mid 1850s. As pointed out by Giglioli and Swyngedouw (2008), *these relations have proven to be extremely resilient over time because of their ability to adapt to changing political and economic contexts…[the] ruling group also proved extremely skilful in presenting their age-old solutions to the water management, mainly based on the construction of additional hydraulic infrastructure, … which should have challenged the status quo*.

Among Sicilian reservoirs, Lake Arancio is one of the best studied and offers a paradigmatic overview of Sicilian man-made lakes. The lake, created in 1951, is located in the South-West Sicily (Italy) at 37°37'37" N and 13°03'53" E, and it is mainly used to retain water for irrigation and recreational purposes. Most of the nutrient loading into Lake Arancio comes from untreated urban wastes (a village of about 7000 inhabitants is located close to the lake's shore) and agriculture. Intensive agriculture in the lake's catchment contributes to a significant increase in nutrients to the lake from fertilizer use as well as the untreated wastes from a wine factory and a pig farm. The lake receives about 12 tons of phosphorus per year from a direct catchemnet area of about 138 km^2. The lake surface is 3.5 km^2 with a volume of 32 x 10^6 m^3 at maximum capacity (180 m a.s.l.). Maximum depth is 30 m at the dam and mean depth is 9 m. These values have been seldom attained due to the peculiar Mediterranean climate with its cyclic drought periods. The climate is characterized by a dry and warm summer periods , alternating with a wet and rainy winter one. Recurrent periods of up to 11-12 years of prolonged drought are also typical. The river-network of the region is mainly formed by torrent-like (often temporary) systems, whose discharge is strictly dependent on precipitation. In general, Sicilian reservoirs are characterized by wide water-level fluctuations because of the alternate periods of water storage and use: the wet winter season and the dry summer season. As a rule, reservoirs level is at maximum in April/May i.e. after the rainy season. During the filling phase, no significant water abstraction occurs. Following this, the absence of precipitation, the rapid raise of temperature and the evapotranspiration losses cause a strong water demand for irrigation and drinking purposes, leading to >90% reduction in the water stored (Naselli-Flores 2003). Thus emptying phase is not compensated by any inflow during summer so that water level reaches its minimum value in October/November. The intensity and extent of water abstraction may differ conspicuously from year to year allowing a variety of physical structures in the water column as a consequence of high flushing rates and abrupt fluctuations in water level. These hydrological events are important factors governing both the biotic and abiotic compartments of these ecosystems.

Furthermore, eutrophication processes appear to proceed much faster in these man-made lakes than in natural ones mainly because prevailing climatic features are enhanced by hydrological manipulations of the reservoirs, and negatively impact water quality (Naselli-Flores 1999).

A remarkable consequence of water level fluctuations observed in Sicilian reservoirs in general, and in Lake Arancio in particular, is the lack of a structured littoral zone. Such large fluctuations do not allow the growth of aquatic macrophytes along the shores, which are stony and do not provide refuge for fish, fish fry and zooplankton. In addition, the stabilizing effect of macrophytes on sediment resunspension is lacking. In Lake Arancio, fish spawning often occurs at the end of February when water temperatures are above 15 °C. Moreover, precipitation may still occur in this period and because of surface runoff silt deposition on fish eggs may increase egg mortality, and it often decreases spawning success (Naselli-Flores and Barone 1997). We know well that fish fry play an important role as consumers of zooplankton particularly of large cladocerans. In Lake Arancio, the decreased predation pressure on zooplankton, and the consequent increase in both numbers and in body size of these herbivores, contribute to select large celled or colonial inedible phytoplankton, thereby profoundly influencing the structure of the entire food web.

In addition, water-level fluctuations, especially summer drawdown, interfere with the periodicity and stability of thermal stratification. The deep location of outlets, typical of reservoirs, allows summer release of hypolimnetic waters causing a depth decrease, but leaving the thickness of the epilimnion unchanged so that the thermocline sinks. However, excessive water abstraction, compromises the stability of the water column causing thermocline to break, and deepening of the mixed layer. The breaking of the thermocline modifies the mixing depth–euphotic depth ratio of these water bodies. Thus, the deepening of the mixed layer may be analogized to the effect of the truncation of the euphotic depth due to an increase of phytoplankton biomass, which is generally taken to be the consequence of a shift towards a higher trophic state (Naselli-Flores 2000). The increase in the mixing depth – euphotic depth ratio modifies the underwater light climate. Consequently, a change in the value z_{mix}/z_{eu} is generally followed by sharp changes in the structure of phytoplankton assemblage. The spring assemblage of organisms is soon replaced by species slender forms having an elongated needle shape, which enables them to withstand highly unbalanced dark:light cycles. Moreover, if the underwater layers are too dark and z_{mix}/z_{eu} is>3.5, Cyanobacteria are selected due to their ability to regulate buoyancy. Being both toxic and inedible, these Cyanobacteria impair the control exerted by herbivore zooplankters on primary producers.

Mediterranean climate also affects nutrient loading temporal patterns. In fact, nutrients from the catchment reach the water bodies only during winter, when precipitation occurs. In this season, according to temperature, productivity is low and no water outflow occurs from the reservoirs; thus, these environments act as a phosphorus sink and their internal loading is constantly increasing At the onset of stratification, the high amount of organic matter causes a very rapid oxygen depletion in the hypolimnion and decrease in the pH. This reduced environmental condition promotes the release of phosphorus trapped in the sediment. The downwards shift of thermocline caused by release of water in summer allows mixing of upper circulating water layers with anoxic deeper water layers of reservoir. Thus, large volumes of bottom water in reservoir mix with upper water layers where they release their nutrient content. This is demonstrated by the frequent pulses of reactive phosphorus recorded in Lake Arancio in summer when no inflow occurs.

Such a pattern can worsen if thermocline breaks. In fact, due to the high summer temperature, reservoirs may show the onset of

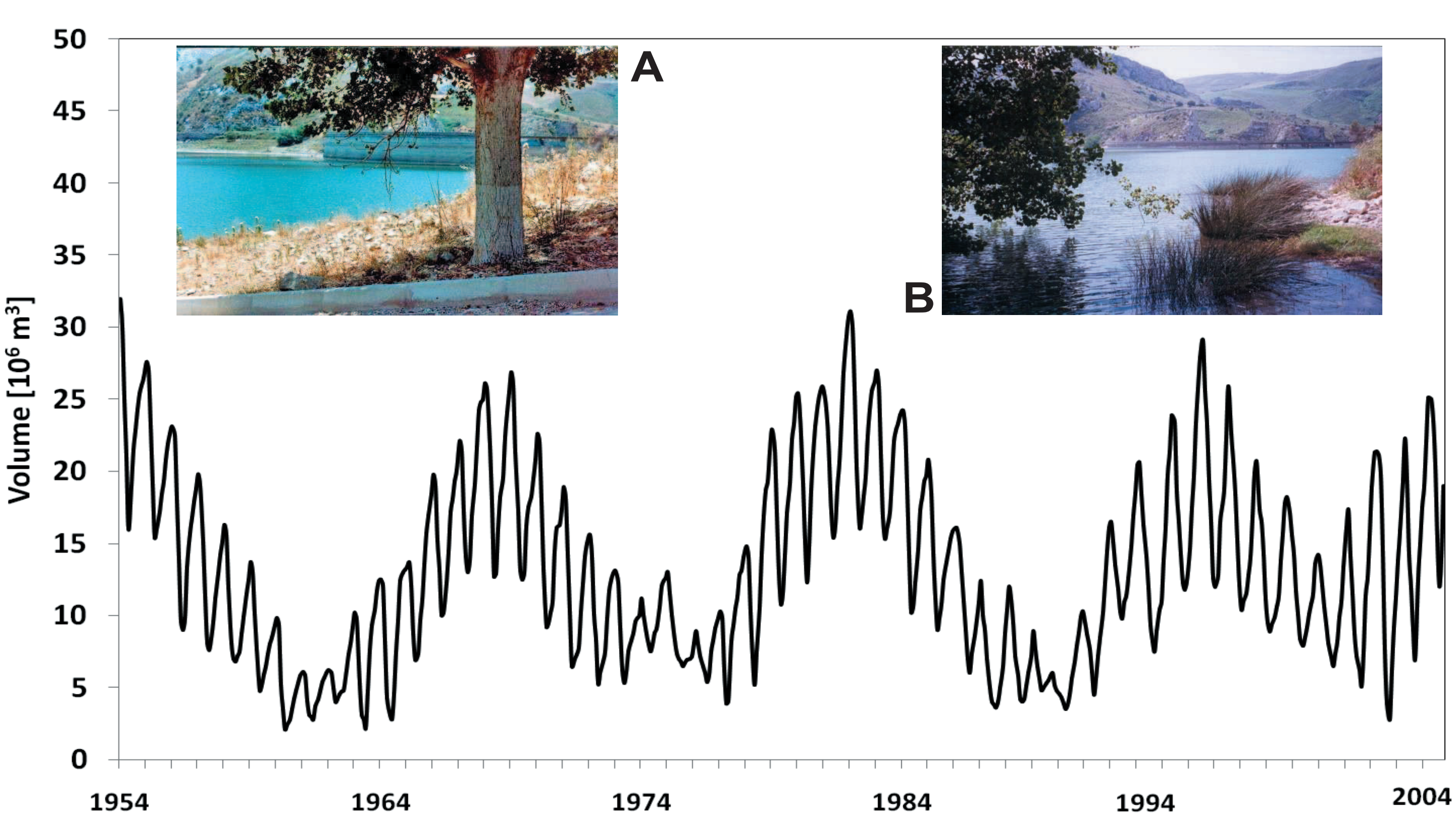

Fig. 1. Water-level fluctuations in Lake Arancio as shown by lake volume variations. A: Lake Arancio at its minimum capacity (early autumn). The tree in the pictures is the same and has on its trunk the sign of spring water level. B: Lake Arancio at its maximum capacity (spring).

diurnal stratification (atelomixis). Consequently, the daily circulation pattern further contribute to nutrient release from the reservoir bottom, and sustains phytoplankton growth throughout the summer. An evaluation of the phosphorus balance in Lake Arancio has shown that more phosphorus enters the reservoir during the rainy season than that is flushed out during the summer emptying phase (Naselli-Flores and Barone 2005). Thus, the anticipated breaking of the thermocline deepens the mixing zone and supplies nutrients, which increase phytoplankton growth and biomass. However, biomass increase is inversely related to water transparency and euphotic depth, so that the ratio of mixing zone-euphotic zone increases, further enhancing Cyanobacteria growth.

The pattern here described has contributed to seriously impair water quality of Lake Arancio and several other reservoirs in the island are facing the same fate. Importantly thus, Mediterranean natural aquatic ecosystems are thus adapted to climate-induced water-level fluctuations, and ephemeral ponds, that are markedly astatic, are common with very rich and diversified biota. The intervening dry periods in these ponds facilitate the hatching of the eggs produced by the crustaceans inhabiting these waters.

Lastly, however, the water-level fluctuations imposed by human activities to Mediterranean man-made lakes often exceed the capacity of these lakes to recover; and pseudo-eutrophication processes are further sustained by the increased temperature values. Unless adequate measures are taken, a decrease in water availability due to climate changes, together with an increasing demand for water to fulfill the water demand for human activities and food production can severely endanger the rich biodiversity in the temporary ponds and contribute to further impair water quality in reservoirs.

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Limnologists in the desert?

Continental waters are spatially isolated, especially in deserts. This simple observation led us to ask: *How do aquatic microinvertebrates disperse; do successful invaders possess unique life history strategies that correlate with specific habitats and/or their ability to disperse?* In the past it has been assumed that small invertebrates such as zooplankton are cosmopolitan because they have minute (≤1 mm) dormant stages with the potential to disperse easily abiotically by water (hydrochory) or wind (anemochory) or biotically by animals (zoochory). The idea is that these dormant zooplankton stages are dispersed widely, but local conditions dictate colonization success: the Baas Becking Principle. Yet a paradox exists. Despite this general dispersal capacity, many species have distinct biogeographical patterns.

Our research seeks to investigate zooplankton, community composition and the roles of dispersal processes in the determining community structure in the Chihuahuan desert (Suárez-Morales et al., 2008; Wallace et al., 2005; Walsh et al., 2007; Walsh et al., 2009). Based on samples from over 130 aquatic habitats in the US and Mexican Chihuahuan desert we have come to following major conclusions.

A large number of species that we found have been defined in the literature as being cosmopolitan (>60%). This, however, may be an

Fig. 1. Big Bend National Park (southwest, Texas, USA), representative of the Chihuahuan Desert of North America, the largest desert of North America.

Fig. 2. A large rock pool (tinaja) in Big Bend National Park.

overestimation, as many may represent cryptic species complexes: e.g., *Epiphanes senta* (Schröder & Walsh, 2007) and *Lecane bulla* (Walsh et al., 2009). In addition, we have found many undescribed species from desert waters and anticipate that additional research by us and others will likely yield more. Some of these species are presumed to be endemic forms, especially in the cyclopoid copepods, that represent the outcome of adaptive processes, which enable survival in these unique conditions.

Collectively all sites possess relatively high percent singletons of rotifer species, sometimes approaching 60%. These species probably represent specialists that are key to specific features in the environment providing both consistency in abiotic features and food web dynamics.

Redundancy Analysis revealed significant associations between environmental parameters and rotifer species distributions among water sources. Rotifer species composition varied by habitat, with permanent systems making a significant contribution to overall species richness. Although rock pools and ephemeral streams are frequently found in the Chihuahuan Desert, relatively few rotifer species were present in these systems. However, rock pool-specialists were abundant in pools with high conductivity and TDS values, high surface area to volume ratios, and with greater surface exposure. Species composition also correlated with high conductivity and water temperature, two variables that strongly co-vary in desert systems.

By assessing the forces in a region characterized by frequent disturbances, we expect that our research will provide insights that may not be apparent through the study of more stable, temperate habitats.

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Rainfall variation patterns and tropical fish diversity: what may change with global warming?

The water level rise of rivers in the rainy season floods adjacent areas, creating a variety of environments (Lowe-McConnell 1999). This season is the breeding period of the majority of the tropical fish fauna, including migratory species, and the new habitats may offer the best conditions for the development of their early life stages (Vazzoler et al. 1997).

Viewed as the major event responsible for tropical climatic variations, the El Niño-Southern Oscillation (ENSO) strongly modifies temperature and rainfall patterns across the globe (Philander 1990). Despite some regional differences in timing and amplitude, the warm phase of ENSO (El Niño) causes lower-than-normal precipitation in the northern and northeastern Brazil, but in the mid-west, southeast and south precipitation is higher-than-normal (INPE/CPTEC 1995-2010). The effects of the cold phase of ENSO (La Niña) on rainfall patterns are opposite to El Niño.

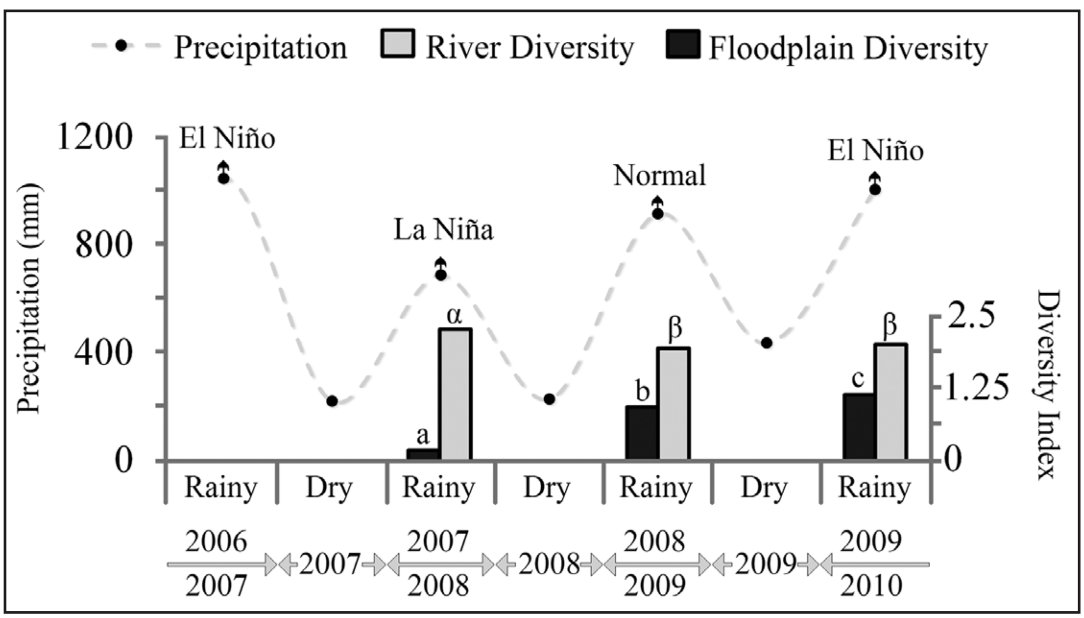

Fig. Cumulative precipitation for rainy and dry seasons from 2006/2007 to 2009/2010, Shannon-Wiener diversity index for the river fishes (all fish specimens minus small juveniles) and for the floodplain's juveniles were calculated. Different letters or symbols above bars indicate significant differences (post hoc Tukey test, P < 0.01).

The lower river flow induced by La Niña in the mid-western, southeastern, and southern Brazil results in a smaller floodplain area, limiting the habitats for fishes both quantitatively and qualitatively. Such effects are similar to those triggered by El Niño in the northern and northeastern regions, whereas in the mid-western to southern regions the increased rainfall expands the floodplain dimensions.

The study presented here is part of a larger project now being carried out in Jacaré Guaçu River, a tributary of Tietê River, which belongs to the Upper Paraná River Basin in southeastern Brazil. The aim was to evaluate the influence of climatic variations on the abundance and diversity of fishes. Juveniles were evaluated in the floodplain, and specimens other than the juveniles in the river. The juveniles' diversity in the floodplain decreased during La Niña event, leading to a lower fish diversity in the river in the next year. El Niño event caused the opposite effect on the fish diversity: the flooded areas benefited the development of early life stages of fishes by increasing their recruitment. Consequently, the juvenile diversity in the floodplain increased during the El Niño event.

The global climatic changes may lead to alterations in the variability pattern of the global atmosphere-ocean system. One of the expected changes is the intensification of the ENSO events, which is supported by observational evidences (Boer et al. 2004). According to these authors, the continued increase in the atmospheric greenhouse gas concentrations will drive the mean temperature of the tropical Pacific Ocean toward an El Niño-like situation. In this scenario, the mid-western, southeastern and southern Brazil will experience rainy seasons with higher-than-normal precipitation, which apparently can have a positive effect on the local fish diversity. On the contrary, rainy seasons with lower-than-normal precipitations in the northern and northeastern regions could lower fish diversity.

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Effect of water level changes in a highly vegetated floodplain wetland in Argentina, South America

Water-level fluctuations, specially their extent, frequency and duration, are dominant forces controlling the functioning of lakes (Leira and Cantonati 2008 and citations therein). The importance of such fluctuations in floodplain lakes is recognised as the primary factor influencing temporal limnological changes. Variations of aquatic communities are driven by hydrological regimes and in particular, phytoplankton changes in response to the duration and intensity of the hydrological fluctuations.

The aquatic environments located in the Otamendi Natural Reserve, a natural floodplain wetland located in the Lower Paraná Basin, Argentina (34º14´S, 58º50´W), comprise two shallow lakes, maximum depth about 1.2 m , and several smaller semi-permanent relict oxbow lakes with a maximum depth of 0.8 m. These systems are profusely vegetated with rooted and floating plants (FFP). When the lakes are free of FFP >1% of the incident light reaches the bottom, whereas up to 99 % attenuation is common under a profuse mat. The water bodies of this wetland have high DOC (22.3 to 56.6 mg L-1) and TP (0.2-3.3 mg L-1) concentrations; and they differ in their underwater light conditions mainly due to differences in the FFP development, which reduces light penetration in the water column (O´Farrell et al., 2003). The region has a temperate climate, without dry season and with hot summers. The wetland system moderates the extreme temperatures and the temporary hydrological deficit producing conditions more similar to those in the humid subtropical zone.

Marked changes in water level were observed over the last decade in this wetland. These changes strongly affected the dynamics of the primary producers, as evidenced by the shift from FFP dominance during very high waters to total phytoplankton with blooms of nitrogen-fixing *Cyanobacteria (Anabaenopsis elenkini and Aphanizomenon aphanizonemoides)* and very high photosynthetic picoplankton abundances during periods of extreme low waters.

As typical for temperate floodplain lakes, the abundance of phytoplankters > 2 µm increases during warm seasons provided that the water level is not very high. On the contrary, the low phytoplankton development during high water level responds to the negative influence of the shading by FFP, which are benefited by the higher water column and nutrient inputs from basin washout and anoxic sediments characteristic of this phase. The conditions imposed by the FFP cover (severe light reduction, low oxygen and high concentration of dissolved nutrients) account for algal assemblages adapted to this extreme scenario: mixotrophic cryptophytes and euglenophytes (Izaguirre et al., 2004). Dry summers of regular hydrological cycles are mainly represented by small centric diatoms, *Cyanobacteria* and green algae (Unrein et al., 2010), although phytoplankton is dominated N-fixing Nostocales during extreme droughts.

Temporal fluctuations of photosynthetic picoplankton are also explained by a combination of changes in temperature and water level. The maxima occur during warm dry periods, whereas the lowest occur during high hydrometric levels, or low temperatures, or both (Izaguirre et al., 2010). Important changes in photosynthetic picoplankton structure are associated with the light conditions imposed by FFP. Under a well-illuminated water column, oxygenic picocyanobacteria and picoeukaryotic populations dominate, whereas anaerobic anoxygenic photosynthetic bacteria prevail under a dense macrophyte cover.

Water level fluctuations in floodplain wetlands are one of the main factors regulating the macrophyte dynamics and their influence on phytoplankton ecology and ecosystem functioning. Under the increasing frequency and intensity of floods and droughts, which are characteristic of the climate change scenario, the patterns described here will allow a more comprehensive and predictive explanation of ecosystem mechanisms. Thus, two alternative possible scenarios may emerge in this context of global warming: either invasive FFP may become dominant or harmful *Cyanobacteria* blooms may prevail.

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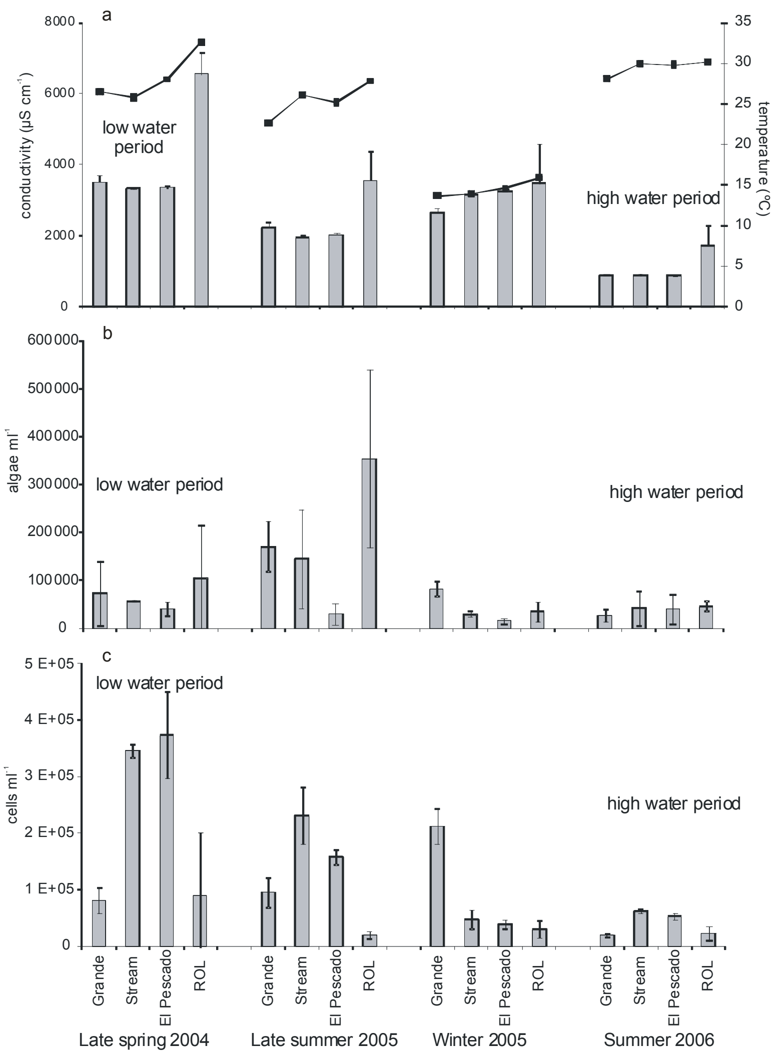

Fig. 1. Seasonal study in different water bodies from the Otamendi Natural Reserve (Lower Paraná Basin, Argentina) from December 2004 to January 2006: conductivity (bars) and temperature (lines) values (a); total phytoplankton > 2 µm abundance (b); picophytoplankton density (c). The highest water period (1) and the lowest water period (2) are illustrated by the photographs and indicated in each graph

Meeting Reports

SIL WG: Plankton Ecology Group (PEG)

Academy Colloquium "Predictability of Plankton Communities in an Unpredictable World"

The symposium was held in Amsterdam from 7 to 9 April 2010, as a part of the PEG activity, under the auspices of the Royal Dutch Academy of Arts and Sciences (KNAW). Fifty scientists and students from 12 countries participated. Each day there were three plenary presentations and a plenary discussion. There were 13 poster presentations and working group discussions on three topical subjects:

1. Chaos vs. predictability in plankton dynamics,
2. Global patterns vs. regional differences in plankton dynamics, and
3. Plankton dynamics under global change

The ultimate goal was to address the current day paradigms, perspectives and environment changes, and to revisit our view on seasonal plankton dynamics.

The meeting was opened officially by Louise Vet (Academy member and director of the Netherlands Institute for Ecology), who stressed the importance of plankton ecology in general ecological theory building. The first plenary lecture was given by Ulrich Sommer (University of Kiel, Germany). He presented a historical perspective on seasonal plankton dynamics, resurrecting temperature as an important ecological factor. He also pointed out gaps in the original PEG-model (Sommer et al. 1986) on plankton succession, and specifically addressed the role of overwintering copepods, microzooplankton, parasites and of food stoichiometry in the seasonal succession of plankton. The second speaker was Jef Huisman (University of Amsterdam, The Netherlands). He viewed the rich diversity of natural plankton from the classical theory of competitive exclusion and niche differentiation and theory on chaotic dynamics. He presented theoretical predictions and experimental evidence on chaotic dynamics in planktonic food webs in an impressive 2319 days lasting experiment. Jef Huisman also showed that predictability in plankton communities is limited to 5 – 15 generations, and that seasonal forcing can entrain plankton biomass with high interannual variability, which is an intrinsic property of multispecies plankton communities. Elena Litchman (Michigan State University, USA) gave a plenary presentation on trait-based approaches to phytoplankton community ecology and evolution. She showed that phytoplankton traits related to resource use and uptake often display trade-offs. Elena Litchman showed that major functional/taxonomic groups differ in their mean trait values and tend to cluster along trade-off curves. She revealed that traits define contrasting ecological strategies that can explain phytoplankton distributions along the nutrient availability gradients.

The second day started with a summary of the first day lectures by Wolf Mooij (Center for Limnology, The Netherlands). Marten Scheffer (Wageningen University, The Netherlands) started his plenary talk with the South American Lake Gradient Analysis Project and showed that fish eliminate large Cladocera in a warm climates, Cyanobacteria prevail in a warm climate and that phytoplankton can be predicted best in terms of their morphology. In the second part of his talk he switched to neutrality and niche theory and explained that there are two ways for co-existence: 1). being sufficiently different; and 2). being sufficiently similar. The second speaker was Vera Huszar (Federal University of Rio de Janeiro, Brazil). She showed that phytoplankton species richness increases from higher latitude (55^{o}S) to lower latitude (5^{o}N). She took us to the tropics showing that certain relationships, such as chlorophyll-nutrient and bacteria-phytoplankton, are weaker in the tropics than in temperate regions. She demonstrated that strong seasonal dynamics in phytoplankton occurs in the tropics as well, strongly driven by hydrology/precipitation. In the third plenary presentation Mathew Leibold (University of Texas, Austin, USA) addressed plankton dynamics as an emergent ecological phenomenon. He showed that perturbations to complex dynamics can 'stabilize' systems, emphasizing that systems do not exist in a vacuum but are influenced by regional species pools.

On the third and last day, Sarian Kosten (Wageningen University) summarized the previous day's proceedings. In the first presentation, Monika Winder (University of Washington, USA) focused on the effects of climate change on plankton phenology.

The Plankton Ecology Meeting participants (Amsterdam, April 2010)

She showed that phytoplankton annual cycles are highly variable not necessarily connected to the annual, seasonal cycle. She also illustrated that responses to climate warming are species specific, which could result in trophic uncoupling of interacting species. In the second plenary lecture, Erik Jeppesen (NERI, Aarhus University, Denmark) emphasized the key role of fish in the trophic dynamics of lakes. He stressed that warming will enhance the risk of increased eutrophication and will lead to higher fish predation on zooplankton. The last speaker, Hans Paerl (University of North Carolina, Chapel Hill, USA) presented dynamics of harmful algal bloom in a world experiencing human and climatically-induced environmental changes. He gave examples on effects of nutrient inputs, hydrological regime, and climatic extremes on the spreading and intensifying harmful blooms.

The plenary discussions were initiated by Jef Huisman and Ulrich Sommer (1st day), Marten Scheffer and Mathew Leibold (2nd day) and Erik Jeppesen and Ulrich Sommer (3rd day). They motivated many participants to discuss the role of chaotic dynamics, predictability, similarity, invasion of plankton species and the fish in determining plankton dynamics. The working groups continued discussions each afternoon, while also posters stimulated an exchange of ideas and promoted discussion.

The enthusiasm of the participants, high quality presentations and discussions in an inspiring environment of the monumental Trippenhuis Building (built between 1660 and 1662), made the meeting a great success: we might expect several spin-offs. We thank Elisa Benincà (University of Amsterdam), Maayke Stomp (University of Amsterdam), Wolf Mooij (Netherlands Institute of Ecology), Sarian Kosten (Wageningen University) and Martine Wagenaar (Royal Dutch Academy of Arts and Sciences) for their great help.

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Wetlands in a Flood Pulsing Environment: Effects on and responses in biodiversity, ecosystem functioning and human society

Report on an International Symposium held in Maun, Botswana 1-5 February 2010.

The symposium, which was well attended with about 200 participants from 26 countries, was held in Maun, Botswana, at the edge of the Okavango Delta, one of the world's largest flood pulsed wetlands. The flood pulse concept has been growing in importance since it was first formulated by Junk and his co-workers in 1989 (2) and it was fitting to make an update from the past 20 years of research. The emphasis was on the importance of flood pulses in wetland flooding, and linked responses in chemistry, biological productivity, biodiversity and human livelihoods, history and culture. About half of the presentations were from African scholars, showing how important selection of venue and thus travel costs is for the participation of scientists from the "developing world" in international meetings.

Wetlands with various flooding frequencies were described. Tidal wetlands, being flooded twice a day, retained as much as 20% of inflowing phosphorus per day and maintained highest biodiversity in the aquatic/terrestrial transition zone. On the other extreme were wetlands that were flooded by episodic events such as the ephemeral rivers of Southern Africa, which require the development of a different protocol for determining environmental reserves. Most studies were, however, on annually flooded wetlands, and in general the original premises made 20 years ago were confirmed: that flood pulsed areas have higher nutrient content, faster nutrient cycling, higher carbon sequestration, higher biological production and higher biodiversity than permanently flooded areas or dry land. In a plenary session Mitsch (3) presented new calculations of carbon budgets from a temperate and a tropical wetland that showed that wetlands ultimately become net sinks. Dynamic modeling indicates that this turning point occurs at about 200 years after establishment. They concluded that wetlands should be conserved, constructed and restored to provide carbon sequestration as well as other ecosystem services.

Practically every paper demonstrated the benefits of the flood pulse to ecosystem services, and the conflict with current natural resource management that "seeks protection through harmony and uniformity with little recognition of ecosystem dynamic behavior". The need for, and design of, new adaptive management strategies backed by policy and law were therefore addressed in two sessions. In an intriguing analysis of African wetland fisheries Kolding (4) showed that fisheries regulations were sometimes outright harmful to the fishery, causing lower fish yield and excluding the poorest people from a necessary protein resource. On a similar note, a number of studies showed that seasonally-pulsed floodplains produced a larger variety of natural resources for human use than permanent waters or dry land. In particular people living marginal existences use them to fall back on when everything else fails.

The symposium confirmed the flood pulse concept as a central paradigm in wetland research and management. It benefitted from the presence of Wolfgang Junk who made a critical overview of the state of the art regarding research on the flood pulse concept. The research frontier is still, however, in an observational and descriptive phase and few experimental studies have been done. The abstracts for the Symposium are published on the organizers' web page: http://www.orc.ub.bw/floodpulse/abslist.html.

Mike Murray-Hudson and **Lars Ramberg (1)**

References

Harry Oppenheimer Okavango Research Centre (HOORC), University of Botswana: www.orc.ub.bw

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Announcements

Dues to SIL - once more.

Dear members,

We are an international society with members from all over the world. Therefore, it is at times somewhat difficult for some members to find out how to pay the dues.. Furthermore, different countries have their own history and some have the membership of SIL linked up with their national limnological society. I shall here try to explain what to do and what not to do. However, first the principal policy: SIL wants to join the modern era of easy transfer of money, i.e. electronically with a credit card and on-line. This may not be feasible if your membership dues are managed by a national society. We have some straight forward methods to pay the dues:

1. A credit card through PayPal on the SIL Website (www.limnology.org). Go to "Pay Dues" and follow the instructions. For making the payment go to the e-mail of our Service Coordinator Denise Johnson (denisej@email.unc.edu). The money is now directly transferred to the SIL account at the University of North Carolina. You need to pay in US $ and, if you like, you may add a few dollars extra to boost up the finances of SIL.
2. Fill out the Membership Form (use the SIL website) with your name and charge card information on it and attach it to Denise Johnson in an email. Then send the credit card information to Denise in a different e-mail, and she will transfer it to a Dues Invoice. You may also fax the filled in Membership Form with the charge card information on it to Denise (+1-336-376-8825).
3. You can also wire money through the Western Union to "Denise Johnson, Graham, NC, USA. Just inform Denise by email so that she can claim the money money sent via to the Western Union.
4. Use your National Representative (NR) in charge of dues (again use the SIL home page to find your NR). Your NR has guidelines for you to use. You pay in local currency and the NR transfers the dues to our account in Zürich.
5. Lastly, you can transfer money directly by sending a bank cheque duly filled in to our office in North Carolina. This is a rather expensive way to transfer money. Look up for details at the SIL home page.

Kindly do not transfer your due from individual members to our Zürich Account and contact only Denise Johnson to make direct payments through PayPal. All the above information may sound trivial but this is needed because to avoid administrative difficulties of finding out who has paid and who has not.

At the Congress in Cape Town (join this unique experience) we launch the new SIL Journal "Inland Waters" in cooperation with the Freshwater Biological Association in the United Kingdom (see also an Announcement by our President Brian Moss). One advantage of this is that paying dues for 2010 will entitle you to receive the current year issues of new Journal. The Executive Committee is fully aware that changes in a Society with a long history of "we have always done like this" is a difficult process, but SIL has to focus on a more efficient and better way to serve its membership.

With respect,

Morten Søndergaard
SIL General Secretary and Treasurer

SIL 2010 Congress, Capetown, South Africa (15-20 August 2010)

Special Session Announcement: "Coupling of Physicaland Biogeochemical Processes In Lakes and Reservoirs"
Physical processes (heat fluxes, wind, thermal stratification, water movements, storm inflows, etc) and chemical and biological regimes of lakes and reservoirs are coupled. Recent studies show great progress in understanding the key role of physical processes in controlling the spatial and temporal dynamics of nutrient loading, sedimentation, fluxes at the sediment-water interface, succession of planktonic organisms, and changes in trophic status. Rapid changes in climate, extent of eutrophication, and pollution require operative measures of ecosystem management. Such measures are impossible without an adequate understanding of the basic processes, and they require the combined efforts of physical limnologists, ecologists, and biogeochemists.

This session is aimed to bring together specialists from various disciplines, fill gaps in communication, stress the importance of interdisciplinary collaborations, and define key problems requiring immediate joint effort.

Drs. Ilia Ostrovsky (ostrovsky@ocean.org.il) and
Sally MacIntyre (sally@icess.ucsb.edu)

SIL WG Aquatic Birds: Announcement

7th Symposium will be held at Kristianstad, Sweden, from 15 to 17 August , 2012.

For further information and regular updates about the symposium, please contact :

Ms Lisa Dessborn
Kristianstad University College
291 88 Kristianstad, Sweden
Telephone: (+46) 44 203464, E-mail: lisa.dessborn@hkr.se
Website: http://home.hkr.se/~del/

WG Coordinator: **Joe Kerekes** [Dartmouth]
Joe.Kerekes@EC.GC.CA

Announcement for Cladocerologists

Within the *International Conference on Invertebrate Reproduction and Development*, which will take place in Prague, Czech Republic on August 16–20, 2010, a special session on *Daphnia* and other cladocerans as model organisms will be organized.

All contributions dealing directly or indirectly with reproduction and development of *Daphnia* and other cladocerans are welcome. Topics of individual presentations may include, among others: interplay of sexual and asexual reproduction; production, hatching and survival of dormant eggs; plasticity of life history traits and factors affecting them including predator-prey and host-parasite interactions; inducible morphological defences; effects of hormone analogues on cladoceran development; interspecific hybridization; gene flow and genetic structure of populations. Depending on abstracts received, oral presentations will be selected to complement each other around specific themes. Selected contributions of the session may be published in a special supplement issue of the *Journal of Limnology*.

For more information, visit the webpage of the conference http://icird.bc.cas.cz or contact the session convenors: Jaromir Seda, Biology Centre of Academy of Sciences of Czech Republic, Ceske Budejovice (seda@hbu.cas.cz) or Adam Petrusek, Faculty of Science, Charles University in Prague (petrusek@cesnet.cz).

SIL WG Plankton Ecology Group: Announcement

Dear plankton ecologists,

I want to invite you to get together for a working group meeting during the upcoming SIL2010 Congress at Cape Town on Monday evening August 16th in the Congress Center. (more information on exact time and room will be provided on site). There will be a presentation of short summary of the last Plankton Ecology Meeting (April 7th – 9th Amsterdam), but also a discussion of important organizational issues, including election of a new PEG office bearer and support persons. Candidates are request to send an email to: plankton@nioo.knaw.nl

I look forward to meeting you in Cape Town,

Miquel Lürling
WG Chairman

Newsletter on global freshwater research

Kev Warburton (photo by Margrit Beemster)

Natural resource managers, NRM groups and researchers are all presented with the need to sift, interpret and digest large volumes of technical information. Faced with the challenges of ever-increasing environmental pressures and a continuous need for broad stakeholder consultation, NRM managers normally operate under stringent time constraints which leave them with few opportunities for background reading outside the sphere of their current projects. Community-based NRM groups typically rely on the coordinator or a few key individuals to disseminate information to members of the group. Within the freshwater research community, there is often limited contact between individuals working in different environments, geographical areas or discipline areas, and researchers may have little time to devote to the broad dissemination of their findings. *Freshwater Research News* (*FRN*) aims to alleviate these problems.

Most environmentally-focussed newsletters are mainly concerned with specific conservation issues, ecological threats and coverage of campaign news. *FRN* is intended to complement such publications by bringing recently-published research findings to a broad audience to increase fundamental understanding of aquatic issues.

FRN is a free electronic publication containing brief, easy-to read summaries of the background and significance of freshwater research projects from around the world. The subject range is wide, with an emphasis on key physical and ecological processes, transferable ideas and applications, and the implications of research results for aquatic resource management. *FRN* 's subscription list includes natural resource managers, conservationists, scientists and educators.

FRN is written and produced by Dr. Kev Warburton, an adjunct research fellow in the School of Environmental Sciences, Charles Sturt University, and the School of Biological Sciences, University of Queensland, Australia.

To receive FRN by email, contact Kev at K.Warburton@uq.edu.au. *FRN* is also archived at: http://conserveonline.org/library/withsearchterm-library.html?searchterm=freshwater+newsletter

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. Proposal should include the names of taxa expected to be studied. 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 July 1, 2010. 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, 2010.

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:

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c/o Ms. Denise Johnson
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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.

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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.