SIL news

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Akuliarusiarsuup Kuua (Watson River) Kitaa Greenland
Photo by Adam Heathcote

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LETTER FROM

The President

When I was contacting colleagues recently via virtual chat or phone, one of the recurrent topics was when we can expect our covid-19 vaccination. A few of us might even report on having got the second shot already. These discussions suggest that the end of a severely restricted professional and private life seems to be in sight. However, when listening to the news, disastrous situations are still reported from several large emerging economies, from Asia such as India, or South America, such as Brazil. It worries me to see that there is a major worldwide divide into economies that have got the financial and medical capacities to come relatively well through the pandemic, and economies that suffer from the consequences in a dramatic way because of financial, medical and political deficits. I am concerned that this divide reflects the typical isolated and self-centred responses of the countries to world-wide challenges, whether these are pandemics as now, or environmental issues, such as global warming. From my perspective, global threats deserve globally coordinated responses, to which all economies have to contribute according to their capacities in a fair and balanced way.

How can SIL contribute to global fairness?
Dealing with a global pandemic is not the core activity of SIL, our limnological society. However, covid-19 makes clear that we are globally intertwined and that it is important that we, as a society, take responsibility to mitigate global imbalances. You may ask yourself in which way SIL, and hence you, can contribute to global fairness. I would like to briefly elucidate three routes along which SIL-members and not-yet members

> "... it is important that we, as a society, take responsibility to mitigate global imbalances."

can become active to improve the internationality of limnological research and application.

Participate in the new SIL mentorship program
First, you may have recognized that SIL has created a new partnership initiative, which is called the mentorship program. This program is dedicated to foster and support international scientific networks of freshwater research, and to empower researchers of tomorrow and facilitate knowledge-transfer to promote limnology to a wider audience. Mentors from developed economies take responsibility for the scientific education and development of young researchers in matching scientific topics from developing economies, by providing supervision, discussion and encouragement. Superficially, the mentorship program may be seen as unidirectional capacity building in developing economies. However, I am convinced that the exchange will become bidirectional. Enthusiastic and motivated young mentees will train their mentors to see the environmental challenges through their eyes. Solutions for global challenges can be found only if globally concerted actions are also locally supported. I would predict that the mentors can learn much about local constraints, which prevent easy solutions, and the needed pragmatism when scientific results have to be applied in the local reality. Therefore, please think about whether you want to become part of this exciting partnership, as a mentor or a mentee.

Let SIL become visible through our international members
A second route towards global fairness is the international visibility of our society. SIL intends to engage in global environmental advocacy, advice and science transfer to politics, as for example by recently co-signing the World Climate Statement, released by the American Fisheries Society. We sign such statements in the name of our members – therefore, it counts how many members SIL has got, and where they are located. SIL is the oldest international limnological society; we will celebrate the 100th anniversary of its foundation in 2022. However, being a SIL member is no longer a professional standard for limnologists, as it was decades ago. I am aware of numerous reasons to leave SIL and become a no-longer member. I am aware of discussions I have had with young limnologists why they feel SIL is not the society they like to be part of. However, I also see the motivation and engagement of many of you to change what SIL stands for and what we do as a society in the international context. Therefore, I would like to argue that all SIL-members can be more active in becoming ambassadors of SIL. Does your colleague know that you are a SIL-member? Does your supervisor or department head understand the opportunities of SIL-members with respect to international interactions and programs? You can check here how you may convince not-yet members to become part of our society – and membership is just a click away.

Participate virtually in our SIL congress in Korea
There is a third activity by which you can support the international network of limnological researchers, to foster collaboration and scientific exchange, and to reduce educational imbalance. As you may know, SIL has held its congresses in many countries and on several continents, to accentuate the vision that SIL is truly international. In August 2021, the 35th SIL congress will be held in Gwangju, Korea. I understand that many of you would have missed participating in the congress for financial reasons. However, the covid19-pandemic forced the Korean organisers and SIL to re-think what it means to hold an international congress. The congress will have a smaller presence component for those who can travel, and a larger virtual component accessible to everyone worldwide. Therefore, imposed by a global crisis, we provide the opportunity for a global meeting in the virtual space, at very moderate costs. I would like to motivate you to take this chance and meet your colleagues and friends, to present your most recent scientific results, and to demonstrate that our limnological society is indeed international.

Learn about the future structure and activities of SIL
Our SIL congress is not only a scientific meeting. It is also the opportunity to meet in the General Assembly and to learn about the changes in statutes of SIL. Furthermore, the newly elected SIL Executive Board members will be available for introduction and questions on their visions for the future of SIL. And last but not least, we will get the opportunity to thank our resigned members of the Executive Board for the hard work during the previous period. Therefore, please mark the meeting on 23rd August in your calendar, and contribute to actively designing our society.

Thomas Mehner
SIL President

Lake Kinneret NW shore, Israel
Photo byTamar Zohary

NEW COMMUNICATIONS &

Membership Coordinator

Meet Michelle Gros, our new Communications & Membership Coordinator! Here's what she had to say about her new position:

"I'm very excited to start working with SIL and I'm hoping to get to know some of you over the coming months. Here's a little more about me. I obtained my BSc and MSc in biology at McGill University studying freshwater food webs. I've been working as a paleolimnology research assistant since 2018. In my free time, I enjoy playing soccer, cooking, and taking care of my plant collection. If you have any questions, feel free to reach out. Talk to you soon!"

Mentorship Program

SIL has launched its mentorship program for students and early careers to gain access to the knowledge of experienced scientists that are willing to offer them advice. This program aims to support capacity building and knowledge transfer, as well as to encourage and support researchers, especially from developing countries. If you wish to become a mentor or a mentee, please click here.

IN THIS ISSUE

Lac Simoncouche, QC, Canada
Photo by Adam Heathcote

Elections and re-organization

OF THE SIL EXECUTIVE BOARD

Prior to the 2021 SIL Congress, elections will be held to replace two vice presidents (VPs) and two student/early career researcher representatives (ECRs) on the SIL executive board. Formal replacement will take place at the end of the 2021 Congress. These elections will initiate a re-organization process within the SIL executive board to address recommendations made by a SIL Governance Review, conducted during 2020/21 by a team of volunteers. The team was chaired by Jack Jones (USA), with Michelle Burford (Australia), Rey Donne S. Papa (Philippines), Cecilia Barouillet (Canada), András Abonyi (Hungary) and David Livingstone (Switzerland) as members. One major recommendation of the governance review team was that a more even spread of responsibilities among SIL board members will contribute to improving its functioning. Four major branches of SIL activities were identified: Communications and Publications, Limnological Education, Promotion of Developing Countries and Global Outreach. The team suggested that a VP will be allocated to be in charge of each such branch. They further proposed that an ECR will be matched to each VP to assist him/her so that the pair will work as a team (Fig. 1).

Given that currently the SIL board has only 3 VP and 2 ECR positions, as dictated by the SIL statutes, changes need to be made to the statutes that will allow increasing the number to 4 VPs and 4 ECRs. These changes to the statutes will be prepared and hopefully approved before or at the 2021 congress. Until these changes are approved, SIL is limited to replacing the existing 4 board members that are stepping down, marked in green in Fig. 1b. Thus, one newly elected pair will be in charge of communications and publications, a second pair in charge of education; the third vice president, the VP for developing countries (Ines O'Farrell) will continue for a second term. In 2022 a second round of elections will be held before the congress in Berlin, to elect a third (new position) ECR who will pair with Ines O'Farrell to promote limnology in developing countries. Also, in 2022 a fourth VP and a fourth ECR, both new positions, will be elected to take charge of the 4th branch, Global Outreach. Also, in 2022 a new General Secretary-Treasurer position will be elected (Fig. 1).

The highlights of the 2021 governance review, including suggestions on how to re-define and create new roles for the SIL National Representatives, will be summarized in the next issue of SILnews.

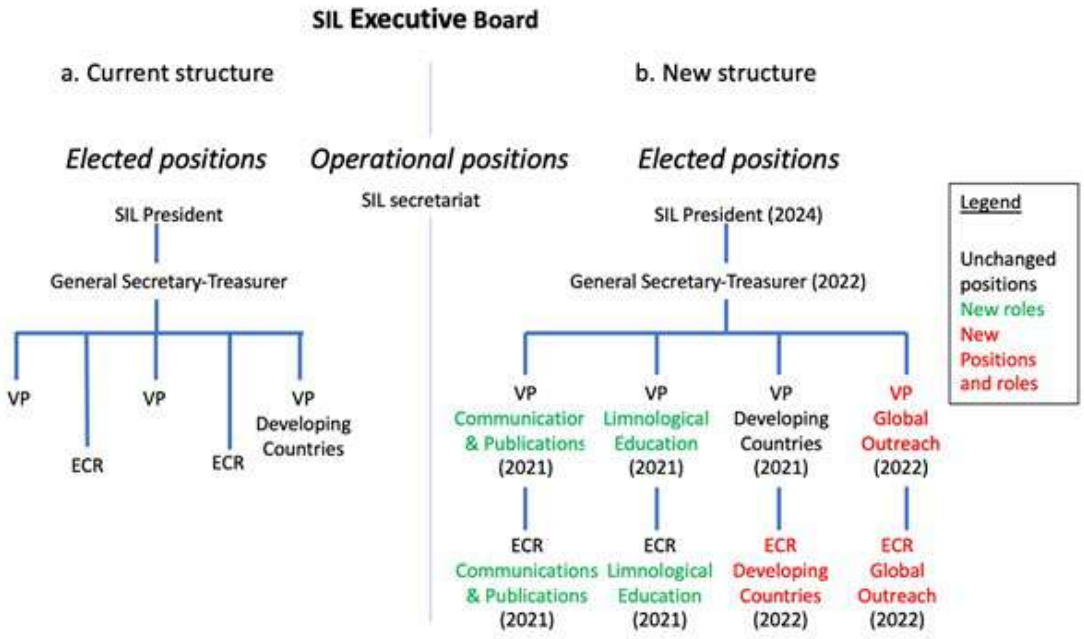


Fig. 1 A schematic diagram of the current (a) and planned (b) structure of the SIL executive board. In the current structure, SIL's elected positions include a president, a general secretary-treasurer, 3 vice president (VP) positions with a defined responsibility (Developing countries) to one of them, and 2 unspecific student/early career representative (ECR) positions. The new structure comprises of 4 VPs and 4 ECRs that are each assigned a responsibility, and work in pairs. The year in which the position will open for election is indicated. The SIL secretariat, including a business director and a communications and membership coordinator, are paid positions that remain unchanged.

35th Congress of the International Society of Limnology

SIL 2021 Gwangju, Korea

AUGUST 22-27, 2021 GWANGJU METROPOLITAN CITY, REPUBLIC OF KOREA

Theme: Biodiversity and Ecosystem Services for Healthy Rivers, Lakes and Humans

Important dates:

July 20, 2021
Presentation file upload deadline

July 31, 2021
Standard registration deadline

Plenary Speakers

BALDI MEMORIAL LECTURE

Michele Burford

The Dean of Research Infrastructure of Griffith University and Professor at the Australian Rivers Institute, Australia

KILHAM MEMORIAL LECTURE

Cayelan Carey

Associate Professor of Freshwater Ecosystem Ecology at the Department of Biological Sciences, Virginia Tech, USA

K-WATER PLENARY LECTURE

Ian Donohue

Professor, School of Natural Sciences, Department of Zoology, Trinity College Dublin, Ireland

Rodolphe Elie Gozlan

Professor, ISEM (Institute of Evolution Sciences of Montpellier), University of Montpellier, CNRS, IRD, EPHE, Montpellier, France

Fengzhi He, Ph.D

Student Competition Winner
Department of Ecosystem Research
IGB, Germany

Soon-Jin Hwang

Professor, Department of Environmental Health Science, Konkuk University, Korea

Bomchul Kim

Professor, Department of Environmental Science, Kangwon National University, Korea

Shinichi Nakano

Professor, Center for Ecological Research,
Kyoto University, Japan

LIST OF
Short Courses

SC-01	Chironomidae identification methodology
SC-02	How to use stable isotopes in ecology and environmental study?
SC-03	Long-term data analysis based on R
SC-04	Ecological Applications of Bayesian Statistics -- with R and Stan
SC-05	Spatial and individual-based models for ecological monitoring through simulation
SC-06	Evolutionary Algorithms: Predictive and Explanatory Modelling of Freshwater Ecosystems by Learning from Ecological Data
SC-07	Aquatic ecosystem modeling (PCLake and GLM-AED2)
SC-08	From data to visualization and storytelling

Side Events

- **Brain date with Eminent Scholars**

  Live streaming program with 10 eminent scholars

- **Photo Contest**

  Categories : habitats, organisms, landscapes, etc

  10 awards will be given at the closing ceremony

- **Show me the River & Lake Wetland Video Contest**

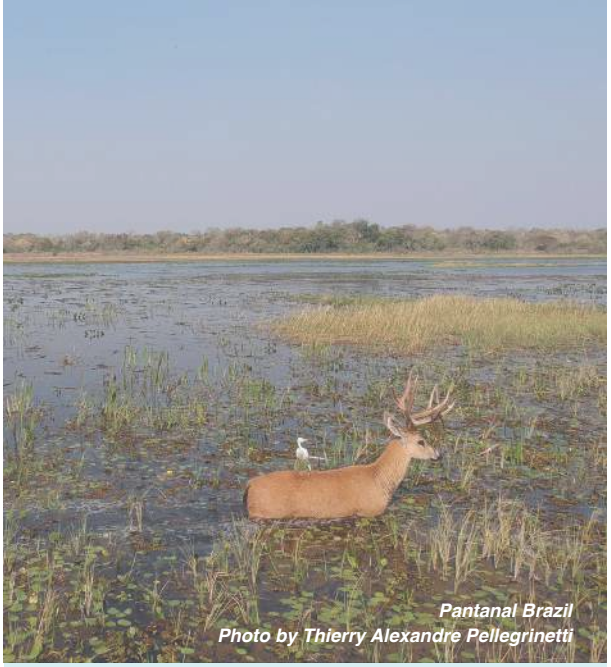
  3 min video of research or field survey will be evaluated

  10 awards will be given at the closing ceremony

- **SIL Job Fair**

- **SIL Auction**

Lake Kinneret Israel
Photo by Tamar Zohary



Pantanal Brazil
Photo by Thierry Alexandre Pellegrinetti

A while ago, I came across Kevin Winkler's paper on the importance of Natural History Museums (Winkler K. 2004. BioScience 54: 455-459) and thought it would be interesting to get an idea of limnological research carried out at these institutions. The *Limnology around the World* section showcases five museums all at the forefront of biodiversity research in their respective countries.

Long time SIL member Robert Flett contributed to the previous issue, and during our correspondence he mentioned that he had a series of photos taken during the ELA experiments. David Schindler's untimely death made these photos every more precious, a tribute to a lot of hard work but also to the fun and enthusiasm that transpires.

Along with David Schindler, we also lost two other world-renowned limnologists – Winfried Lampert and Brij Gopal.

Reading the heartfelt tributes written about them, I can only say let's leave good memories.

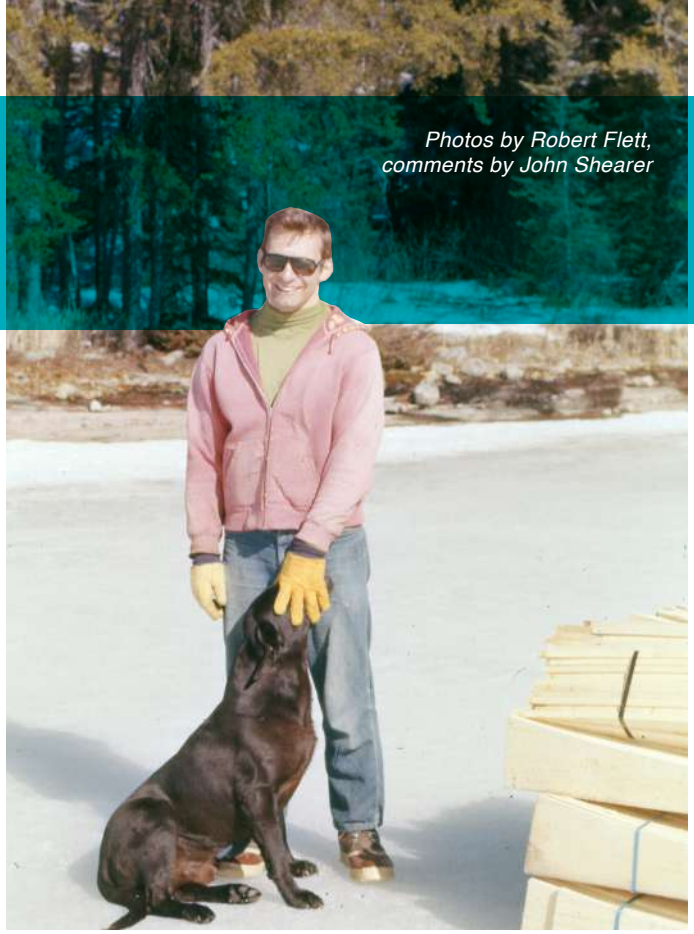
Giovanna Flaim

Editor, SILnews

History in the Making

Limnological history in the making: A behind the scenes look at the ELA

Photos by Robert Flett, comments by John Shearer



All of us know about the now famous experiment in the Canadian Experimental Lakes Area (ELA) to study the role of phosphorous in algal blooms. Few of us realize how much work was involved in planning and carrying out this endeavor. SIL member, Dr. Robert Flett, was a graduate student studying nitrogen fixation in the lakes David Schindler was manipulating, and these are some of his photos that give us an idea of what was involved! John Shearer, a colleague of David at the time, has provided the comments.

Dave giving instructions to Therese and Eric Matheson for assembly of the Lake 223 mesocosm frames. (6 April 1976)

A camp crew has arrived to begin the two-day task of assembling and constructing the flotation frames for the 10 metre mesocosms to be installed in Lake 223 for the acidification pilot studies. (6 April 1976 at Lake 223)

Michael Turner, Ken Mills, Sandy Chalanchuk, and Therese Ruszczynski with Dave and Plato in the rear (5 April 1976 at Roddy Landing)

The semi has dropped off 14 tons of fertilizer and 6 tons of acid and the gang is waiting for the chopper to start slinging it to the various lakes. (Afternoon of 5 April 1976 at Roddy Landing)

Dave doing dishes in the camp kitchen. After our 10 days canoeing and camping on the South Nahanni River, it appears that we were able to instill in Dave a desire to clean up after preparing a meal and dirtying dishes. Because Marge (our cook) was not watching him with her whip at ready, it was probably a Sunday when the cooks were not on duty. (autumn 1975)

The Hughes 500 helicopter transported tube frames and fertilizer to several lakes. Here it is depositing tube frame materials on the ice. (Lake 223 morning of 5 April 1976)

A gang of ruffians enjoying a coffee break during the slinging operations for sending tube frames and acid to Lake 223 and fertilizer to other lakes. (5 April 1976 at Roddy landing)

A Hughes 500 chopper slinging a section of large diameter corrugated culvert. While these culverts may have been used to store fertilizer on some occasions, their primary purpose was to store the sugar used as a carbon addition to selected lakes. A lot of sugar was lost to bears at L226 in 1973, so the culvert was installed not long afterward. Herman Schneider devised a bear-resistant insert for closing the ends. Most probably, this culvert section was being air-lifted to the island in Lake 302 in preparation for the sugar that was added to the north basin.

LIMNOLOGY AROUND THE WORLD: AUSTRALIA

Caddisflies of the Otway Ranges, Victoria, Australia

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We are both curators at Museums Victoria in Melbourne. In mid 2018 we began an assessment of stream communities in the Otway Ranges, about 150-200 km south west of Melbourne, after this region had suffered from bushfires. We chose to concentrate on adult caddisflies as these are numerous and diverse in this region, but we also sampled adult mayflies and stoneflies (EPT taxa). These three orders are known to be sensitive to disturbances both man-made and natural and are thus obvious targets for any assessment of river conditions. Here we deal solely with the caddisflies.

The Otway Ranges is a region of high country (maximum elevation is about 600m) that lies adjacent to Bass Strait and stretches for about 120 km along the coast, which points in a south-west north-east direction. It is mostly covered in forest, which has been logged in the past, but today much of the region is included in the Great Otway National Park. Numerous rivers arise in these ranges with those in the southern part of the ranges generally flowing short distances (< 50km) before they reach the sea.

Between October 2018 and April 2021, we surveyed the caddisfly communities at many of these shorter rivers. Our aim was to assess caddisfly diversity by photographing, capturing and subsequently identifying live adult specimens. For many of these species, live photographs were not previously available; so knowledge of their natural colours and wing patterns was absent. From our high resolution images we will produce a photographic key to the adult caddisflies in the belief that an identification key will facilitate future environmental surveys by non-specialists such as staff from the national park. The Otway Ranges have been repeatedly burnt by wildfire and naturally one of the concerns of the national park authorities is to determine the extent of disturbance and the degree of recovery of invertebrate species, especially those in rivers which can be inundated with ash and sediment after fires.

Our main technique was high resolution digital macro photography. Adults were photographed during the day when they emerge onto rocks or vegetation along the banks. At night adults were attracted using UV lights. We have discovered that a UV light set up underneath a bridge provides excellent conditions for photography (Fig. 1). Adults usually will settle on the vertical walls underneath a bridge where they can be readily photographed. Thus our survey work was done both at night and during the day, but night work tended to produce the most species. After several photos had been taken of each specimen, the adult was captured using a pooter and preserved in 70% ethanol. This proved very productive and provided specimens at all sites examined. Preserved specimens were identified using existing keys under low magnification. Photos and specimens were registered in the museum's collection database.

A total of 2300 individual caddisflies, representing at least 63 species and 19 families, were individually photographed and collected at 36 sites, encompassing 17 creeks and rivers (Table 1). Most specimens were of described species. However, we found a small number of undescribed species. The range of families encountered was typical for forested catchments in Victoria and the number of species recorded represented about one third of those known from Victoria. The most diverse families (Leptoceridae, Hydrobiosidae, Conoesucidae, Philorheithridae) in the Otways are also diverse elsewhere in Australia. Photos of the adults (Fig. 2) show differences in colour, wing pattern, antennal length and size. These characteristics have enabled us to distinguish species and provide diagnostic features that will be incorporated into a key to the adults. Because of their high resolution our photos can be greatly enlarged. This is a distinct advantage when searching for critical characters on the adults.

Fig. 1 A typical sampling site in the Otway Ranges showing the river bed and the UV lights set up underneath a bridge.

Fig. 2 *Caddisflies* (Trichoptera) from the Great Otway National Park. Body length in mm. *Anisocentropus bicoloratus* (Calamoceratidae), female, NMV TRI55315, 10.3 mm (upper left); *Hampa patona* (Conoesucidae), male, NMV TRI55492, 6.6 mm (upper centre); *Apsilochorema gisbum* (Hydrobiosidae), male, NMV TRI55491, 8.2 mm (upper right); *Asmicridea edwardsi* (Hydropsychidae), male, NMV TRI55459, 8.5 mm (lower left); *Hydrobiosella gibbera* (Philopotamidae) (lower centre); *Tasimia palpata* (Tasimiidae), male, NMV TRI55431, 6.5 mm (lower right). The NMV codes are the registration numbers of the specimens.

At several of our sites we have samples from every month of the year. These data will enable us to investigate the timing of emergence and the length of the life cycles of the caddisfly species. Such biological data may be invaluable in determining the effects of disturbances on this fauna. We also have photos of adult mayflies and stoneflies of the Otways. There appear to be fewer photographic features for these taxa that are useful for distinguishing species, but this opinion may change with further work.

Bushfires appear to have had little long-lasting effect on the diversity of EPT taxa in the Otway Ranges. However, we have yet to examine compositional differences between sites with different fire histories. We hope that producing a photographic key to the adult caddisflies will enable such assessments to be made in the future with greater ease.

Details of our initial work on this project during the 2018-2019 Otway Bioscan, including a short video describing our techniques, can be viewed here.

The final report arising from the Otway Bioscan, including additional information and images of all EPT taxa sampled, can be downloaded here.

https://museumsvictoria.com.au/

https://doi.org/10.5281/zenodo.4889830

Table 1. Caddisflies collected in the Great Otway National Park from October 2018 to April 2021. The number of species collected, and the number of rivers where each family was encountered are shown. A total of 17 rivers were sampled.

Family	No. of species	No. of rivers
Atriplectidae	1	10
Calamoceratidae	2	6
Calocidae	2	5
Conoesucidae	6	10
Ecnomidae	5	9
Glossosomatidae	2	7
Helicophidae	1	3
Helicopsychidae	2	5
Hydrobiosidae	9	12
Hydropsychidae	2	9
Hydroptilidae	>1	5
Kokiriidae	1	1
Leptoceridae	16	13
Limnephilidae	1	3
Odontoceridae	1	3
Philopotamidae	2	6
Philorheithridae	6	9
Polycentropodidae	2	8
Tasimiidae	2	5

LIMNOLOGY AROUND THE WORLD: ITALY

Limnological research at the Science Museum of Trento: Biodiversity of extreme environments

Valeria Lencioni
Chief-Curator of the Invertebrate Zoology and Hydrobiology Department,
Science Museum of Trento, Italy
Email: **valeria.lencioni@muse.it**

Most people are under the impression that entomologists working in a Natural History Museums spend their time managing dusty collections of insects, organizing events for class trips and the general public, teaching natural sciences to young students or working on exhibitions. Nowadays Natural History Museums are institutions dedicated to the documentation, protection, exploitation and valorization of natural and cultural diversity where entomologists in particular are at the forefront of environmental research. At least this is the mission of the MUSE, the Science Museum of Trento (Italy), previously Museo Tridentino di Scienze Naturali, the first museum in Italy that harmoniously blends nature, science and technology.

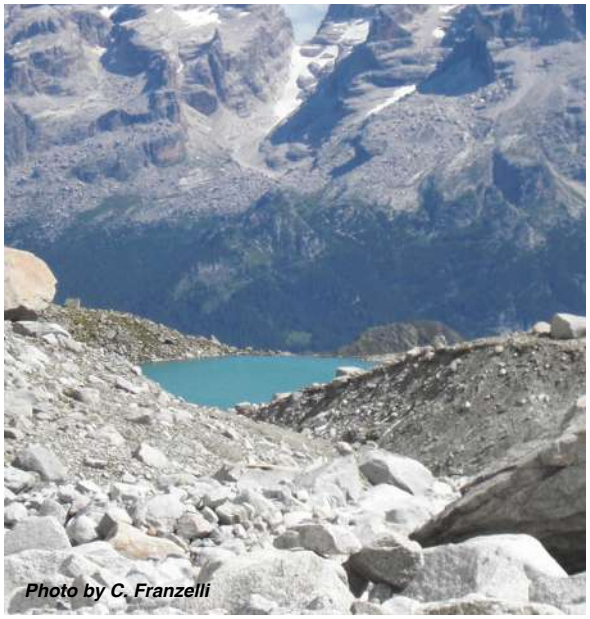

Fig. 1 Vedretta Lake (2600 m a.s.l.), Trentino, Italian Alps.

Fascinated by extreme habitats, with a background in limnology gained during my Masters' thesis twenty-five years ago I started to study the ecology of headwaters (springs, lakes and streams) in glaciated areas of the European Alps (Fig. 1), the Arctic (Fig. 2) and the Karakorum (Fig. 3), in Asia. A great adventure started at the Museo Tridentino di Scienze Naturali that offered a stimulating, smart and creative environment for young researchers, giving me the possibility to satisfy my curiosity of nature and passion for mountains, aquatic habitats and insects.

Within a team mainly represented by women, I climb peaks and glaciers to study the macroinvertebrate communities living in cold waters, from springs to ponds, lakes and streams (Fig. 4). Specifically, my main focus is on morphological, physiological, phenological and genetic adaptation to cold in chironomids (Diptera Chironomidae), the most frequent and abundant taxon living in glacier-fed streams and other high altitude and latitude freshwater habitats, today threatened by extinction by climate change and pollution. Within the scenario of climate change, my attention has been devoted to studying the vulnerability and response of benthic communities to glacier retreat and the associated reduced discharge, increasing water temperatures and pollution. Changes in glacial biodiversity with an emphasis on macroinvertebrates, are approached holistically, with studies ranging from single genes to ecosystems. It is becoming increasingly clear that glaciers are a secondary source of pollution for the freshwaters they feed, acting as a temporary sink for many organic and inorganic pollutants that have been transported by the atmosphere from medium to long distances. Long-term studies coupled with experimental laboratory data are showing that wild populations of insects are suffering with evidence of local extinction of the most specialized cold hardy species such as *Diamesa steinboecki*, the "ice fly" and other Diamesa species (Fig. 5).

Fig. 2 Bayelva glacier-fed stream (Svalbard Islands, Spitzbergen)

Specimens of this and all the cold hardy species collected in the Alps, Arctic and Karakorum are preserved in the MUSE's collections. Unlike universities and other public or private research and monitoring institutions, the museum stores collected organisms or parts of them (e.g. DNA vouchers) and therefore they remain available for studies of biogeography, ecology, and systematics to researchers of today and tomorrow. For instance, the MUSE maintains the biggest Italian collection of glacial insects, with over 800,000 specimens collected since 1996 (90% in ethanol and the rest as microscopic slides or pinned specimens) which will also be useful in the future in reconstructing the effects of today's environmental changes on biodiversity of mountain freshwaters.

The results of all our research activities find space in museum rooms and have been inspiring science cafés, interviews and workshops, to discuss sensitive issues like pharmaceutical pollution in running waters and to encourage sustainable behavior and environmental management.

Being a researcher in a Natural History Museum like MUSE gives me the opportunity to interact with other scientists, but also non-academic stakeholders and citizens through cutting-edge communications media. Museums offer a physical space that is ideal for knowledge transfer that is rooted in scientific research centered on documenting nature and its changes, but spreads its branches not only to the local community where research is conducted, but to all interested in biodiversity and the challenges it faces.

Fig. 3 Rakapochi Glacier, Bagrot Valley, Karakorum, Pakistan, taken from an altitude of 4500 m a.s.l.

Some Recent Publications

Lencioni V, Rodriguez-Prieto A, Allegrucci G. 2021. Congruence between molecular and morphological systematics of Alpine non-biting midges (Chironomidae, Diamesinae). Zoologica Scripta 50(4): 455-472.

Lencioni V, Franceschini A, Paoli F, Debiasi D. 2021. Structural and functional changes in the macroinvertebrate community in Alpine stream networks fed by shrinking glaciers. Fundamental and Applied Limnology 194(3): 237–258.

Lencioni V, Bellamoli F, Paoli F. 2020. Multi-level effects of emerging contaminants on macroinvertebrates in Alpine streams: from DNA to the ecosystem. Ecological Indicators 117: 106660.

Bernabò P, Viero G, Lencioni V. 2020. A long noncoding RNA acts as a post-transcriptional regulator of heat shock protein (HSP70) synthesis in the cold hardy *Diamesa tonsa* under heat shock. PLoS ONE 15(4): e0227172.

Lencioni V. 2018. Glacial influence and stream macroinvertebrate biodiversity under climate change: Lessons from the Southern Alps. Science of the Total Environment 622: 563–575.

Lencioni V, Jousson O, Guella G, Bernabo P. 2015. Cold adaptive potential of chironomids overwintering in a glacial stream. Physiological Entomology 40: 43–53.

Lencioni V, Spitale D. 2015. Diversity and distribution of benthic and hyporheic fauna in different stream types on an alpine glacial floodplain. Hydrobiologia 751: 73–87.

https://www.muse.it

https://doi.org/10.5281/zenodo.4889854

Fig. 4 Sampling of adult chironomids at the front of the Agola Glacier, Trentino, Italian Alps (2596 m a.s.l.) by the author.

Fig. 5 *Diamesa zernyi* adult on the snowpack.

LIMNOLOGY AROUND THE WORLD: KENYA

Limnological research work at National Museums of Kenya (NMK)

John Kochey Kipyegon[1] and Joylene Kanyaris[2]
[1]Senior Research Scientist - Invertebrate Zoology Section, National Museums of Kenya
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Fig. 1 Field sampling in various Kenyian aquatic habitats

The National Museums of Kenya (NMK) is a multidisciplinary institution whose mission is to promote the conservation and sustainable utilization of national and cultural heritage through generation, documentation and dissemination of research and collection management knowledge, information and innovations for the benefit of Kenya and the world. The Directorate of National Research and Repository (DNRR) is the research arm of NMK which is vested with the core function of conducting research on the natural heritage of the country as well as collecting and managing the national scientific reference collection.

At NMK our aquatic research work focuses on limnology and marine studies with special emphasis on taxonomy, molecular genetics, ecology and aquaculture of fish, aquatic macro and micro-invertebrates and macrophytes/algae and linking communities with biodiversity research. Fig. 1 shows some field sampling in various habitats. We have a passion for aquatic biodiversity research and conservation based on our academic backgrounds. Dr. Kochey has a Bachelor of Science degree in Fisheries (1998), MSC in Aquatic Ecology (2013) and Ph. D in Natural Science-Molecular Biology-Aquatic from J.W. Goethe-University Frankfurt/main, Germany (2018). Ms Joylene has a Bachelor of Science in Botany and Zoology and MSC in Biology, specialization in Human Ecology from Vrije Universiteit Brussels, Belgium.

At NMK we are involved in many limnological research activities across the diverse aquatic environments of Kenya and also globally with a view to documenting species distribution and diversity. Ongoing and recent projects include: Population and conservation status of the endemic and endangered freshwater crab in Lake Chala in Kenya-Tanzania supported by Mohammed Bin Zayeed species conservation (MBZ) grant 2020; the study of natural diet of the fresh water prawn genus *Macrobrachium* for informed aquaculture initiatives and potential use of these prawns in biocontrol of schistosomiasis disease vector snails in Kenya supported by WIOMSA-MARGI grant 2021; Mapping the aquatic biodiversity of the upper Tana river catchment in Kenya supported by The National Conservancy (TNC); Aquatic biodiversity of Mt. Elgon and Cherangani hills in Kenya collaborative project under Kunming Institute of Zoology China (KIZ)/SAJOREC- Chinese Academy of Science; Ecological monitoring of large scale water abstraction/impoundment project: the Northern Collector Tunnel Phase I (NCT) in Aberdare slopes Muranga county; Mapping of disease vector snails in Kenya: Mwea rice fields in Kirinyaga county, Lake Ol Bollosat in Kenya, Upper river Tana Catchment among others.

Past collaborative international projects we are involved with include: Evolution of biodiversity of lake Malawi; DOI 10.1007/s10750-013-1705-4; DOI 10.1007/s10750-017-3292-2; http://rolschultheiss.weebly.com/uploads/2/1/1/3/21138208/field-school_impulse_02_13.pdf; The Mara Project in Kenya; Aquatic macro-invertebrates and fish the River Mara basin organized by Yale University USA (Cary Institute of Ecosystem studies) funded by the National Science Foundation; https://mara.yale.edu/news/food-web-short-course.

We also curate databases of NMK scientific specimen collections as a way of sharing data with other users which is an ongoing activity: Examples include: Occurrence data of some freshwater crabs housed at NMK. Species checklist of fresh/brackish water prawns genus Macrobrachium in Kenya.

We are also involved in fisheries aquaculture activities. https://www.was.org/meetings/ShowAbstract.aspx?Id=136037. https://hds.hebis.de/ubffm/Record/HEB440405319

Other limnological monitoring surveys include updating the biodiversity Ol Al Nyiro Nature conservancy in Laikipia Kenya c/o Kuki Gallmann Memorial foundation.

In light of the above Limnological activities, we encourage joint collaborative networks with like-minded international SIL members/peers to build synergies for informed conservation of freshwater biodiversity and habitats.

https://www.museums.or.ke/

https://doi.org/10.5281/zenodo.4889847

LIMNOLOGY AROUND THE WORLD: JAPAN

The Lake Biwa Museum – a window into the geology, history and life of an ancient Japanese lake

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Lake Biwa, located in a monsoon area in east Asia, is the largest lake in Japan, with a surface area of 670 km^2, and a maximum depth of 104 m. Lake Biwa is divided into two basins – the wide and deep north basin, and the narrower and shallower south basin. The surface area and mean water depth of the north basin are 618 km^2 and 43 m and those of the south basin are 52 km2 and 4 m, respectively. Lake Biwa is classified as one of the world's few 'ancient' lakes, with the current north basin forming about 400 000 years ago. More than 1700 species of animals, plants, and protists have been reported from the lake, some 60 of which are endemic species/subspecies. More than 450 rivers and streams flow into Lake Biwa, but there is only one natural outlet, the Seta River (Setagawa). The outflow from Lake Biwa is controlled by the Setagawa weir located on the river, and is carefully managed as even small changes in water levels of the lake are critical in shaping the littoral habitats and spawning sites of native fish (Mizuno et al. 2010, Fujioka et al. 2013).

The Lake Biwa Museum (LBM) was established in 1996, with a theme of "Lakes and People". It aims to comprehensively cover the natural history and culture of Shiga Prefecture, the area of which is almost identical to the catchment area of the lake, and provide exhibitions and experience programs that will entice visitors to explore the local area. The LBM is a Shiga prefectural research institute with as many as 30 research scientists with different specialties belonging to three research groups: Cultural History and Geoscience, Biotic and Human Interactions, and Museum Studies. Owing to the diversity of researchers' specialties, research at LBM is wide ranging and interdisciplinary, dealing with a variety of aspects related to the lake and its catchment area. Many limnological projects on the lake are carried out utilizing our research boat *Umindo* (Fig. 1).

In 2020, the LBM completed a comprehensive six-year long renovation, and the results of our research and other museum activities are incorporated into the renewed displays in the four major exhibition rooms. In the Geological History exhibition room, covering the origins of the lake, the local geology and past environments, the most outstanding exhibit is a replica of a 4 m tall elephant, closely related to an extinct species that used to live in the area - viewed from one side, the skeleton is visible, from the other, the body is reconstructed. The Human History exhibition room showcases research on people's lifestyles in the past, traditional fishing methods and irrigation techniques, and historic flooding events (the highest was in 1896, with a water level of +3.76 m). A large traditional wooden cargo boat, with a design unique to Shiga Prefecture, relates how the lake used to be a major transport route. The Nature Connecting with our Lifestyles exhibition room takes an in-depth look into the lake today, its surrounding landscapes, and how humans have changed the lake and habitats. For example, one display shows how water use in the Lake Biwa catchment area has changed in the last 120 years (Fig. 2). An old rural house, which was donated to the museum, shows how life in Japan has dramatically changed since the 1960s, and how this has affected the lake. The last exhibition room or the LBM's Aquarium (Fig. 3), is one of the largest freshwater aquariums in Japan. It features many aquatic species living in and around the lake, such as the giant Biwa catfish, and many Japanese endangered fishes, carefully conserved in captivity in the LBM. Other ancient lakes in the world, such as Lake Baikal and Lake Tanganyika, are also featured. The Micro-Aquarium section displays some of the micro-fauna and flora living in the lake with the aid of microscopes, highlighting the role that these tiny species play in the ecosystem of the lake. In addition, there are two Discovery Rooms, one for children and another for adults, with hands-on exhibits and specimens that can be handled and studied. In the LBM's grounds, visitors can stroll passed reconstructions of ancient

Fig. 1 *Umindo,* the research boat of the LBM

Fig. 2 Exhibition showing changes in water use

forests, observe the tree canopies from the Treetop Walk, and enjoy an expansive view of Lake Biwa. Every year, a thematic special exhibition introduces visitors to topics about natural science or culture, organised around the research specialty of one the LBM's research scientists.

The LBM also strongly supports citizen science activities. These activities are open from children to seniors, across all generations. There are two systems that people can join, the most well-known one, *Hashikake*, consists of 26 different groups, while there are also the *Field Reporters*. These two systems are operated mainly by citizen members with advisory assistance of the research scientists in the museum. Some research results coming from these systems have become published research papers and reports.

The LBM has cooperation agreements with some other museums and institutions that have a joint interest in aquatic environments, such as the Nakdonggang National Institute of Biological Resources in Korea, and Baikal Museum of the Siberian Branch of Russian Academy of Science. Through the agreements, joint activities, such as seminars and exhibitions, have been held, and specimens are exchanged for research and exhibits.

If you have a chance to come to Japan, we warmly welcome you to the LBM! Find out more at www.biwahaku.jp/english. You can also read about Lake Biwa in the recent book (2014) *Lake Biwa Guidebook*. Shiga Prefecture, Otsu.

Fig. 3 The tunnel tank of the Aquarium, representing the off-shore habitat of Lake Biwa

Acknowledgments

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https://www.biwahaku.jp/

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Photo: Lake Biwa Japan

LIMNOLOGY AROUND THE WORLD: UNITED STATES

The St. Croix Watershed Research Station

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The St. Croix Watershed Research Station (SCWRS) is the environmental research institute of the Science Museum of Minnesota, the largest public exhibit museum in the Upper Midwest (U.S.A). Founded in 1989 as a field research station along the shoreline of the St. Croix River, it has since grown into a world class analytical laboratory and center for aquatic research. We are a small team of scientists with expertise in aquatic ecology, paleolimnology, and hydrology who work at the interface between land and water.

In addition to the basic research produced by our scientists, our laboratories provide biological and chemical analyses for partners and collaborators around the world. The radiometric laboratory, founded by Daniel Engstrom (retired), and now overseen by Adam Heathcote, is one of the most active lake-sediment dating laboratories in the world. To date, more than 1,500 sediment cores have been dated by a combination of the radio-isotopes ^{210}Pb and ^{137}Cs spanning every continent on Earth. These dating techniques have been critical to the proliferation of paleolimnological studies that examine the impact of anthropogenic activities and contaminants to aquatic ecosystems. The microscopy laboratory, overseen by Mark Edlund, specializes in the identification and enumeration of siliceous algae (diatoms and chrysophytes) used as bioindicators in both paleo- and neo-limnological applications. Dr. Edlund and the lab are leading contributors to the Diatoms of North America taxonomic reference website (diatoms.org) and have described over sixty new diatom species based on work at SCWRS (Fig. 2).

Our scientists are currently studying some of the leading threats to aquatic ecosystems from as far away as Greenland and Mongolia to right in our backyard along the St. Croix River

Fig. 1 SCWRS scientists sampling water quality on Lake of the Woods (Minnesota, USA) as part of a decade long collaboration between state, federal, tribal, and international agencies to determine how to best manage this ecologically and economically important water body.

As part of a non-profit museum, our research focus has evolved as we have grown and the research expertise of our staff has broadened. The mission of our museum, "Turn on the science: Inspire learning. Inform policy. Improve lives", guides our research program and allows us to work with a diverse set of stakeholders that are concerned about the environmental condition of our aquatic resources. This includes working with state, federal, indigenous, and international agencies to provide the science needed to make the best management decisions possible (Fig. 1), and critically, delivering the results of that science to the public in an accessible fashion as an independent and respected scientific education institution.

(Fig. 3). Our work is centered on doing the science most critical to protecting our lakes and streams and, importantly, as a museum we focus on how to best communicate these results in ways that are accessible to the broader public. This includes everything from interfacing with social and traditional media to helping produce exhibits on our museum floor. As a museum set in one of the most lake-rich regions of the United States, we are always looking for new ways to showcase the aquatic sciences to the public and you can follow our outreach efforts at @sciencemuseummn and @scwrs_mn on Twitter.

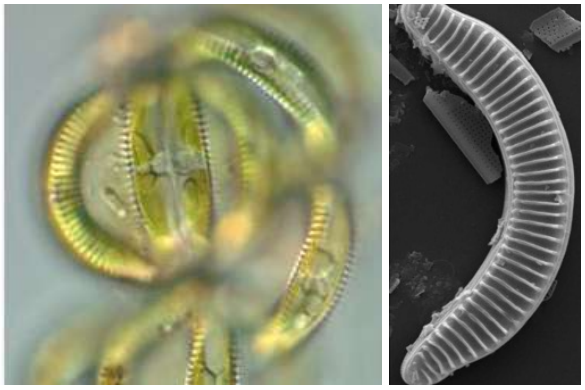

Fig. 2 A living colony (left) and a single valve (right) of ***Semiorbis eliasiae***, a new species of diatom recently described by SCWRS scientists and collaborators (Edlund et al. 2021) and found in a long-shore embayment of Lake Superior's Apostle Islands National Park (Outer Island, Wisconsin, USA).

Fig. 3 (Top) SCWRS scientist Adam Heathcote and students from Newcastle University (UK) mapping a remote lake in Southwest Greenland as part of an international expedition measuring the effects of climate change on lakes. (Bottom) SCWRS scientists collecting a piston core from Bad Medicine Lake (Minnesota, USA) as part of a paleolimnological study to look at the effect of introduced fish species on lower trophic levels.

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https://www.smm.org/scwrs

https://doi.org/10.5281/zenodo.4889852

Tonolli Memorial Award

The Tonolli Fund of SIL was created in 1985 through a bequest from Vittorio and Livia Tonolli, well known limnologists at the Istituto Italiano di Idrobiologia in Pallanza, Italy. The purpose of the fund is to provide assistance to young limnologists in developing countries and encourage them to join SIL. Information about the fund can be found at **LIMNOLOGY.ORG/tonolli-memorial-award.** Below are two reports from recent Tonolli Fund recipients.

Argentina

Shallow lakes from the Salado River basin (Buenos Aires, Argentina): effects of anthropogenic activities

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Shallow lakes are the predominant aquatic ecosystems in the Pampa Region, playing an important role in local economies by providing ecosystem services such as irrigation, recreation and fishing. These water bodies are naturally enriched in nutrients (Quirós and Drago, 1999), although in the last years some have begun to change from a eutrophic to hypertrophic state due to nitrogen and phosphorus discharges related to human activities (Portela *et al.,* 2009). Besides, these lakes are located in a lowland river basin, so they are affected by runoff from agriculture and other pollutants (Vera *et al.,* 2010), causing an overall deterioration in water quality and ecosystem services.

The Salado River basin is located in the centre of the Pampa Region, one of the most productive areas of Argentina. The aquatic environments associated with this basin are strongly affected by a high heterogeneity in land use. In particular, the upper basin is characterized by agricultural use (soybean-corn-wheat rotations) with high requirements of agrochemicals; while the lower basin is characterized by livestock and pastures (Gabellone *et al.,* 2005). These differences between basins affect the phytoplankton (Sánchez *et al.,* 2021) and bacterioplankton (Nuozzi *et al.,* in prep.) community compositions. Here, our main objective was to characterize land use in the areas surrounding shallow lakes throughout the Salado River basin, in order to disentangle its effect on water quality and sanitary state of these water bodies.

In October 2019 we sampled 15 shallow lakes (24 sampling points) from the headwaters to the mouth of the Salado River. All water bodies were connected to the river and presented different levels of anthropogenic impact. We also included a wetland with less anthropogenic impact located near Campos del Tuyú National Park (Ramsar site), as a control (Fig. 1). Environmental and biological variables were assessed for each sampling point (Secchi disk transparency, temperature, dissolved oxygen, pH, conductivity, turbidity, organic and inorganic suspended solids, soluble reactive phosphorus (SRP), ammonium, dissolved organic carbon, chlorophyll-a). We also quantified atrazine concentrations and fecal indicator bacteria *(Escherichia coli)* to evaluate the water quality and sanitary state of these aquatic ecosystems. Land use in the 1 km zone around each shallow lake was categorized as agriculture, livestock, urbanization and wetlands using public geospatial information (de Abelleyra *et al.,* 2019).

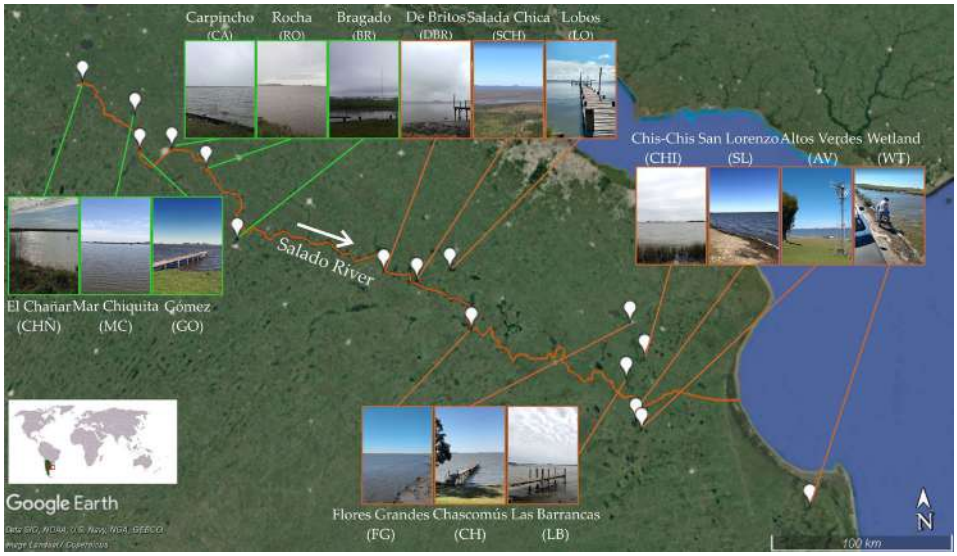

Fig. 1: Map depicting the 14 shallow lakes and the wetland selected for the study. The Salado River is highlighted in red, the upper basin lakes in green and the lower basin lakes in orange. Lake name abbreviations are written in parentheses.

Statistical analysis of the data separated lakes into the upper and lower basins. The main distinguishing factors were atrazine, agriculture and SRP for the upper basin and livestock for the lower basin including the wetland (Fig. 2). Agricultural land use was positively correlated with atrazine and SRP and negatively correlated with dissolved oxygen. The same variables showed opposite correlations with livestock. The wetland showed no agriculture use and undetectable atrazine concentrations; however it was affected by livestock activities.

Indicator bacteria, such as *E. coli* surprisingly did not correlate with any variables. However, in some lakes, the *E. coli* levels were above the limits established for recreational waters (US EPA, 1986). Concentrations of the herbicide atrazine exceeded the reference levels associated with chronic toxicity for phytoplankton communities (Pratt *et al.,* 1988) only in one lake.

In conclusion, anthropogenic activities in this basin affect not only water quality and the sanitary state of the shallow lakes, but also the ecosystem services they provide. Even so, we are unaware to what extent this affects the upper levels of the food-web of these lakes. Our results support the hypothesis that the upper basin is under more anthropogenic pressure due to higher concentrations of SRP and atrazine as a consequence of land use tied to agriculture. The fact that *E. coli* was not correlated with any other variable suggests that the presence of this fecal indicator bacteria is related to point discharges of untreated sewage. Altogether, this creates a situation of great concern for both ecosystems and human health, as these shallow lakes are used for recreational purposes and provide many other ecosystem services. In further studies we will test the effect of land use on bacterioplankton communities throughout the entire Salado River Basin shallow lakes.

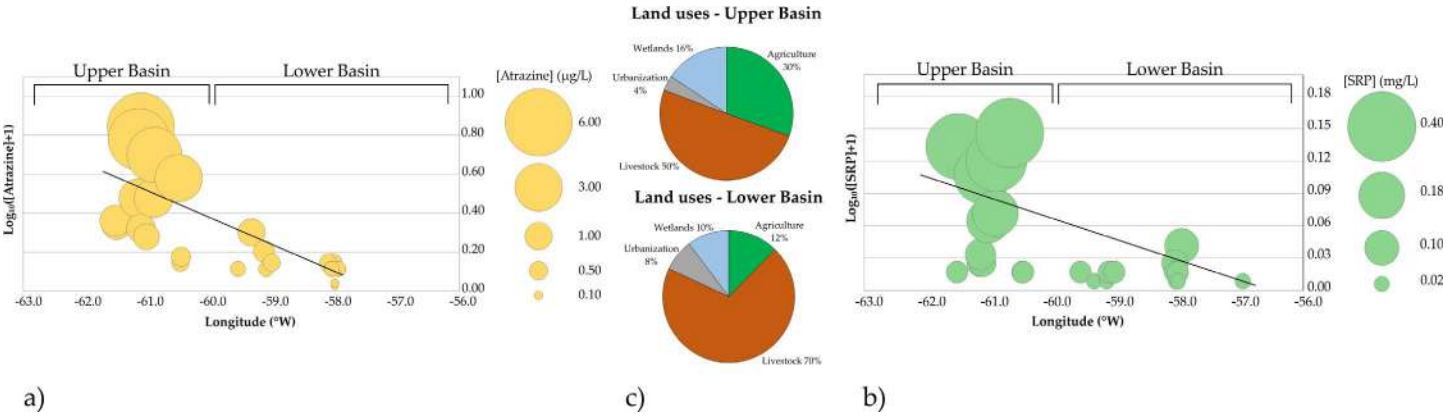

Fig. 2: a) Bubble scatter charts of changes in atrazine concentrations relative to longitude and b) SRP concentrations relative to longitude; c) pie chart land use (agriculture, livestock, urbanization and wetlands) for upper and lower Salado River basins

Romina Schiaffino, Guillermina Nuozzi and Mara Sagua. Photo by Daniel Bea

Our study will help policy makers to formulate knowledge-based decisions and to recommend more effective models of protection, management and restoration of these valuable aquatic environments.

Acknowledegments

Mara Sagua and Romina Schiaffino would like to thank SIL for both Tonolli awards (2019 and 2016 respectively). Funding for this research was also provided by FONCYT and UNNOBA (PICT 2017-0891, SIB 2019-0575, PICTO 2019-0006)

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India

Reduction in cladoceran taxonomic and functional diversity after restoration of a shallow urban reservoir in India.

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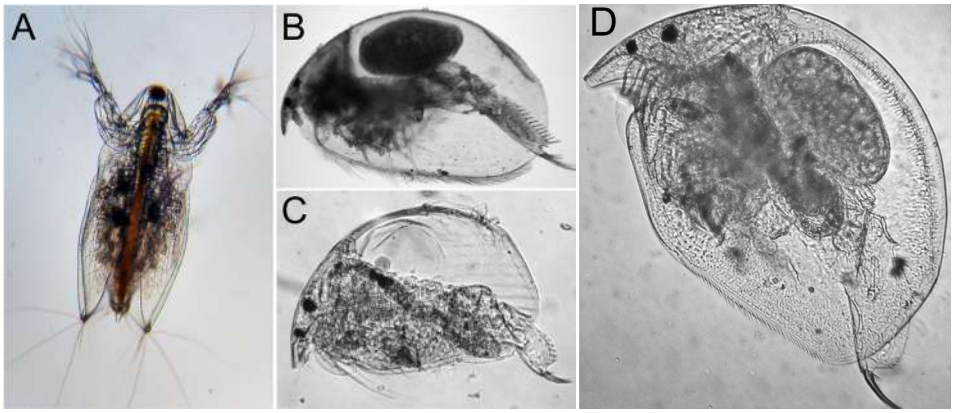

Fig. 2: A-D: Some of the cladoceran species found in the early phase of the collection. A. *Latonopsis australis;* B. *Oxyurella singalensis;* C. *Coronatella rectangula;* D. *Leberis punctatus.*

Worldwide, anthropogenic disturbances are decreasing species and functional diversity of various ecosystems including aquatic biomes (Carpenter et al. 2011). Small freshwater reservoirs are commonly created in or around urban regions as sources of potable/usable water, and recreational and/or aquaculture spaces. Additionally, they act as buffers against environmental fluctuations and serve as biodiversity reserves (Jurzcak et al. 2019). Due to the land-use patterns in their surroundings, they often face disturbances like structural modifications, extrinsic nutrient loading, high siltation and inorganic pollution, which trigger undesirable phenomena such as eutrophication and algal blooms. Such deteriorating health of these habitats prompts implementation of restoration measures, which are often undertaken without proper ecological assessment, and can in turn aggravate the situation. Studying the impacts of restoration activities on the local biota is important, although such studies are lacking from India.

We conducted this study to explore the effects of restoration on an urban reservoir in Pune city, India, specifically analyzing the changes in community composition of Cladocera at the taxonomic and functional levels.

Pashan Lake (18°31'59"N; 73°47'18"E) is situated south-west of Pune City, India (Fig. 1A, B), formed due to the damming of a small river (Ramnadi) in the early 1900's. There has been a sustained increase in urbanization around the lake periphery over the years, leading to severe eutrophication of the reservoir. The subsequent restoration work was carried out between 2008-2013 which included de-siltation, re-contouring, construction of a retaining wall and an artificial island etc. (Yardi et al. 2019 for details). Prior to this intervention, the lake had a rich diversity of habitats and biota, ranging from macrophytes and aquatic invertebrates to birds. Post restoration, the lake surface was covered entirely by *Pistia* and *Eichornia* species (Fig. 1C).

We collected zooplankton from Pashan reservoir during 2009/2010 as part of a larger survey, following a qualitative sampling of multiple sites in the littoral/sub-littoral regions using hand and tow nets. Following a similar strategy, we sampled the reservoir in 2016. Based on the phases of restoration, we categorized the samples into 'early' (2009-2010) and 'late' (2016) phases and screened and identified the cladocerans using the latest taxonomical keys. We analyzed the difference in cladoceran species composition using incidence data and used functional traits data (Rizo et al. 2017) to calculate the functional composition, richness and redundancy for both the phases.

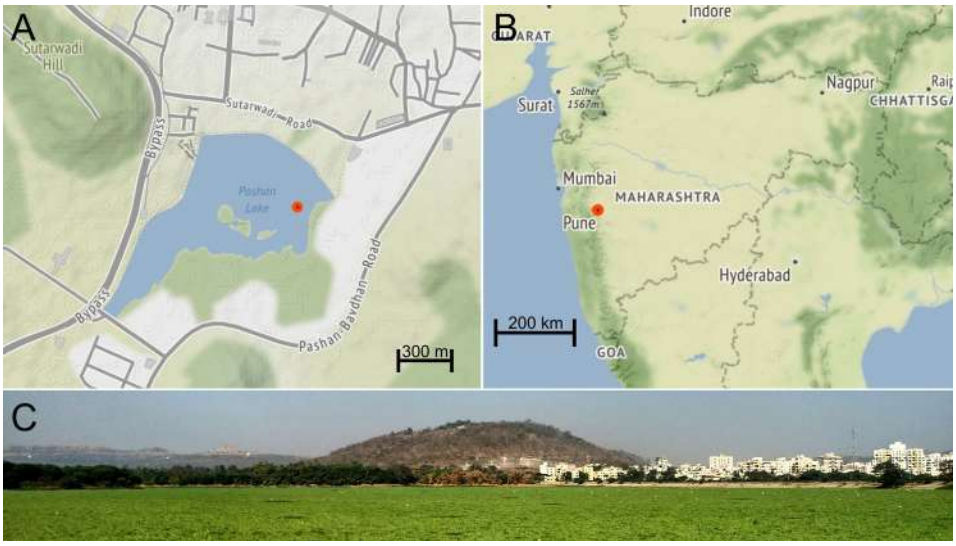

Fig.1: A-B: Pashan water reservoir location; C. Pashan lake in the late phase (2016).

A significant taxonomic reduction, both of Cladoceran species and families, was seen from the early phase to the late phase (28 species in early phase, 9 species in the late phase). Species like *Oxyurella singalensis* Daday, 1862, *Coronatella rectangula* Sars, 1862 s.lat. and *Leberis punctatus* Daday, 1898 (Fig. 2) were observed only in the early phase while locally common species like *Ceriodaphnia cornuta* Sars, 1885 s.lat. and *Moina micrura* Kurz, 1874 were seen in both the phases. In addition, functional groups, Functional richness and redundancy were also significantly reduced from the early to the late phase.

Our observations on the cladoceran fauna in the two phases indicated an alteration of community composition driven entirely by species loss, leading to a decrease in functional diversity. This could have occurred due to a combination of factors including a) alteration of habitat structure (e.g. topographic changes, destruction of habitats), b) removal of aquatic macrophytes, c) removal of egg banks, d) fish introduction and e) increased levels of untreated sewage. These impacts also showed a loss of regionally rare species from the late phase community, a characteristic of biotic homogenization which has been observed in urban habitats facing multiple stressors (Rahel 2002). These data highlight the importance of ecologically informed strategies for urban habitat restoration.

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HUGO SARMENTO | BRAZIL

I am an aquatic ecologist, Professor at the Universidade Federal de São Carlos (UFSCar) in Brazil, head of the Laboratory of Microbial Processes and Biodiversity (LMPB). Originally from Portugal, I graduated in Biology (University of Minho), and moved to Belgium where I did my PhD under the supervision of Jean-Pierre Descy at the University of Namur, Belgium. There, I had the unique opportunity to study plankton ecology in the East African Great Lakes while working on several projects in temperate lakes, related to water quality and the implementation of the European Water Framework Directive in Belgium and France. I was also a posdoc at the Institut del Ciències del Mar (CSIC – Barcelona) and at the Universidade Federal do Rio Grande do Norte (Natal, Brazil). I am member of the editorial board of Freshwater Biology, PeerJ, Limnology and Oceanography Letters, and ISME Communications.

In our lab we investigate the life of aquatic microbes in the tropics. We study the ecology, biotic interactions, structure and function of the aquatic microbiome, mainly in tropical regions. Our research involves field studies, but also laboratory and field experiments, addressing microbiome driven ecological processes.

Brazil harbors amazingly vast and pristine aquatic resources in totally different biomes, such as the Amazon or the Pantanal. In that sense, there is still a lot to explore here! On the other hand, while most developed countries have improved their water quality during the last decades, in Brazil (and most developing countries) the water quality curve is still on its way down.

SIL should further support the participation of researchers (especially students) from southern countries in all societal activities.

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BRIAN DOYLE | IRELAND

I am currently in a state of blissful lethargy having recently submitted my PhD thesis! My studies were conducted through the Centre for Freshwater and Environmental Studies at Dundalk Institute of Technology, and the Irish Marine Institute. The title of my thesis was 'Resolving the organic carbon budget of a humic, oligotrophic lake in the west of Ireland' and the focus of my research was Lough Feeagh, a freshwater lake in Co. Mayo on the Irish Atlantic coast. The lake and its surrounding peatland catchment is an important index site for diadromous fish monitoring and long-term environmental observation of catchment change. Lough Feeagh has been a monitoring site for fisheries research since the 1950's and automated monitoring equipment has been deployed throughout the catchment since the mid 1990's. My research goal was to quantify the organic carbon flux within the many components of the aquatic carbon cycle of the lake. Inputs included allochthonous carbon from surface water, groundwater and atmospheric deposition, outputs included outflow and burial. Organic carbon is also created and removed from the lake by autochthonous primary production, respiration and photolysis.

Studying my PhD was an amazing and transformative experience for me. I feel very lucky to have had the chance to study a project in limnology, where so many separate scientific disciplines merge together. My studies also involved a number of collaborations, a process I thoroughly enjoyed. As a new member of SIL, I hope to continue in the future. Roll on the next scientific adventure!

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VERONA NAVA | ITALY

I become interested in limnology during my Bachelor's and Master's degrees in Environmental Sciences. I studied different intriguing subjects and it was challenging to decide where to focus but I soon discovered that in limnology it is possible to integrate so many aspects that you never get bored!

I am currently a third-year PhD student at the University of Milano-Bicocca (Italy). I am studying how different anthropogenic stressors affect freshwater ecosystems. In particular, my research focuses on microplastics, tiny plastic particles that are receiving increasing attention. Studies about these contaminants in freshwater systems are still limited, thus my research focuses on understanding their occurrence and distribution in lakes and rivers with different anthropogenic impacts. Besides this, I am also investigating how microplastics interact with freshwater organisms and in particular with microalgae, as fundamental components at the base of aquatic food webs.

SIL had a special role in the trajectory of my career in limnology. The conference in Nanjing was my first scientific conference. There, I had the chance to meet amazing scientists, and I found a society made of people helpful and inclusive. Besides, many opportunities arise from this conference for me. I am extremely happy to help SIL also with the management of their website, and it is amazing to see the passion and the commitment of the people involved in SIL for pressing environmental issues that are affecting freshwater ecosystems.

I am looking forward to attending the next SIL meeting and benefiting from all the opportunities that will come from this amazing society!

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MAXINE ALLAYNE DARLENE MOWE | SINGAPORE

I am an aquatic ecologist and lecturer at the National University of Singapore. My main research interest is phytoplankton and zooplankton ecology, more specifically cyanobacterial bloom ecology and impacts of eutrophication and other pollutants (microplastics) in freshwater systems. My post-doctoral research focused on the use of macrophytes for restoration of water quality while my PhD research focused on tropical cyanobacterial blooms and the effects of environmental variables on the growth and toxin production of isolated cyanobacterial strains. What I love about plankton research, is the ability to see an infinity of taxa in a small drop of lake water. The microscopic world of plankton will always be fascinating to me and the endless questions continue to drive me to find out more and motivate my students to keep exploring this field.

Singapore is a water scarce nation even though we get an annual average rainfall of more than 2,000 mm. Surface water in reservoirs is a very important source of potable water which is increasingly threatened by cyanobacterial blooms in some reservoirs. Currently, we are aware of the different cyanobacterial taxa that cause blooms in our water bodies but a deeper understanding of limiting nutrients in our reservoirs will aid in better prediction and management of cyanobacterial blooms. My experience of SIL has been enriching and I am always excited to come for conferences to share my research and gain knowledge from other scientists. SIL provides young scientists an accessible and welcoming platform to voice our views and to interact with the most prominent and experienced aquatic ecologists worldwide.

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Obituaries

Brij Gopal

1944 - 2021

Dr. Brij Gopal, former Jawaharlal Nehru University, Delhi Professor and noted river ecologist, passed away in Delhi on 4th Jan 2021. Known for his forthright and honest discussions on river and wetland stewardship and policies, Dr. Gopal left behind a legacy of wetland ecologists, scientific publications, policy statements and institutions. He was the founder and President of the National Institute of Ecology and Founder-Coordinator of the Centre for Inland Waters in South Asia.

By the time he had retired in 2009 as Professor of Environmental Science from the Jawaharlal Nehru University, New Delhi, he had worked in all aspects of ecology, biodiversity, ecosystem functioning, water quality, economic valuation, conservation, restoration and management of a variety of aquatic ecosystems from the high dry deserts of the Himalayas till the deep mangroves of the Sundarbans at the mouth of the Ganga. He examined traditional management by local communities, socio-economic aspects, climate change and developed, reviewed and critiqued policy and law in the context of integrated water resources management.

He was the first recipient of the Young Scientist Medal of the Indian National Science Academy (1974) and has been the only recipient of the Naumann-Thienemann Medal (2004) of the International Association of Limnology (SIL) from Asia, Africa and South America. He was the second Asian recipient of the International Fellow Award (1997) of the Society of Wetland Scientists. He was also a guest Professor at Zurich and Editor - in Chief, IJEES for several decades. He was one of the lead authors of the 2007 Nobel Peace Prize winning - IPCC's Fourth Assessment Report (2007). He was also a winner of the Royal Bank of Scotland, India's 'Earth Hero' award in 2018, for going beyond the call of duty in preserving the planets ecological assets.

He had a long association with INTECOL, having organized its first international conference in New Delhi, India in 1980. He was also a regular participant in SWS meetings, and active in Indian and international science and river/wetland management issues. His legacy is visible through his publications, as well as his students and the many colleagues that he mentored and supported, as well as the many lectures and conference talks that he presented.

Dr Gopal served on numerous committees related to wetlands, rivers, lakes, fisheries, forests, EIA, etc., including those of the ICAR, Planning Commission, Ministry of Environment and Forests, India, State High Court of Himachal Pradesh and the Supreme Court of India. He was Chair of Wetland Conservation and Management at the Chhattisgarh State Planning commission, and the National Green Tribunal. Recently he was a Member of the NGT appointed Principal Committee for Restoring river Yamuna, and the Ministry of Water Resources Committee on Restructuring of CWC and CGWB.

During his teaching years Dr. Gopal mentored many of students who are currently placed in eminent positions nationally and internationally. He is survived by his daughters, Sudha and Anjali, his son Rajiv, and his grandchildren.

Dr. Malavika Chauhan
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Winfried Lampert

1941 - 2021

Winfried Lampert with his flow-through systems for ecophysiological zooplankton experimentation.

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On 6 March 2021 the international community of limnologists and ecologists lost one of its most outstanding and creative personalities, Prof. Dr. Winfried Lampert.

Winfried Lampert was born 1941 in Oppeln/Opole (today Poland). He studied biology at the University of Freiburg (Germany) and completed his doctorate with a thesis on the population dynamics of whitefish in Lake Schluchsee under the supervision of Prof. Hans-Joachim Elster. Thereafter he shifted towards the study of zooplankton ecology and became a key person in establishing *Daphnia* as a model organism. After his time as an Assistant Professor at the University of Freiburg, he became University Docent (equivalent to Associate Professor) at Frankfurt. In 1980 he became Leader of an Independent Working Group at the Max-Planck-Institute for Limnology at Plön. In 1984 he became Director at the Max-Planck-Institute of Limnology and established the Department of Ecophysiology. He retired in 2006 and continued active research as a Guest Professor at the University of Bergen (Norway), but kept an office at the Max-Planck-Institute which was meanwhile converted into the Max-Planck-Institute for Evolutionary Biology. He continued to work on publications and book projects.

Winfried Lampert's work with *Daphnia* started from the motivation to explain the behavior in natural ecosystems from the physiology of nutrition. But he also included the other side in his research portfolio, the avoidance of being eaten. With his work on vertical migration of zooplankton he terminated long-lasting debates about the ultimate reason for this behavior in favor of the predator avoidance hypothesis. With his pioneering work on the clear-water-phase, a mid-season minimum of phytoplankton biomass caused by excessive grazing of *Daphnia* on phytoplankton, he laid the foundations for the entrenchment of the concept of top-down control in plankton ecology, thus making plankton ecology an integral part of a central debate of general community ecology during the 1970s and 1980s. His research was always strongly motivated by the question how the demands, capabilities and behavior of organisms in the ecosystem had been shaped by natural selection. Evolutionary questions played an ever increasing ingredient in his research and paved the way of transforming the MPI for Limnology into an MPI for Evolutionary Biology. *Daphnia* remained the core model organism throughout his scientific career. *Daphnia*'s fast and parthenogenetic reproduction permits the quick production of genetically identical experimental animals, a pre-requisite for many of Lampert's research questions. But contrary to many other "model organisms" (e.g. *Drosophila, Arabidopsis,…*), *Daphnia* plays a central role in the pelagic food web of many lakes and is, therefore, far away from being the typical white laboratory rat.

Many of Lampert's crucial findings, such as the evolutionary explanation of vertical migration, were final answers to long lasting scientific controversies and moved the topic from the battle ground of scientific debate to the domain of canonical textbook knowledge of limnology. His role in expanding the body of limnological and ecological knowledge was acknowledged by numerous awards, among others the Naumann-Thienemann Medal of the International Society of Limnology (1995), the Ecology Institute Prize in Limnetic Ecology (2006), the Winberg Medal of the Russian Hydrobiological Society (2006), and the Redfield Lifetime Achievement Award of the Association for the Sciences of Limnology and Oceanography (2012).

Winfried Lampert was not only a true pioneer in many of his scientific questions, he also developed the adequate methodology and infrastructure. Outstanding examples are the flow-through systems which permit the cultivation of zooplankton under highly defined food conditions and the 12 m high plankton towers at Plön for the study of zooplankton vertical migration. The excellent infrastructure at Plön was one of the reasons for attracting numerous scientists from everywhere in the world and making the Max-Planck-Institute an, maybe "the", international center of limnological research. However, Lampert's active attitude in inviting international guest scientists and recruiting scientific staff members from a multitude of countries was even more important in creating an international flair at Plön. He was supported in this respect by his wife Renate, who featured great hospitality during various private invitations.

We both were scientists at his Department of Ecophysiology. It was a time full of inspiration, opportunities and joy. His style of leadership would probably not be considered politically correct today. He was the rough leader of the pack, the dominant alpha animal, but at the same time he was extremely reliable, careful and loyal to his people. He offered us opportunities, inspiration, critique and challenges. We, the former early and mid-career scientists having been members of his group, had all the necessary infrastructure and full freedom for our research. On the other hand, he also expected success and had a watchful and incorruptible eye on the quality of science. He made it crystal clear to us that we have to prove ourselves in the harshness of the outside world, not only in the warmth

and security of the home institute. But he also imported the inspiration of the outside world into the MPIL by hosting numerous guest scientists from the international communities of limnology, ecology and evolutionary biology. With great joy we remember extended and inspiring discussions with Maciej Gliwicz, Sue and Peter Kilham, Bob Sterner, Jim Grover, Bill DeMott, Joanna Pijanowska, Nelson Hairston, Jim Haney, Petter Larsson, Larry Weider and many others.

As a mentor of new generations of scientists Winfried remains unsurpassed. Around 30 of his former students have become full professors or otherwise leading scientists all over the world. Who else in the field can claim such a success? Having worked in his group has been a superb starting ramp for all of us. We all will always remember him with utmost gratitude and we are proud of having been members of the pack.

A selection of W. Lampert's most influential publications

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PROFESSOR WINFRIED LAMPERT AND HIS EPOCH IN EXPERIMENTAL LIMNOLOGY

Professor Winfried Lampert passed away on 6 March 2021.
With him ended a splendid era of experimental studies in limnology.
This article is about his remarkable life journey and unforgettable contribution to the study of inland waters.

Winfried Lampert was born on 20 September 1941 in East Prussia, the city of Oppeln (modern Poland), from where his family was forced to leave to southern Germany due to the approach of the front in 1944. Before entering the University of Freiberg, Lampert had worked in the printing house of this city and forever retained an interest and respect for publishing. These qualities were brilliantly manifested in his post as Editor-in-Chief of *Archiv für Hydrobiologie*, later becoming Fundamental and *Applied Limnology*, then a Q1 journal. After graduating from the University of Freiburg, Lampert began his research at the Institute of Fisheries in Konstanz, and in 1971 he defended his PhD thesis (Lampert, 1971) on the taxonomy, biology, and population dynamics of white fish *Coregonus* in Schluchsee. It was there that Lampert first became seriously interested in *Daphnia*, which plays a crucial role in the transformation of energy from light fixing algae to fish in limnetic systems.

Quite quickly, at the age of 36, Winfried Lampert defended his habilitation dissertation on the carbon balance of *Daphnia pulex* in various environmental conditions. According to Lampert himself, such a rapid transition from ichthyology to the biology of cladocerans as the most important link in the trophic pyramid of freshwater reservoirs was facilitated by his participation in the 1972 SIL Congress, held in Leningrad under the leadership of Professor Winberg, one of the conveners of the international biological programme for assessing productivity in continental reservoirs. Winfried Lambert had always felt sincere respect and interest for Professor Winberg and for the contribution of Russian science to the study of the productivity of limnic systems. It was no coincidence that in October 2005, he accepted the invitation of the Hydrobiological Society at the Russian Academy of Sciences and took part in a report in the jubilee conference dedicated to the 100th anniversary of Winberg's birth. After, in 2006 at the Congress of the Hydrobiological Society of Russia (HSR), he was elected a foreign member of the HSR and became the first foreign laureate of the Winberg Commemorative Medal, awarded for outstanding achievements in the field of productive hydrobiology. In 1980, he organized a research group within a small institute, a former limnological station, of the Max Planck system in Plön, becoming its director in 1984 and contributing to its transformation into an international research center for experimental limnology.

He clearly understood how the advancement of limnology depended on conducting well-organized experiments to clarify and quantify the role of various factors in the functioning of complex lake systems.

After his promotion to director of Plön, Winfried Lampert went to the president of Max Planck with an unusual idea for a biologist—create a laboratory facility that reproduces conditions in a lake with controlled temperatures, migratory behaviour of organisms, quantity and quality of food, light conditions, etc. The project, called Limno Tower, was a stainless-steel pipe 11 meters high and 1 m^2 in area with cooling and heating elements, making it possible to recreate a temperature gradient similar to that found in lakes in summer, as well as a built-in a sampling system allowing to capture organisms at 30 cm intervals by micro-pumps and special traps (Lampert, 1989).

According to Lampert himself, the president of the Max Planck Society in Munich at that time was a specialist in physics. Seeing the new project, he 'made big eyes' and exclaimed: 'I had no idea that such complex and expensive devices could be used in your area' and immediately approved the project and financed the construction of two installations. 'If only I knew', Lampert later exclaimed, 'that it would be so easy, I would request the construction of not two, but four towers! And so, in order to achieve the necessary replicability of the results, we had to carry out at least two consecutive identical experiments that took much more time'. Nevertheless, even without this, the appearance of an unusual and, perhaps, the most powerful experimental instrument in limnology glorified its developer and, along with him, the entire Max Planck Institute of Limnology worldwide.

Scientists can now experimentally test and study such complex behavioral phenomena as daily vertical migrations of aquatic organisms, assess the nutritional balance of organisms in real-time, and many other aspects of limnology that previously could only be guessed at. One such guess, suggested in the 1930s by Russian professor Michael Kozhov, was the role of fish as a trigger for vertical migration of zooplankton in Baikal. What other reasons for determining vertical migration that have not been expressed in literature throughout the 20th century!

Experimental proof of Kozhov's hypothesis was obtained by Lampert's lab in Plön. Due to clonal variability and high sensitivity to changes in trophy, natural populations of *Daphnia* are rather inconvenient for experimental works. Lampert made them an ideal model for limnological experiments. The genetic polymorphism of clones was minimized by him because even in mass experiments involving tens of thousands of individuals in his laboratory, parthenogenetic offspring obtained from a single female were used—a perfectly aligned genotype! The equality of trophic conditions, which was most difficult to gain in long-time experiments, was achieved by the permanent quality of cultivation of *Scenedesmus obliquus* algae and their precise dosed supply into the flow-through vessels by peristaltic pumps at the constant rate in any number (usually 10) variants of the experimental animals being raised. Lampert also designed flow-through microsystems where conditions were monitored by their participants and highly qualified technical personnel trained by Lampert.

It is no exaggeration to say that nowhere in the world had anything like this existed to ensure high-quality experiments in limnoecology, and Plön became a Mecca for the lake plankton ecology research. M.Lynch, A. Ghilarov, B. DeMott, Z. Gliwicz, L. Weider, A. Duncan, U. Sommer, N. Jorgensen, N. Hairston, J. Pijanowska, P. Dawidowicz, P. Larsson, J. Haney, and others, whose works have largely written modern limnology, have worked here. Despite the undoubtable organizational talent that manifested itself in the creation of an exceptional research centre, Lampert himself considered his main aim as finding, attracting and supporting talented people. This search was conducted by him continuously, starting with students who from universities throughout Germany, as well as other countries of the world, sought to get their internships in Plön. Without considering the costs, many candidates were selected and invited to the Institute for a month. They were given similar small research tasks, and at the end of this period, according to the results obtained, a selected few began their careers as graduates of the Max Planck Institute of Limnology.

Lampert personally attended many scientific conferences and invited speakers to Plön, first for a short time, and then sometimes to become Institute staff that was surprisingly small and consisted of truly outstanding and productive researchers.

The core of the team has always been composed of young scientists—graduate students, PhD students, and researchers invited for several months from many countries of the world. Many hydrobiologists now actively working in science (and the hundreds of people passed through his Institute) have fond memories of the time spent in Plön as a cherished standard of scientific activity. It was considered a great honour for young researchers to be a co-author of articles with Lampert, who never agreed to simply add his name, even at the end of the list of authors, the traditional place for professors.

The complete list of Winfried Lampert's publications, (Google Scholar, 2021), contains 222 titles, as well as the number of citations to these works. For some, e.g., the PEG-model of the limnetic ecosystem (Sommer *et al.,* 1986), the number of citations exceeds two thousand, and the total number of times Lampert is cited is currently approaching twenty thousand and will undoubtedly increase over time.

One of my best articles was done in Plön, and I am especially proud that my coauthor was Winfried Lampert (Alekseev & Lampert, 2001).

I first came to Plön in 2001, when Lampert was ending his career as director; the Institute worked like a perfect clock, and it seemed that everything happened by itself. The warehouse for equipment and reagents was a self-service. Everyone used it without any approval, and the only thing that the sign on the door asked for was to write in the journal if depletion of any resource was detected by somebody. The day after the recording, as if by magic, this resource was renewed.

Lampert always arrived early in the morning engaging exclusively in writing and editorial work and did not receive anyone until two o'clock. Technicians also arrived early to set up equipment and prepare the experiments and cultures. By the time the scientists arrived, everything was ready for immediate work. Perhaps the only resource that was valued above all was the time of researchers. While no one controlled or noted the working hours of scientists, everyone who got into this Eden for experimenters understood that, unlike the biblical Paradise, the time spent in it was finite. I often stayed up late at work but almost never was the last to leave; so attractive was this world of pure science, created and supported by Lampert.

In his personal communication, Winfried was a very simple person and showed a slight self-irony, which often distinguishes outstanding people. In one of his last major works, a monograph on *Daphnia* as a model object in limnology (Lampert, 2011), he opened with an amusing story about the beginning of his work in Plön as the director. The time coincided with his son's first day at school that unpredictably turned into tears for the boy. The teacher asked the first graders what did their fathers' do? Young Lampert answered honestly: 'my dad breeds water fleas'. And the whole class, including the teacher, laughed loudly while the poor boy wept.

I happened to be at the Institute on the day Lampert officially retired. Numerous students and colleagues staged a farewell concert in his honor, and he responded with a heartfelt speech about his scientific path from student to director of the Max Planck Institute. His conclusive words to younger fellows became: 'Take all the challenges without fear and use all the chances that life offers you!'

Winfried Lampert himself followed this principle all his life, and that is why he achieved so much and so significantly changed his science—experimental limnology.

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David W. Schindler

1940 - 2021

Photo by Suzanne Bayley, wife and fellow scientist

David W. Schindler, one of limnology's most prominent and recognizable champions, passed away on March 4, 2021. During his long and prolific career spanning 6 decades, Dave is perhaps best remembered for his whole-lake experimental approaches to address questions related to eutrophication, climate change, and chemical pollutants. To those who knew him, he was also a passionate advocate for the environment, a remarkable intellect, an avid reader, a fierce debater, a hearty outdoorsman, and (perhaps surprisingly to some) a patient mentor. Importantly, he was an outstanding role model, not only for his prowess in conducting ground-breaking science, but also by demonstrating the importance of communicating scientific findings to policy makers and the public-at-large. Many politicians would prefer not to hear what he had to say, but they also knew they could not ignore him. Dave was fearless.

As he once noted: "Hassling with politicians is like playing chess with a gorilla. The game is boring, and you know you're going to win, but you have to be prepared to duck once in a while when they get angry and take a swing at you."

Dave first developed his love of lakes from his rural upbringing in Minnesota. He spent his early years dividing his time between working on his parents' farm and fishing on nearby lakes, where his early interest in lake ecosystems flourished. As a student, he began his apprenticeship in limnology in Gabriel Comita's lab at North Dakota State University, which gave him his first taste of research with an ecosystem perspective. As an outstanding student and athlete at university, Dave was awarded a Rhodes Scholarship and did his doctoral studies at Oxford University under the tutelage of Sir Charles Elton. He then emigrated to Canada, where he briefly accepted a faculty position at Trent University in Peterborough, Ontario. However, in 1968, he accepted an offer by Jack Vallentyne and the Fisheries Research Board of Canada to become the founding scientific director of the fledgling Experimental Lakes Area (ELA) in northwestern Ontario, Canada. The Canadian federal government had just recently set aside over 40 lakes for large-scale ecosystem studies on the effects of pollution on lakes and fisheries. As ELA director, he led interdisciplinary research on the effects of eutrophication, acid rain, watershed management practices, climate change, and other anthropogenic perturbations on aquatic ecosystems.

His early collaborative research on the importance of phosphorus on algal blooms brought international attention to the nascent ELA in the early 1970s. At the time, harmful algal blooms were increasing in number and frequency worldwide, and their causes were fiercely debated. One of Dave's approaches to inform the eutrophication debate was to divide a narrow section of ELA's Lake 226 with a curtain and fertilize one side with carbon and nitrogen, and the other side with carbon, nitrogen, and phosphorus. Only the side fertilized with phosphorus developed a massive algal bloom, providing clear experimental evidence of the role of phosphorus in the eutrophication of lakes. The photo became one of the most famous images in environmental sciences, broadcast internationally and reproduced in numerous textbooks, magazines, and newspapers (see inset photo). This research ultimately led to regulations to limit phosphorus as well as new technologies to remove phosphorus in water treatment, a move that improved water quality worldwide. The success of phosphorus abatement in controlling algal blooms has since become a testament to Dave's early intuitions, not just to the science of limnology, but to the improvement of water quality and to the quality of life for millions of people. In the process, Dave helped transform the science of limnology from an obscure academic discipline to a mainstream science with direct

The photo that went around the world: The eutrophication experiments led by David W. Schindler at the Experimental Lakes Area in northwestern Ontario changed how we manage algal blooms in lakes.

Dave relaxing in the Canadian wilderness – where he always seemed the happiest. Photo by Stefan Himmer

applications to public policy, human health, and ecosystem management.

He next turned his attention to lake acidification at the ELA. Once again showing a remarkable insight for emerging threats, Dave led a series of experiments to gradually acidify Lake 223 and Lake 302 at ELA to quantify the detrimental impacts of acid rain on aquatic ecosystems. In one long-term experiment, Dave and his team gradually acidified Lake 223 from a starting pH of 6.8 in 1974 to a pH of 5.1 by 1983. In the meantime, they documented the gradual collapse of the pelagic and benthic foodwebs in the acidified lake. Dave's talent for public communication was again apparent when he presented striking photos of emaciated lake trout from the acidified lake from the collapse of the foodwebs supporting them. Once his team halted the acid treatments, the aquatic communities began to rebound, showing that mitigation efforts would produce results. However, Dave's research prowess was again matched by his brilliant communication skills and his tireless efforts to explain the impacts of acidification. The 30th anniversary of the signing of the Canada-US Acid Rain Treaty occurred a few weeks after Dave died – as noted by many scientists remembering that benchmark, it was clear that his research and dogged advocacy were key to making that major agreement a reality.

Other whole lake experiments followed on a diversity of issues. Dave and his collaborators always seemed "ahead of the curve", producing convincing data on developing issues that many other scientists were only starting to appreciate. His work at ELA was instrumental in formulating ecological management policy around the world.

In 1989, Dave left the Canadian government civil service and took up a Killam Memorial Professorship at the University of Alberta in Edmonton, where his activities expanded to include, among others, the limnology of alpine lakes in the Canadian Rocky Mountains, the environmental impacts of the Alberta oilsands, and the long-range transport of persistent organic pollutants. His collaborative work in the Alberta oilsands caught international headlines when he showed that bitumen extraction and upgrading released high quantities of polycyclic aromatic hydrocarbons and metals via atmospheric deposition, despite claims by some that the oilsands region had no measurable impacts. Despite early criticisms of the research, reviews by major scientific panels supported his research conclusions, and further concluded that previous monitoring programs in the oil sands were deficient. This led to further studies, and subsequent policy changes.

Notably, much of Dave's more recent research and outreach activities focused on environmental issues linked to Canada's Indigenous peoples. With his strong commitment to social justice, and armed with an arsenal of convincing data, Dave was a formidable opponent to industries and politicians who hoped to downplay environmental issues. They knew that if Dave was not satisfied by their commitments and answers, the media would be more than willing to communicate his concerns.

Dave's research has produced over 350 peer-reviewed publications, a remarkable record for someone who has also devoted himself tirelessly to public engagements and public service to environmental causes. His long service record includes leading the International Joint Commission's Expert Committee on Ecology and Geochemistry, and the US Academy of Sciences' Committee on the Atmosphere and the Biosphere. He has also served as President of the American Society of Limnology and Oceanography, and as a Canadian National Representative to the International Limnological Society (SIL).

His list of scientific honours is too long to mention, but includes the inaugural Stockholm Water Prize in 1991 from the Royal Swedish Academy of Sciences, the Naumann-Thienemann Medal from SIL in 1989, and the 3 major research awards from ASLO, namely the G.E. Hutchinson Medal, the Ruth Patrick Award for Environmental Problem Solving, and the A.C. Redfield Award for Lifetime Achievement. Other honours include being named an Officer of the Order of Canada, Canada's highest civilian honour, Fellow of the Royal Society in both the UK and Canada, and a Member of the National Academy of Sciences (USA).

In summary, David Schindler had an unfaltering record of doing revolutionary research in directions that, in hindsight, were the most important aquatic environmental issues of his time. His accomplishments are remarkable for their diversity, their large-scale, long-term approaches to ecosystem problems, and for their extraordinary success at influencing environmental policy in Canada and internationally. We have lost an outstanding scientist, communicator, mentor, and friend.

More reading on David W. Schindler:

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