Hydrobiologia
https://doi.org/10.1007/s10750-018-3872-9

PHYTOPLANKTON & BIOTIC INTERACTIONS

Phytoplankton and its biotic interactions: Colin Reynolds' legacy to phytoplankton ecologists

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Received: 17 December 2018 / Revised: 17 December 2018 / Accepted: 20 December 2018

The 18th workshop of the International Association for Phytoplankton Taxonomy and Ecology (IAP), the first "tropical" IAP ever, the third one outside Europe, and the first one in South America, was held in Natal, Brazil, from August 27 to September 3, 2017, and its main ecological theme was the *Phytoplankton and its biotic interactions.* The taxonomic topic of the workshop was chosen based on function instead of phylogeny, and to link to the ecological theme of the workshop, the taxonomic theme was therefore centered on mixotrophic microalgae.

The IAP is much more than an international scientific society. It is a circle of friends, initially grouping because of their love for phytoplankton and then just for the pleasure to meet each other (and discuss about phytoplankton). Three of these friends, Giuseppe (Peppe) Morabito, Jaroslava (Jarka) Komárková, and Colin Reynolds passed away since our last meeting in Greece.

Production process of this volume recalls that of the first one. When that volume (Padisák et al., 1993) was almost ready, we got the sad information on Hutchinson's, the teacher of modern ecology, sudden death. Therefore, a last-minute change was done to honor his memory and the preface of that volume was titled the

Guest editors: Hugo Sarmento, Irina Izaguirre, Vanessa Becker & Vera L. M. Huszar / Phytoplankton and its Biotic Interactions

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10750-018-3872-9) contains supplementary material, which is available to authorized users.

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Published online: 24 January 2019

"Hutchinson's heritage: the diversity-disturbance relationship in phytoplankton" (Sommer et al., 1993). Our beloved teacher and colleague, Colin Reynolds left the living world when all papers in this volume went online. In the title of this preface, we intend to recognize his immeasurable contribution to our science and to science in general.

The analysis of biotic interactions in the pelagic, and in particular in its microscopic compartment, was the perspective used by Colin Reynolds to present his beautiful and visionary ideas on ecosystem theory (Reynolds, 1997). The sad news of Colin's death reached the community of phytoplankton ecologists as these lines were composed and left all of us with a deep sense of deprivation. Colin was actually a mentor, a friend, and an active member of the IAP family. With his books, he deeply contributed to the development of most of the ideas that this group of phytoplankton ecologists have produced (Reynolds, 1984, 2006 and about 200 influential papers) in the last 25 years, also through editing and co-editing several Special Issues of *Hydrobiologia* summarizing the IAP's outcomes. We all feel genuinely indebted for the vast legacy of scientific thoughts and human qualities he has left us.

We will never forget all those friends who left us: their smile and kindness were fully reflected in their way to promote and advance aquatic sciences (rare virtues, nowadays). We will keep on feeling the warmth of their friendship.

The main IAP objectives are to get together preeminent as well as young scientists and students working on various aspects of phytoplankton taxonomy and ecology to discuss topics of current interest. Thirty-eight scientists from fourteen countries (Argentina, Brazil, China, Croatia, Czech Republic, Denmark, France, Hungary, Israel, Italy, Poland, Portugal, Uruguay, USA) participated in this workshop. A group photo of the participants can be found in Supplementary Material I.

There were 39 presentations (5 plenary lectures, 20 oral presentations, and 13 posters) followed by fruitful discussions on different aspects of this broad. The microscopy sessions occupied 2 days and were guided by established taxonomists who jointly examined fresh and preserved samples brought by the participants. The 'traditional' IAP field trip visited a reservoir in the Caatinga (White Forest). Brazil has six biomes: Amazon, Brazilian savannah (Cerrado), Atlantic forest, Pampa, Pantanal, and Caatinga. During this trip, participants had a unique opportunity to experience the semi-arid conditions of Caatinga, a region where climate change has already influenced ecosystems and people's lives. On this trip, the participants saw a critical state of the water bodies in this region, which has been affected by a severe drought that has been lasting since 6 years, leading to an extremely low water level. The reservoir usually has high phytoplankton biomass with permanent blooms of cyanobacteria, which are not rare when water level is decreasing or dominated by mixotrophs (mainly cryptophytes) when water level reaches a critical depth.

The IAP was constituted in 1979 (Kristiansen, 2003), and since then 18 workshops were carried out at different locations around the world. From the workshop held at Baja (Hungary) in 1991, each meeting focused on a particular ecological theme, as well as on defined taxonomic topics, which were addressed both in plenary talks and in microscopy sessions. The proceedings of these workshops have been published as peer-reviewed articles, constituting significant contributions in the field of the phytoplankton ecology. The following proceedings volumes were published in special issues of Hydrobiologia:

1991: Baja, Hungary (Padisák et al., 1993)
1993: Mont Rigi, Belgium (Descy et al., 1994)
1996: Granada, Spain (Álvarez-Cobelas et al., 1998)
1998: Shrewsbury, England (Reynolds et al., 2000)
1999: Delta Marsh, Canada (Hamilton et al., 2000)
2002: Castelbuono, Italy (Naselli-Flores et al., 2003)
2005: Sapanca, Turkey (Albay et al., 2007)
2008: Golan Heights, Israel (Zohary et al., 2010)
2011: San Michele all'Adige, Italy (Salmaso et al., 2012)
2014: Kastoria, Greece (Naselli-Flores & Padisák, 2016)
2017: Natal, Brazil (Sarmento et al., this volume)

During the 18th IAP workshop, a tribute was paid to Jean-Pierre Descy for the occasion of his retirement. His contributions on river phytoplankton ecology, modeling, and development of innovative methods

were decisive for the development of aquatic sciences, especially in Africa. Jean-Pierre organized the 9th IAP meeting in 1993 and edited the *Hydrobiologia* special issue together with Colin Reynolds and Judit Padisák. A list of Jean-Pierre Descy publications can be found in Supplementary Material II.

This volume includes a selection of 13 original research papers related to the themes of the workshop. Five papers focused on mixotrophic phytoplankton: one of them (Gerea et al., 2019) analyzed the grazing impact and prey preference of different mixotrophic taxa in oligotrophic lakes, concluding that herbivory represents a key process in the mixotrophic carbon cycling in this kind of environments; two papers focused mainly on the toxic bloom-forming haptophyte *Prymnesium parvum* N. Carter (Cagle et al., 2019; Naselli-Flores & Barone, 2019), the first one investigated the compounding effects of co-occurring disturbances on the populations of this species, whereas the second one evidenced that an increased availability of suitable preys can stimulate the growth of this phagotrophic algae. Costa et al. (2019) showed that in tropical semi-arid reservoirs, extreme droughts may favor the presence of mixotrophic organisms, and Feitosa et al. (2019) analyzed the carbon partitioning in plankton communities in an Amazonian floodplain system and the strength of interactions among components of the microbial food web and the classical food chain. The authors concluded that hydrology is a key factor shaping biotic interactions during low-water periods, and that the microbial food web plays a key role in floodplain lakes, being potential mixotrophy an important strategy in phytoplankton. Two articles focused on invasive species: one of them (Crossetti et al., 2019) explored interactions of phytoplankton species during the invasion of *Ceratium furcoides* (Levander) Langhans in South America and the environmental conditions that contributed to its establishment in eutrophic reservoirs; in the second one, long-term studies carried out in Lake Kinneret evidenced the lack of relationship between environmental factors and population changes on *Mougeotia* (Zygnematales), suggesting the existence of genetically distinct cryptic species, or high physiological plasticity (Zohary et al., 2019). A long-term study conducted in an oligo-mesotrophic lake from Germany (Selmeczy et al., 2019) showed a decrease in the efficiency of trophic coupling between phytoplankton and zooplankton, being the stronger and longer lasting stratification the main driver of the observed changes, which highlights the influence of climate change on the plankton communities. Cardoso et al. (2019) analyzed changes in phytoplankton, zooplankton, and periphyton in a tropical lake, observing that phytoplankton size classes varied similarly to the smaller size classes of zooplankton in the pelagic zone, whereas most periphyton size classes coincided with the larger zooplankton in the littoral zone. On the other hand, the paper by Saad et al. (2019) showed differences in phytoplankton structure between fish-less and fish-stocked lakes from Patagonia, with the presence of phycocyanin-rich picocyanobacteria only in fish-stocked lakes, and also the dominance of cyanobacteria in these systems. Another article dealt with biotic interactions between cyanobacteria and zooplankton at community level (Josué et al., 2019), evidencing that eutrophication and cyanobacterial dominance change the composition of zooplankton traits and reduce functional dispersion, leading to zooplankton niche overlap. Finally, the paper by Batista et al. (2019) described methanogenic archaea associated to *Microcystis* sp. in field samples and in cultures.

We thank all referees who invested their time in preparing reviews for the manuscripts of this special issue and in helping to bring this volume to its present standard. A special thank goes to the publishing units of Springer for their assistance during the publication process.

The IAP organization committee and participants are grateful to Universidade Federal do Rio Grande do Norte (UFRN), Universidade Federal de São Carlos (UFScar), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Process 88881.139081/2017-01), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, Process 2014/14139-3), Ecology Brasil and Hidrelétrica Santo Antônio-Santo Antônio Energia that funded the workshop. We also thank Museu Nacional, Universidade Federal do Rio de Janeiro, Instituto de Investigaciones Biotecnológicas – Instituto de Chascomús (IIB-INTECH), Universidade Federal do Rio Grande do Sul, and Universidad de Buenos Aires for the support.

Acknowledgements Funding was provided by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Grant No.

88881.139081/2017-01) and Fundação de Amparo à Pesquisa do Estado de São Paulo (BR) (Grant No. 2014/14139-3).

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