



Preface: Blasts from the past and back to the future

11th International Symposium on Cladocera

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Following the kind invitation of the organizers Christian Laforsch and Max Rabus, the 11th International Symposium on Cladocera gathered scientists from all over the world working on multi-disciplinary aspects of Cladoceran biology. The meeting is renowned to house Cladoceran research from multiple disciplines including evolutionary history, host–parasite and predator–prey interactions, phylogeny, environmental genomics, population genetics, biogeography, systematics, and taxonomy.

First being held in 1986 in Hungary, this meeting recurs every 3 years. The 11th meeting was held in Kulmbach, Germany, from September the 24th to the 29th, 2017, in the wonderful Plassenburg Castle in the

margravial city of Kulmbach, Germany. During this 1 week, scientists from all around the globe coming from Austria, Belarus, Belgium, Brazil, China, Czechia, Germany, India, Norway, Mexico, Poland, Switzerland, Russia, Thailand, and the USA came to Kulmbach and presented 45 talks and 31 posters on Cladocera biology. The diversity of contributions provided new insights, perspectives, and advances to the multiple facets of Cladocera research. Following the tradition, this meeting was again organized in one session providing each participant with the opportunity to follow and discuss the breadth of the field. Long and fruitful discussions on recent results were held throughout the poster session accompanied by assorted craft beer typical for this region of Franconia.

As keynote speaker, Dieter Ebert (University of Basel) presented exciting insights into the “diversity panel” which is a collection of clones from > 170 populations of Eurasia, Africa, and North America. Using this panel, Dieter Ebert travels in geographic space and demonstrates genetic and phenotypic divergence of diverse traits, including patterns of local adaptation in *Daphnia magna* (Yampolsky et al., 2013; Fields et al., 2015; Lange et al., 2015; Roulin et al., 2016). Ralph Tollrian (Ruhr-University Bochum) presented in his keynote novel insights into the field of predator induced phenotypic plasticity in the model system *Daphnia*, which is among the most striking examples of this phenomenon. Yet, not only did Ralph Tollrian show how *Daphnia* perceives and

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interprets environmental cues predicting predation pressure (Weiss et al. 2015a, b, 2016, 2018) but he also presented remarkable data on the biomechanical properties of morphological defenses and how these render *Daphnia* less susceptible to different predators (Kruppert et al., 2016, 2017, 2019).

These conference proceedings offer an overview over the whole diversity of research that was presented at the symposium. As species of the order Cladocera comprise a group of small crustaceans inhabiting freshwater bodies world wide, they have been and still are popular models for freshwater ecology research. Particularly, many Cladocerans are able to respond promptly to environmental changes and are very sensitive to environmental contaminants such as pharmaceuticals and microplastics (Rivetti et al., 2016; Imhof et al., 2017). In addition, they occupy a central position in food webs as being a trophic link and serving as the major natural food source for fishes and other predatory invertebrates. Especially, *Daphnia* is known for its ability to convert phytoplankton biomass into animal biomass, and extensive research in recent decades has indicated that the availability of essential lipids in seston is key to *Daphnia* fitness, e.g., thermal tolerance during diel vertical migration (DVM) (Müller-Navarra, 2008; Brzeziński & von Elert, 2015). Werner et al. here show that body content of polyunsaturated fatty acids (PUFAs) varied among a *D. magna* population and was negatively correlated with heat tolerance. This variation in PUFA content is hypothesized to affect fish-induced diel vertical migration amplitudes (Werner et al., 2018). Fink & Windisch detail differential gene expression involved in the physiological pathways associated with the nutritionally highly important omega-3 PUFAs (Fink & Windisch, 2018). The authors demonstrate that the dietary availability of the omega-3 PUFA EPA affects the expression of some previously investigated genes that were almost exclusively dependent on omega-6 PUFAs. This supports the understudied idea that there is an EPA-dependent eicosanoid pathway in *D. magna*, which has repercussions for our understanding of the biochemical physiology of this essential dietary compound and its role for zooplankton nutrition.

Cladocerans have a short generation cycle, and the transparent carapace allows, e.g., easy observation of offspring in the maternal brood pouch. Moreover, many Cladocerans can switch between clonal and sexual reproduction, so that under favorable

conditions, organisms reproduce clonally thereby effectively increasing population size of environmentally adapted phenotypes. The deterioration of environmental conditions induces sexual reproduction and thus genetic diversity. Sexually produced embryos are genetically encoded to go through a state of suspended animation. Encapsulated in a protective shell, the ephippium, these embryos accumulate season-by-season in the sediments. We can use these dormant egg banks to travel back in time and interrogate several decades-old populations upon resurrection (Weider et al., 2018). Complemented by long-term environmental data and *Next-generation Sequencing* strategies, we may obtain insights into the involved eco-evolutionary processes like adaptation, hybridization, introgression, speciation, and gene flow. In fact, it is possible to link candidate genome regions to selection pressures resulting from, e.g., stressors such as predation, parasitism, or toxins released during cyanobacteria blooms. Genomic approaches are now also rounded up by proteomic analysis in order to obtain a more comprehensive understanding of the associated molecular pathways (Otte et al., 2018).

But not only can we use Cladocerans to travel with them in time and space; some Cladocerans now boldly go where no Cladocera has gone before; i.e., to space, as they are promising candidates for bioregenerative life support systems as presented by Miriam Knie and Christian Laforsch (Knie et al., 2018). Other contributions covered aspects of taxonomy, diversity, predation, food quality, physiology, stress, and eco-evo interactions; more molecular-orientated topics were population genetics and omics approaches.

It will be interesting to see the further developments in the field at the 12th Cladocera Symposium, which will be organized by Piet Spaak and Adam Petrussek in Verbania, Italy, right next to the beautiful Lago Maggiore from October 4, 2020, to October 10, 2020. This will be a special occasion as it will be a Joint Meeting of the Cladocera symposium and the *Daphnia* Genomics Consortium.

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