# IRGC NEWS

INTERNATIONAL RESEARCH GROUP ON CHAROPHYTES

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**Edited by: K. Torn, M. Casanova, S. Schneider, A. Pukacz and E. Nat**

# 30

## March 2019

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*Chara baltica* in the Baltic Sea.

## *EDITORIAL*

Time is flying, and another year has passed with interesting charophyte activities. We had an exciting and very successful GEC meeting in Palermo, organized by Angelo Troia, who managed to recruit a large group of colleagues and students, helping with the organization of the meeting but also presenting results of their newly started charophyte research. Angelo really managed to spread the “charophyte virus”, and it seems many of his colleagues got “infected”. I am happy to see that a strong charophyte group is developing on Sicily. A very big “thanks” to Angelo and his co-workers! Please find more information on the GEC meeting, including a short description of the scientific presentations and the excursions, in this issue of the NEWS. Also, I have the feeling that the number of publications on charophytes has been increasing over the last few years. I have not counted the numbers, but I notice that I have to be more and more “selective” when summarizing last year’s publications on charophytes. One of the more ground-breaking studies probably was the publication of the *Chara braunii* genome, which allowed insights into the evolution of land plants from their aquatic ancestors.

I already look forward to our next meeting, which will be in March 2020, in Gammarth, Tunisia. Although not far from Sicily (air-line distance), the location is very exotic in the sense that it will be our first meeting on the African continent. More information about this forthcoming meeting also is provided in this issue of the NEWS.

In the year 2019, our organization celebrates a special anniversary. The IRGC is turning 30! This means we have put the years of being a teenager and a young adult behind us. And we are very much alive and kicking! I am looking forward to many more productive years with exciting new science on charophytes, and I am sure our members will continue to contribute to the increasing knowledge on charophyte ecology, biogeography, paleoecology, physiology, genetics, etc. The next opportunity to celebrate our “birthday” will be the IRGC meeting in Tunisia. Please let me know if you have a good idea how to celebrate this anniversary. 😉

I warmly welcome our new members and thank all of you who contribute to keeping our organization alive, by contributing to the IRGC NEWS, the website, meetings, our Facebook group or by promoting charophyte research in any other way. Please continue to recruit students, they are important for keeping up the enthusiasm for our fascinating group of algae also in the future!

**Susanne Schneider**

## *CALL FOR NOMINATIONS TO THE EXECUTIVE COMMITTEE OF THE IRGC*

Dear friends and colleagues,

The next **General Assembly** of the IRGC will be held during the 8th International Symposium on Extant and Fossil Charophytes, which will take place in March 2020 in Gammarth, Tunisia. An important task of the General Assembly is the **election of the Executive Committee** of the IRGC.

Since the IRGC meeting and therefore also the General Assembly in 2020 will take place in spring instead of in autumn (because most charophyte sites in Tunisia will be dry in autumn) we are announcing the need for elections already in this issue of the NEWS (the next NEWS will be issued in March 2020, which is obviously too late for announcements concerning a meeting which is to be held in the same month).

**This is to announce formally the need for the election of a President, Vice-President, Secretary and Treasurer. In addition, we will need a minimum of two members-at-large.**

The members of the current executive committee, Susanne Schneider (President), Andrzej Pukacz (Vice-President), Kaire Torn (Secretary) and Emile Nat (Treasurer) are eligible for a new term and are willing to accept the office if elected.

Nevertheless, all IRGC members are invited to submit/suggest names of other candidates to serve on the executive committee for a four-year term (from the Gammarth General Assembly to the following General Assembly). According to our statutes, all candidates must be current members of the IRGC (which means they also must have paid their membership fees), and nominations shall provide evidence that the nominee is willing to accept office if elected.

Members-at-large are members which have a "special role" in the IRGC. They are formal members of the IRGC executive committee. However, according to our statutes, some important roles in the IRGC can only be filled by people which are NOT in the executive committee. For example, at least one of two auditors of the IRGC accounts must NOT be part of the executive committee. Presently, the members-at-large are Robin Scribailo (management of the charophyte-L), and Dominique Auderset-Joye (keeping track of the charophyte bibliography). Members-at-large do not have to be elected, but agreed upon during the General Assembly.

Please send your nomination no later than 31 August 2019, preferably by email to Susanne Schneider, Norwegian Institute for Water Research, Gaustadalleen 21, 0349 Oslo, Norway.

susi.schneider@niva.no

The list of nominees will be circulated three months before the general Assembly by email to all members, in the form of a voting ballot.

Thank you for your interest in keeping the IRGC an active organization!

**Susanne Schneider**

## *WELCOME TO NEW MEMBERS*

It is a great pleasure to welcome our new members: Chrysoula Christia (Greece), Elvan Demirci (Turkey), Anna Millozza (Italy), Jordi Pérez-Cano (Spain), Sherim Tulegenov (Kazakhstan) are warmly welcomed.

## *REPORT ON PAST MEETINGS*

### 22nd Meeting of the Group of European Charophytologists (GEC), Palermo (Italy)

#### *Scientific sessions – fossil charophytes*

The oral and poster presentations during the GEC meeting of Palermo provided an overview of the evolution of charophyte floras since the Middle Jurassic (174.1-163.5 million years ago) until the Quaternary (2,58 million years ago to present). The charophyte floras dominated by the Porocharaceae family during the Jurassic were substituted by Clavatoraceae-rich floras during the Lower Cretaceous (145-100.5 million years ago), which were in turn outcompeted by the establishment and evolution of the current Characeae floras during the Upper Cretaceous (100.5 million of years ago) until now.

The Middle Jurassic (174.1-163.5 millions of years ago) flora from the Kef El Anéba section (South Tunisian Atlas) documented by **Khaled Trabelsi** dates back to the Bajocian (178-168 millions of years ago) and late Callovian (166-163.5 millions of years ago). Both assemblages are very rich in porocharacean genera as *Porochara, Auerbachichara, Stenochara* and *Stellatochara* which represent an intermediate flora between the Late Triassic (237-201.3 millions of years ago) charophyte floras and the Late Jurassic (163.5-145 millions of years ago) ones. We hope that Khaled and his collaborators will continue working in this area to obtain more information about this poorly-known time period. During the Lower Cretaceous (145-100-5 millions of years ago) the porocharaceans were displaced to brackish settings by the ongoing development of the clavatoraceans. The paleoecological study of **Jordi Pérez-Cano** sheds light on this substitution. The authors have observed that brackish clastic lagoons with benthic foraminifera were rich in *Echinochara peckii* var. *lazarii*, a strange and rare clavatoracean, while the coeval carbonatic brackish lagoons were only composed by porocharaceans. Family Clavatoraceae achieved the maximum richness during the Barremian and Aptian stages, 129.4-113 millions of years ago. During this time, Europe and North Africa consisted of a Tethyan Archipielago forming a unique charophyte bioprovince. This area acted as a place of origin of new charophyte species (clavatoraceans) and some of them migrated to other parts of the world and became cosmopolitan. The study of **Carles Martín-Closas** showed that this Archipelago was divided into two paleogeographic areas separated by a latitudinal factor. The substitution of the floras dominated by the family Clavatoraceae by floras of the family Characeae occurred during the Cenomanian to Santonian (100.5- 83.6 millions of years ago) coinciding with a significant gap in the fossil record. The data obtained by **Sha Li** in the Songliao basin (NE China) partially fills this gap, showing a drastic decrease of clavatoracean diversity, only represented by the species *Atopochara trivolvis restricta* and an ongoing characean diversification, with especially the oldest occurrence of genus *Lychnothamnus* worldwide. The characeans quickly expanded around the world. The data provided by **Alba Vicente** showed the charophyte floras from the Upper Cretaceous of the Cabullona Basin (NE of Sonora, Mexico), where Alba Vicente is doing post-doctoral research. The charophyte assemblages were dominated by species of genera *Lychnothamnus, Sphaerochara* (=*Tolypella* section *Rothia*) and *Microchara*. This is the oldest evidence of the genus *Lychnothamnus* in North America with an age of upper Campanian (79-72.1 millions of years ago). Although the Upper Cretaceous charophytes from Europe are extensively studied, there are still many points of interest. The Provence Basin (France) has been extensively studied in order to describe the European charophytes from the end-Cretaceous (83.6-66.0 millions of years ago), many of them characterized by Louis Grambast in 1970's. The current PhD project developed by **Roch-Alexandre Benoit** aims to achieve a better understanding of the taxonomy and paleoecology of these charophytes by comparison with other basins (Pyrenees and Romania).

The beginning of the Cenozoic era (66.0 millions of years ago), recorded the diversification of most of characean genera that had appeared during the end Cretaceous (83.6-66.0 millions of years ago). **Josep Sanjuan Gribau** presented new data from the Cedar Breaks National Monument (SE Utah; United States) dated as upper Paleocene or Early Eocene (59.2-47.8 millions of years ago). The charophyte assemblages described in this non-marine section are composed by species of *Microchara, Dughiella*, *Peckichara* and *Lychnothamnus*. This flora poses an exciting problem to investigate. According to the European charophyte biozonation, the genus *Microchara* disappeared earlier, during the Danian stage (66.0-61.6 milions of years ago) in Eurasia. How to explain then the occurrence of this more modern *Microchara* in America? I encourage Josep and the other members of the team to solve this biostratigraphic and paleobiogeographic problem. During the

Neogene, the floras are more similar to those from the present day. **Aizhan Zhamangara** showed new data from Ili Basin (SE Kazakhstan), which is situated in-between Europe and Asia. For instance, during the Late Miocene and Pliocene (11.63-2.58 millions of years ago) the flora was characterized by *Nitellopsis meriani* (an ancestor of the extent *N. obtusa), Nitellopsis helvetica, Lychnothamnus barbatus, Chara vulgaris* and *Chara globularis*, while in the Pliocene (5.33-2.58 millions of years ago) *Lychnothamnus barbatus* and *Chara globularis* occur associated with *Chara papii,* other *Chara* species, *Nitellopsis auberkerovii* and *N. aktauensis*. These assemblages reveal great affinities of the Kazakh floras with the contemporary ones in Europe. The presentation of **Elvan Demirci** has provided an excellent state of the art of the Neogene Turkish charophyte record. This epoch is present in several basins in Turkey and provides an excellent basis in order to compare European with Middle East coeval assemblages. The recent past is the clue to understand the present. **André-Marie Dendiviel** studied several logs from the lake Afourgagh, located in Middle Atlas (Morocco) that provided an exciting record about the last 8,500 years evolution of this lake. Seven phases have been dated with $^{13}C$ and correlated with different periods of the lake history including the Roman presence in Morocco and the increase of the use of water to cropping. The charophytes were mostly restricted to the initial and wetter periods of the lacustrine evolution (8,200 to 4,200 years).

**Jordi Pérez-Cano (Spain)**

### *Scientific sessions – extant charophytes*

The poster session continued with the first presentations on extant charophytes, tackling a wide range of studies on their taxonomy, distribution and ecology. **Michelle T. Casanova** highlighted the usefulness and reliability of the oospore characters for the taxonomy of *Nitella* species by presenting several images of oospores -obtained with scanning electron microscopy- from type material of this genus. She posed her plans to create an international, public and collaborative repository of oospore images during her stay as curator of the Algae collection in the Natural History Museum of London. Some colleagues working with fossil gyrogonites reminded the extant working group to pay attention to the position of the fructifications for obtaining really informative and valuable images. **Ralf Becker** and Anja Holzhausen presented the last work of Petra Nowak regarding genetic analyses of *Tolypella* species. *T. glomerata* was confirmed as a distinct taxon from the genetically indistinguishable *T. nidifica/T. salina*, but some specimens morphologically determined as *T. glomerata* appeared as genetically different. These results triggered an extensive and amusing debate about the morphological and genetic variations in this genus. From the most recent approaches, **Angelo Troia** switched to the most traditional ones in an original review of the pre-Linnaean illustrations that constituted part of the characterization of some *Chara* species and that, consequently, should be considered as original material for these taxa. The next three posters summarized the material hosted in several Italian herbariums, highlighting the role of this material to understand the historic occurrence of species across regions. **Anna Millozza** focused on the extensive cryptogamic collections of the RO Herbarium and showed pictures and distribution maps of the material from the *C. hispida* complex. **Laura Guglielmone** presented the cryptogamic collection of the TO Herbarium, highlighting some unpublished material of Italian charophytes. And, finally, **Angelo Troia** focused on the PAL and FT Herbariums, including historical material from disappeared Italian populations and African locations. These last four posters reflected the extraordinary engagement of the new Italian charophytologists to gather all the available information from valuable data sources. Afterwards, **Zofija Sinkevičienė** presented part of the data gathered for the chapter devoted to *C. filiformis* in the European Charophyte Monograph, including the morphometry of the fructifications, the ecological requirements and the distribution of the species in Lithuania. More related to the conservation and management of charophyte habitats, **Elisabeth Lambert** talked about a French canal (Marans-La Rochelle) created in 1805 for commercial traffic but currently used for recreation. The recent removal of aquatic invasive species, such as *Egeria densa*, and the extraction of silts to allow for fishing and canoeing have allowed the reappearance, from the oospore bank, of charophyte species that had been absent from the canal for fifty years. This has been particularly true in the south part of the canal, where it is deeper, connected to the water table and with clearer water than in the north part. As the chairperson of the poster session, **Mariusz Pełechaty** introduced himself and presented the aims and approaches of its research project, focused on measuring the capacity of charophytes and submerged vascular plants to capture and fix carbon in the sediment of several Poland lakes. Some preliminary results of this project, presented by **Małgorzata Strzałek**, showed differences between lakes from two regions with distinct climate conditions: a longer growing season and a higher proportion of overwintering green charophytes were found in the warmer region. Finally, **Aizhan Zhamangara** presented an interesting poster, of which the first author was Bazargul Zhapparova, about the application of geographic information systems in the study of the distribution and the ecological requirements of macrophytes, particularly charophytes, in Kazakhstan.

After all these fascinating talks and discussions, the first day ended up with a lovely tour through the Palermo city centre, kindly guided by Angelo, in which we could enjoy the most remarkable monuments, such as the astonishing Praetorian Fountain (known as "the Square of Shame"), the beautiful Cathedral, or the prominent Royal Palace.

What a nice first day!

The second day of the meeting continued with the oral communications about extant charophytes. The session started with the presentation of **Irmgard Blindow** about the tricky and nerve-wracking species within the *Chara hispida* complex. She pointed out the difficulties of distinguishing some species due to the high morphological variability of the specimens growing in different locations and under different ecological conditions. Likewise, the recurring debate of "what a species is" and "how to separate them" was opened. Continuing with the taxonomic challenges, **Susanne Schneider** highlighted the existence of transition features between some charophyte species. Thus, some samples from Serbia, genetically identified as *C. contraria*, showed the characteristic habitus of this species, but microscopic details of *C. virgata.* Similarly, a sample identified as *C. connivens*, according to morphology, genetically fitted in a separate sub-cluster of *C. globularis*. What a messy group of organisms!

After this interesting taxonomic debate, **Michelle T. Casanova** got us into the impressive charophyte diversity of Australia's Northern Territory by means of a long-term project that has allowed her to describe the occurrence of 39 species (being 15 of them entirely new species). She encouraged us to have an open mind when studying unexplored areas, particularly regarding the potential appearance of undescribed taxa. For his part, **Roman Romanov** showed us the results of a rigorous and detailed study of the diversity, occurrence and distribution of charophytesfrom Israel. He described new locations and assessed the changes in the previously described ones with conjunction of field sampling and the revision of herbaria material. Getting closer to where the meeting was taking place, **Ralf Becker** presented the diversity and occurrence of the charophytes in Sardinia (Italy), considering the island as a hotspot for the conservation of this group in the Mediterranean region. Through his 10-year field study, he evaluated the state of conservation of the Sardinian populations, identifying their major threats: tourism, industry and global change. Without moving from the Italian region, **Angelo Troia** shared the tough work that he and his colleagues have been doing during this last year of collecting, reviewing and completing the information of charophytes in Sicily, with the help of other colleagues like R. Becker, R. Romanov and K. van de Weyer.

After these great and stimulating talks, we went for an enjoyable meal in the lovely Botanical Garden. On a full stomach, the session about the ecology of extant charophytes began with the presentation of

**Michał Brzozowski**. He talked about the effect of depth on the production and morphometry of *Lychnothamnus barbatus* gyrogonites, including both moderns and subfossils. Mainly in autumn, there was a positive correlation between gyrogonite production and depth. Although, in general, subfossil gyrogonites were bigger than modern ones, both tended to be smaller when produced at greater depths. This presentation triggered an interesting discussion on the relevance of this kind of studies to relate the ecological and palaeoecological research on charophytes. Coming up next, **Anja Holzhausen** emphasized the importance of oospore banks in the restoration and conservation of ecosystems with charophyte meadows. With this in mind, the restoration potential of 23 north-eastern German lakes was assessed, showing that nearly 30% of oospores were not viable and, in most occasions, the viable ones occurred in low layers of the sediment. In the next talk, **Riccardo Guarino** applied a phytosociological approach to charophyte ecology, showing the different associations between them and other macrophytes. He suggested the phenology as a crucial element to understand the succession that occurs in these associations. Also highlighting the importance of phenology, **Sara Calero** summarized the research carried out in her PhD thesis about the reproductive timing of charophytes. By means of intensive field samplings, detailed observations of the sexual characters and the application of circular statistics during a 3-year study period, she has established an accurate methodology to assess the phenological state of charophytes related to the environmental conditions. Her work has also shown that charophytes are better sentinels of climate change than angiosperms. **Eric Puche** showed the results of a mesocosm experiment, in which the charophyte meadows were subjected to three global change-related scenarios (with temperature and radiation as experimental factors). Charophyte meadows were favoured by an increase in temperature and were able to withstand changes in the received radiation. Furthermore, the results from this experiment will be useful to understand how charophyte response to environmental changes affects the whole planktonic-benthic community around them.

Outdoor poster session. Photo by Susanne Schneider.

Group of charophytologists in the entrance of the Cathedral of Palermo. Photo by Sara Calero.

Botanical Garden of the University of Palermo. Photo by Susanne Schneider.

Finally, **Anna Geraci** and **Elisabetta Oddo** presented a project started this year at Lago Preola (which we were lucky enough to visit at during our first post-conference excursion). In this lake, they have found a charophyte population, provisionally identified as *C. baltica*. This population is been compared with a population of *Najas marina* from a nearby lake. They are studying the isotopic composition of the two macrophytes to understand their ecophysiology and the trophic relationships within the water basins they inhabit.

With a storm of ideas in mind, the assembly of the GEC association and the closing ceremony of the meeting took place. After an intense day, we could enjoy a rich and wonderful dinner in the centre of Palermo as the closure of the meeting.

Thanks to Angelo and the rest of the organising committee for a great time in Sicily. The science, the city and the food were fantastic!

**Sara Calero and Eric Puche (Spain)**

### *Field trip 1*

The Province of Trapani, famous for its vineyards, is also interesting for its natural reserves, especially in the southern part of the Province. That is where the first field trip took place. It was organised in two main stops, and the visit to a vineyard, where we could stay for lunch.

We took off from Palermo around 8:30 am by bus, and our hosts gave us a lot of interesting information during the road trip to the South.

They explained to us that the region, full of citrus groves and sugar canes, was named “the Golden Cradle”, and considered as a paradise by the first settlers. In the area of Palermo, there are a lot invasive species, such as *Pennisetum* sp and *Opuntia* sp, which completely modified the landscape. To see a more natural and typical landscape of Sicily, it is necessary to go away from this region.

They also explained that there were a lot of mesozoic limestones near Palermo, their emergence resulted from the collision between the African and the Eurasian plates. More to the South, were we were heading, the underground is composed by sandstones and flysch, and gypsum underneath (from 1 to 30 meters in thickness), which really contributed to the good growth of vines and olive trees.

The farmers usually pulverise the sandstones to make it easier to cultivate, but this has a direct consequence: the gypsum is easier to dissolve after such a treatment, and the sandstones collapse from place to place. Apparently, some of the lakes in the surrounding area were formed by this process.

The first stop was in the Natural Reserve of “Lago Preola e Gorghi Tondi”, near Mazara del Vello, where we arrived at 11:30 am. We couldn’t stay long there because a storm was approaching, but it was enough time for Jean-Nicolas Haas to give us some explanations about Lago Preola and the surroundings.

The lake was studied by researchers from the University of Berne (Switzerland), especially in relation to its sedimentation, which represent a total of nearly 12000 years of deposition, with a thickness of 10 m. They gathered a lot of information concerning the evolution of the landscape and vegetation, and also about the changes in the lake water levels, by searching for palynological, sedimentological and faunal evidences in these sediments. In the beginning, nearly 12000 years ago, the area was an open grassland. The first trees to grow here, around 9500 years ago, were pistachio, forming a thick forest close to the lake. The lake at that time, between 12000 and 9500 years ago, was slightly brackish, as evidenced by the presence of pollen of *Cladium mariscus* and some *Ruppia* sp in the sediment.

From 9500 to 7500 years ago, a lot of change occurred, due probably to widespread fires. It is considered that they were natural fires, but it is not clear if human activities had an influence on these changes. The climate became much wetter and the lake, due to increased summer precipitation, became a freshwater lake, with higher water levels (about 3 or 4 meters higher than today). Evidence for a wetter climate comes from the presence of pollen of *Quercus ilex* and *Olea* sp in the sediment core.

The next big change in climate occurred around 4500 years ago, with dryer conditions during summer (frequent droughts) and higher precipitation in spring, resulting in a dramatic drop in lake water level, probably lower than today. The lake became a brackish water system (indicated by the presence of *Ruppia maritima* among other things). This seems to correlate with other observations all around the Mediterranean Sea, especially in the eastern part, involving drastic climatic changes, but also social changes, with the disappearance of complete societies, and appearance of new ones (so called “4.2 ka BP event”).

This brackish water system remained until now, with big fires modifying the area towards an open landscape, as we know it today. This time, the human impact was, for sure, an important part of these changes, and not the climate.

For this study, charophytes, and water plants generally, were never taken into account, and Prof. Haas suggested it could be a good thing to do in the next few years. In addition to what Prof. Haas said, Angelo Troia informed us about past recordings of *Nitella* sp during a dry period in the area, but none of these records were recent. During the discussion, some of us went to the water to see if there were any characeans. They found some *Chara baltica* near the shore. We left Lago Preola at noon, in order to avoid the approaching storm, and to visit a vineyard really close to our location: Tenuta Gorghi Tondi.

Identification of charophytes. Photo by Susanne Schneider.

This vineyard has been within the same natural reserve as our first stop, since 1998, and the owners produce organic wines. After a short visit of their facilities, we had the pleasure to taste some of their best vines (Vivitis, Rajah, etc.), with typical dishes from the province to accompany them.

We had to leave this wonderful place around 3:30 pm, in order to go to the last stop of the fieldtrip, a salina close to the city of Marsala. We stayed there long enough to see that there were no characeans at this time of the year. Prof. Troia explained to us that the season had been really dry, and it would be better to come back later in the year, around October or November, to find some of them. He added that there were reports of *Lamprothamnium papulosum* in a lagoon nearby (Laguna dello Stagnone), but, like the previous station, these where not recent ones.

Instead of characeans, we found a lot of *Stuckenia pectinata* along with *Ruppia* sp. We eventually got back to the bus around 6:30 pm to get back to Palermo.

**Roch-Alexandre Benoit (France)**

### *Field trip 2*

A smaller group of charophytologists were able to go to the Nebrodi Mountains for the second field trip. We left the 'cradle of Palermo' (the valley and city surrounded by the sharp-edged mountains) and went through the ancient terraced hillsides of Messina. Eventually the bus left the highway and climbed the switch-back road into the mountains. Our bus-driver negotiated the narrow streets of San Fratello (where they speak a different dialect, a result of invasion and settlement of Normans in the 12 century), and soon we were in the natural park. We had come through Cork Oak (*Quercus suber*) and Turkey Oak (*Quercus cerris*) forests, eventually into the Beech forest (*Fagus sylvatica*) where we could see semi-wild pigs off the side of the road. Our excellent accommodation was revealed among the dripping trees and mossy woodland, and we had a marvellous meal of local vegetables, with a momentary view of Mt Etna through the mists. Half our company spent the night at another location.

The next morning we took a short trip into the mountains, heading for Lago Maulazzo. Along the way we collected a species of *Chara* in a spring at the edge of the road. A bit more walking and the lovely lake appeared, with clouds and mountains reflected, and emergent *Potamogeton* leaves on the surface. Some of our number braved the cool water to dive for charophytes, but the only ones were found at the edge *Nitella mucronata.*

We (mostly) walked back to the bus, taking photos of the wild *Cyclamen* and *Crocus,* and lots of fungi on the way. We arrived back at our hotel to have a feast of vegetables, meats, cheeses, sausages, fruits and cake, along with plenty of good red wine. Every meal was a banquet, and although there was lots of walking I don't think anyone lost weight! Many thanks to Angelo and his team for providing an excellent trip, marvellous accommodation and incomparable food! *Perfetto!*

**Michelle Casanova (Australia)**

## Meeting of the German-speaking charophytologists in 2018

The annual meeting of the German Charophytologists had to change its name 2018. Meeting abroad or at least having excursions into neighbour states wasn't new, but the meeting in Austria necessitated special attention to nomenclatural issues. The new name better reflects the character of the increasingly international meeting. The meeting itself, organised by Prof. Karl-Georg Bernhardt from Universität für Bodenkultur Wien, took place from 07.06. to 10.06.2019 at the station of the "WasserCluster" in Lunz, Austria.

Altogether 38 participants – many more than expected – resulted in a crowded seminar room, boosting lively debates after the 10 interesting presentations. A presentation by Priv.-Doz. Dr. Robert Ptacnik introduced us to the lake beside the station. This was a pretty good start, because the first excursion revealed that Charophyte-meadows, observed by many colleagues the year before, are almost gone in the Lunzer Untersee. There was still crystal-clear water and no signs of severe competition by higher plants – so it was a big surprise to all of us, who had seen the lake before. The following excursions to Mittersee and Obersee more than compensated for the lack of charophytes in Untersee. Not only charophytes, but also higher plants that occurred along the path were presented by Prof. Bernhardt, raising discussion among the colleagues about plant characters and peculiarities, and this slowed the speed of climbing to Obersee to a comfortable pace. A group of divers sampled the Erlaufsee in parallel and as always, time for determination and preparation of herbarium material was far too short. Therefore, all debates about weighting of characters and delineation of borders had to be continued during the conference dinner. Usually you wouldn't spend many words about this – but this conference dinner, held in a location with free view of the lake, was surely a landmark and the traditional barbecue we had in the meetings before are indeed no match. So it was also the first meeting with the menu printed on the program. The program as well as the lists of higher plants and charophytes found, can be downloaded from the AG Chara-D homepage: https://www.oekologie.uni-rostock.de/characeen-deutschlands/veranstaltungen/.

Next day's excursion, organised by Dr. Karin Pall, introduced us to a lake-type that is pretty rare in Germany. The Attersee, a carbonate-rich large lake, offered 11 species of charophytes and wherever the lake was sampled divers and grapnellers got interesting material. It took the whole day, and again, time for the determination workshop was too short, but it was worth each minute of travel to this rather distant part of Austria.

The last day was dedicated to presentations, 9 colleagues used the opportunity to present and discuss their findings and ideas. John Bruinsma introduced us to the progress on compilation of a Dutch Compendium of Charophytology and recruited volunteers for help with the drawings. Hendrik Schubert started his presentation encouraging a debate about species concepts, Heiko Korsch, for the first time, presented the status of his ongoing project of compilation of world-wide distribution of European Charophytes (at least part of the work is in press and will be available via RMB in January).

The next round of presentations dealt specifically with the distribution of Charophytes in Austria. First Michael Hohla and, in a separate lecture Karin Pall, presented an immense database about Austrian charophytes, both raising questions about taxonomic as well as ecophysiological details.

The last session was dealing exactly with these aspects. Anja Holzhausen presented the results of an investigation of oospore seed banks of 23 lakes in northern Germany, initiated for estimation of the restoration potential of the sediment seed bank, and consequently including taxonomic determination and vitality testing. Petra Nowak presented the results of a phylogenetic approach to solve the long-lasting problem of discrimination between *Tolypella nidifica*, and *T. salina*. In order to get a grip to the recent work of William Perez, *T. glomerata* was included as well and the results were surprising at least, raising a lot of new questions as well as debates. Sebastian Bernhard presented an analysis of the pro and cons of RUV's in macrophytes mapping. It was surprising to many of the participants how developed this technique is already also on the low-cost sector and it gave some thoughts especially for winter campaigns. Silke Oldorff took the chance to present the huge success of her already awarded initiative of citizen science: "Tauchen für den Naturschutz". By activating hobby divers through guiding and teaching them about aquatic Flora, she was rewarded by data from a multitude of lakes and will probably soon able to present phenological data as well.

The meeting was closed by Prof. Bernhardt after a brief agreement about the next meeting, organised by Irmgard Blindow and being held in Sweden.

**Hendrik Schubert, Karl-Georg Bernhardt (Germany)**

Plunge in or not? The water of Mittersee, filled with charophytes and crystal clear lying in the glittering sunshine, was freezing cold! Still 4 colleagues took the risk at least for a few minutes.

Finally! The trip to Obersee was exhausting. About 7 km each leg, not to speak about altitude – so picnic was the first activity, before science occupied our minds again.

## *FORTHCOMING MEETINGS*

### *GEC and IRGC meetings*

**23–26 March 2020**
**8th International Symposium on Extant and Fossil Charophytes**
Gammarth, Tunisia
Contact: Khaled Trabelsi trabkhalfss@yahoo.fr
***Please find the first circular included to this NEWS***

**September 2021**
**23rd Meeting of the Group of European Charophytologists**
Latvia, Riga. Organizer: Egita Zviedre

### *Other meetings*

**25–30 August 2019**
**7th European Phycological Congress**
Zagreb, Croatia
http://epcseven.biol.pmf.hr/

**2–6 September 2019**
**International Long Term Ecological Research Network (ILTER)**
**2nd Open Science Meeting**
Center for Environmental Research, Leipzig, Germany.
http://www.ilter-2019-leipzig.de

**August 2020**
**16th International Symposium on Aquatic Plants**
Denmark, contact: Tenna Riis (tenna.riis@bios.au.dk)

**12–19 September 2020**
**11th International Organisation of Palaeo-botany (IOP)**
Prague, Czech Republic
www.prague2020.cz

**28 February–5 March 2021**
**Aquatic Sciences Meeting**
Palma de Mallorca, Spain
https://www.aslo.org

**21–26 March 2021**
**12th International Phycological Congress (IPC2021)**
Puerto Varas, Chile
https://ipc2021.com/

### Author meeting and workshop of the European Charophyte monograph project

#### *St. Petersburg, Russia, 24th-29th of March 2019*

This meeting is dedicated to the preparation of a European monograph on Charophytes, a project which started in 2017 and aims to the develop a commonly agreed concept of species delineation for the continent of Europe. In addition, it will compile all available data on distribution and ecology of Charophytes in Europe, serving a comprehensive overview for field ecologists as well as a basis for bioindication projects.

St. Petersburg has been chosen as a conference site not because of its accessibility (and beauty, of course) but because the Botanical institute of the RAS harbors a unique collection of herbarium specimens, which have been very important for the development of the species concept as well as for compiling the distribution data. The meeting will be held at the Komarov Botanical Institute of one of the oldest (since 1914) academic institutions in Russia. This meeting will consist of three parts:

1) authors meeting, focusing on the harmonization of the structure of the species chapters and allowing for a discussion about the contents of the “main chapters”.

2) a determination workshop, focusing on check of the voluminous material stored in the herbarium of the Komarov-Institute and allowing for discussion of species delineation concepts by comparison of the various determination keys in use.

3) a field excursion to ponds in the Petergof, a small town near St. Petesrburg well known as a place of province residence of tsar’s. Where participants can gather the morphologically interesting specimen of the Chara hispida-complex in Olga`s pond and after that visit the Grand Palace.

Holding the meeting in St. Petersburg will introduce the participants from western Europe and overseas to the kind of material available at the Komarov-Institute, and also give them a chance to work with it, become familiar with the opportunities these collections are offering and to encourage direct cooperation with our Russian colleagues.

To date 35 people have applied to participate in this meeting (24 participants from European countries, 11 from Russia).

**Elena Chemeris (Russia)**

***REFERENCE ARTICLE***

## What's new about Chara? A short overview over some interesting charophyte studies published in 2018

On 7th of January 2019 I searched Web of Science, using the search criteria "Chara" and "2018". Since this is the 7th time I am trying to summarize the previous year's charophyte publications for the NEWS, I am starting to get an overview, although it is unofficial and not based on data. The number of papers returned by such a search is typically around 100 (this time it was 97 papers). In every year, many of the papers deal with the stellar phenomenon which also is called Chara. But I do get the impression that more and more good papers describing important ecological phenomena are published on "our" *Chara*. I think this is a positive development, and I take it as a sign that charophytes are more recognized, also for the important function they have in the ecosystem. I therefore tolerate the small disadvantage that it gets increasingly difficult to select which papers to include in the article you are now reading. If your paper should not be included, please just remember that my selection only represents my personal background and interest, and it has nothing to do with the quality or the importance of a publication. A particular apology goes to the paleo-ecologists among us … I simply lack the background to understand the significance of your publications in sufficient detail to be able to summarize them in an understandable way. I decided to skip all articles resulting from the IRGC meeting in Astana, which were published (in printed version) early 2018 in a special issue in Botany Letters. Please check https://tandfonline.com/toc/tabg21/165/1?nav=tocList, and ask the first authors for a pdf, in case you do not have access to Botany Letters.

Encrustation of charophytes was one of the "hot topics" in last year's charophyte research, and Anne Herbst published several papers on it. Herbst et al. (a) followed the encrustation of six charophyte species monthly over a period of one year. They found that encrustation sometimes followed a seasonal pattern. Unfortunately, however, this was not always the case, and there was no consistency, since different species behaved differently in different lakes. And the lakes themselves were not consistently different either. They also found that the precipitated $CaCO_3$ on charophytes correlated negatively with the inorganic carbon concentration in the lakes. In my view, this indicates that precipitation by macrophytes, related to photosynthesis, affected lake water chemistry, leading to reduced inorganic carbon concentrations. From other publications it is known that inorganic carbon concentrations within dense charophyte beds are greatly reduced during the day (partly because the bicarbonate is taken up by the charophytes, and partly because of precipitation as $CaCO_3$ on the *Chara* surface). However, respiration occurs during night, leading to much higher inorganic carbon concentrations during night. This means there are large daily variations in inorganic carbon concentrations, particularly in dense *Chara* beds. So, I guess that the density of *Chara* patches also may affect water inorganic carbon concentrations, and this may explain different seasonal patterns in lakes. Herbst and Schubert found that -not surprisingly- younger parts of the charophyte thallus were less incrusted than older parts. Remarkably, however, there also was one lake where no differences in encrustation occurred along the plant thallus. Another remarkable finding was that encrustation of *Chara hispida* from a slightly saline pond was NOT different from hardwater lakes. This is remarkable because Herbst et al. (b), who studied encrustation of charophytes from fresh and brackish water habitats, found that individuals (*C. aspera* and *C. tomentosa*) from fresh water sites had a much higher carbonate content than individuals from brackish water sites.

Sand-Jensen et al. tried to find the "reasons" for calcification in *Chara*. They tested seven *Chara* species and showed that all of them were able to efficiently use bicarbonate. Through calcification, *Chara* species can maintain photosynthesis also at high pH, which can give them a competitive advantage over other species. This is also the reason why they can form dense stands in oligotrophic hardwater lakes and ponds, where inorganic carbon actually may be limiting in the middle of warm sunny summer days. Also Sviben et al. studied encrustation in *Chara*, but unfortunately the deepest sample (10 m) was a different species (*C. globularis*) than the samples from shallower waters (*C. subspinosa* from 1 and 5 m). That's why they cannot really say if it was depth, or species-specific differences, which lead to the observation of two times as much calcification in shallow compared to deep water. My personal guess is that both contributed to the observed differences. The authors also found differences in pigment composition, not only between the different depths, but also between upper and lower thallus parts. It is nice to see some of my own «old» results which were published many years ago confirmed.

Carbon is not the only important nutrient for charophytes. Nitrogen doubtlessly also plays a central role. Puche et al. performed a laboratory experiment to study the effects of warming and an increase in nitrate concentrations on two *Chara* species. Increased temperature favoured the growth of both species, but an increase in nitrate did not have any apparent effect on growth or on *Chara* architecture. However, %N in the plant tissue increased, indicating that *Chara* took up the additional nitrogen. There were some differences between species (*C. vulgaris* and *C. hispida*), and between the ecosystems from where the samples were collected, and the authors conclude that this may lead to differential responses of *Chara* ecosystems to expected future changes in the environment. Rodrigo et al. also studied the effect of nitrate on *C. hispida* and *C. vulgaris* growth. They exposed the *Chara* to a wide range of nitrate concentrations (0.5-50 mg $NO_3$-N/l) and found that the charophytes grew in all treatments. Interestingly, however, growth was reduced in all cases at the highest concentrations! This means that an increased nitrate availability will not kill *Chara,* at least not within the time tested in these experiments. *Chara* indeed can continue to grow, but high nitrate concentrations are not beneficial either. If other species are better able to use the nitrate, they may outcompete the *Chara* at higher concentrations.

Charophytes have long been used as eco-engineers, i.e. people try to actively use charophytes to reach a desired effect in an ecosystem. The degree to which charophytes can prevent blooms of cyanobacteria is an old discussion. Zloch et al. did a study on the allelopathic effect of *C. aspera*, *C. baltica* and *C. canescens* on the picocyanobacterium *Synechococcus* sp. They used water extracts of dried *Chara* specimen and found that *C. baltica* had the strongest allelopathic effect. However, in some cases the extracts also seemed to have increased cyanobacterial growth! In my view, this may simply have occurred because the *Chara* extract provided additional nutrients to the cyanobacteria. The authors nevertheless suggest that *C. baltica* has the potential to mitigate cyanobacterial blooms. I think this is easier said than done. Using dried *C. baltica* seems kind of unrealistic to me: who would want to throw dried *C. baltica* into a pond to prevent cyanobacterial blooms? And using living specimen also seems challenging to me, because in a water body which experiences cyanobacterial blooms it will not be easy to establish dense stands of *C. baltica*!

Mahdizadeh et al. investigated the ability of *Chara* sp. to remove phenol from an aqueous solution. After 4 hours, 72% of the phenol was removed by *Chara* (including the epiphytes growing on the *Chara*!). They also found that living *Chara* material was much more effective than dead material. The removal was optimum when the experiment was run at a pH of 5 and a temperature of 30 degrees Celsius. Indeed, the authors also state that the *Chara* was "re-usable", although the removal efficiency declined the more often the *Chara* was used. This last statement really surprised me. In my experience, few charophytes can survive a pH of 5 for a prolonged period of time, so how is it possible to «re-use» them? And where will they harvest the -presumably large- amounts of *Chara* which are necessary to treat bigger volumes of water containing phenol? To me it seems that more questions need to be answered before this technique can be put into practice.

Liu and Wu where not interested in whether the charophytes would remove toxins from the water, but rather if *Chara* is able to survive the toxic effects of linear alkylbenzene sulfonate (LAS), a substance which the authors claim is a common organic pollutant in freshwater environments. Since earlier studies on LAS have shown that toxicity on aquatic plants is species specific, the authors tested its effect on *Chara vulgaris*. It turned out that there indeed were effects detectable at "lower" doses of 1 mg/l (the dry weight of *Chara* was reduced and the activity of oxidative enzymes increased). However, the authors nevertheless concluded that even higher doses (5 mg/l) were far from lethal, although they indeed caused some damage. I must admit that I am a little sceptical about their conclusions because I am not sure to which degree these results are ecologically relevant. Firstly, I am wondering if 1 mg/l really should be called LOW concentration. And secondly, the experiment lasted two weeks only! If some effects are apparent already after 2 weeks, I think it is highly likely that the *Chara* will suffer seriously if it is exposed to this toxin for a prolonged period of time. In my view, these results may not be used to conclude that *Chara* ecosystems happily would survive LAS pollution.

Absolonova et al. studied the impact of salt stress on *Chara australis*. For non-physiologists, like myself, these papers are sometimes not easy to understand. But if I understood correctly, the bottom line is that salinity interferes with pH at the cell wall, by affecting the proton pump and H+/OH- channels. The authors used a special type of microscopy which enabled them to "see pH" outside the cell wall. Salinity caused the formation of alkaline spots on the cell wall, and "destroyed" the pH banding pattern which normally is present on the cell wall. So it seems the problem with salinity is not so much the osmotic component in itself, but more related to changes in pH in and on the cell wall.

There also were some publications on individual species, and on species distribution. Brzozowski et al. described the occurrence of *Lychnothamnus barbatus*, a very rare species which often is associated with oligotrophic conditions, in a meso-eutrophic lake in Poland. *Lychnothamnus* occurred together with "eutrophic" species like *Myriophyllum spicatum* and *Ceratophyllum demersum*. However, *Lychnothamnus* occurred deeper than the other species. In general, I think we should start to acknowledge that charophyte habitats are not necessarily "oligotrophic". In dense charophyte beds, photosynthesis may be as high as in eutrophic plankton-dominated lakes! The difference is that photosynthesis is confined to the bottom (= benthos) in charophyte lakes, while it is pelagic in "typical" eutrophic lakes. But there is a lot of primary production going on also in charophyte lakes, and the nutrients necessary to support this production often are in the sediment.

Karol et al. studied *Chara brittonii*, a species which is endemic to North America and has previously been described from only few localities. They found the species in nine localities, and phylogenetic analyses of these samples placed *C. brittonii* among a paraphyletic grade of *C. foliolosa* sensu lato. They therefore conclude that *C. foliolosa* must be split up into several species, and that *C. brittonii* is a distinct species worthy of conservation. In my view, if a taxon really is phylogenetically separate, then there are reasons to treat it as a species, so I would agree with the authors. I also really appreciate the fact that this manuscript was published in a journal called «Brittonia». What an admirable sense for details!

Blindow et al. published the first part of their extensive work on the taxonomy and distribution of charophytes in Chile. They did a lot of work, both in the field and by checking herbaria. Interestingly, they observed high within-species variability in the length of spines, bract cells and stipulodes as well as branchlet cortication, and consequently suggest that these traits are of limited value for species identification. Those of you who have heard some of my presentations in the last years will understand that I certainly agree with Blindow et al. for that matter. 😉

Several papers were in some way or another on grazing, and our charophytes played both direct and indirect roles. A very interesting study was done by Hesselschwerdt and Wantzen. The 'killer shrimp' *Dikerogammarus villosus* is a relatively new invader to Lake Constance, and feeds on our good old *Gammarus roeselii*. The killer shrimp, however, prefers warm temperatures, which is why the predation on *Gammarus* was strongly reduced at temperatures below 6 degrees. *G. roeselii* can therefore disperse throughout the littoral in winter, when it can avoid predation by the killer shrimp. Artificial heating of a section of the lake shore, however, resulted in local extinction of *G. roeselii* by the killer shrimp. These “killers” just completely consumed the *Gammarus*! This means that climate change is bad news for *Gammarus* in lakes where the killer shrimp also is present! Very interestingly, however, *Chara* sp. inhibited predation by the killer shrimp on *G. roeselii*. The authors do not really say why this was the case, but maybe the *Gammarus* just was hiding in our dear charophytes? Whether or not *Gammarus roeselii* can survive in Lake Constance will therefore depend on our charophytes: if they decline, the combined effect of warmer temperatures and less charophytes may be the end of *Gammarus*. If the charophytes should manage to survive, however, there is hope also for *Gammarus*!

But there also are other, more exotic, grazers! Allen et al. studied the diet of Antillean manatees (also called sea cows) in Belize. They microscopically examined mouth (sic!), digestive tract and faecal samples, and found that seagrasses clearly were eaten most. However, mangroves and algae also were important food items. And among the algae, next to *Ulva* sp. and *Lyngbya* sp., was our *Chara* sp.!!! I am wondering which species of *Chara* it was … it must have been one of those which tolerate quite a bit of salinity.

Wood et al. published an interesting study on crayfish herbivory. They first checked how much *Myriopyllum exalbescens*, *Elodea canadensis* and *Chara* sp. the crayfish eats. Not surprisingly, because this was known from before, the crayfish preferred *Chara* over the other macrophytes, but all three species were eaten, and the differences were not large. But there is a fish (largemouth bass) which feeds on the crayfish! And when the crayfish “smelled” the bass (the fish could not actively reach the crayfish in the enclosure, it could only “threaten” the crayfish by their “smell”), the crayfish changed its feeding behaviour! Firstly, they crayfish started to eat more when they smelled the fish, probably simply because they were stressed and therefore needed more food to cope with the stress. And secondly, they also only consumed very little *Myriophyllum*, but much more *Elodea* and *Chara*!! So, in the same way as we may start eating more chocolate but not more vegetables when we are stressed, the crayfish starts to eat *Chara* and *Elodea* but not *Myriophyllum* when stressed! This means the fish has an indirect effect on the macrophyte community, by changing the feeding behaviour of the crayfish! In other words: also fish which do NOT actively feed on macrophytes may in fact change macrophyte communities!!

But crayfish are not only being a danger for our charophytes. In fact, some crayfish are endangered themselves. Beaune et al. asked the question if the presence of charophytes can be used as a sign if an ecosystem is a suitable habitat for the endangered crayfish *Austropotamobius pallipes*. And yes, they found that crayfish presence was consistently associated with *Chara* species (such as *C. aspera*, *C. virgata*, *C. fragifera*, *C. polyacantha* and *C. vulgaris*). So, the authors suggest that the presence of *Chara* species is a simple (for those that know charophytes!!) and low-cost tool for determining whether or not a habitat is suitable for re-establishment of this endangered crayfish. The only challenge I see is that the crayfish may like the charophytes too much … many of us have seen habitats where the charophytes were completely “eaten up” by crayfish! Let us hope the re-introduction of the crayfish will be successful, but not too successful.

And important paper was published by Nishiyama and VERY many co-authors, who have analysed the genome of *C. braunii*. This was not only a very extensive and laborious work, but it also revealed a lot of interesting details with respect to the evolution of land plant features. Several algal lineages evolved to occupy terrestrial environments, but only one represents the land plant ancestor, and our charophytes are very closely related to that. The draft genome of *C. braunii* revealed many plant-like features important for colonization of land that evolved in charophytic algae. This means that they evolved BEFORE land was colonized. One of these features is the phragmoplast, i.e. the structure that builds the cell wall between daughter cells. The phragmoplast is assumed to have enabled filament branching. That means it probably has enabled the complex morphology of our charophytes. Land plants have evolved the phragmoplast a bit further, i.e. it is not identical with the *Chara* phragmoplast, but our charophytes seem to have been the inventor of it! The *C. braunii* genome revealed several other evolutionary novelties, including phytohormones and features controlling sexual reproduction.

Finally, there was a study which quite contrasts with our usual efforts to protect charophytes. *Nitellopsis obtusa* is considered invasive in Minnesota, and Glisson et al. tested how to best control this species. They examined the effects of mechanical and algaecide treatments on *N. obtusa* biomass, bulbil density, and bulbil viability. To their great worry and my equally great happiness, they found that bulbil viability actually was greatest in the area treated with the algaecide!! They then did a second treatment with the algaecide to check if this would kill the *Nitellopsis*, but also the second treatment did not really reduce *Nitellopsis* biomass, and instead lead to an increase in bulbil density. The authors find the ability of *N. obtusa* to regenerate and persist following algaecide treatment concerning. In fact, I think the opposite is true! In my view, herbicide treatment (Using the word "treatment" is a euphemism! In fact, it is not a treatment, but a mass killing!) is used far too easily. Instead of spraying toxins into aquatic ecosystems, the authors and the water managers should try to figure out some important issues. (1) What is the underlying reason of the mass development, and can we do something about it? (2) What are the ecological consequences of the herbicide treatment for other than the target species? And most importantly (3) Which other organism is likely to take advantage of the removal of the charophytes? Dense patches of *Nitellopsis* contain quite a few nutrients, and it is naïve to believe that nobody will use the nutrients which are obviously in the ecosystem. In fact, planktonic algae, including toxic cyanobacteria, are the most likely candidates to use these nutrients once *Nitellopsis* has been removed. This means, if they should manage to eradicate the *Nitellopsis* from the ecosystem, they will likely get problems which are much worse than any trouble the charophytes may have caused!

**Susanne Schneider (Norway)**

(references in the text and in the list below are given without the year published, since this is 2018 in all instances)


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## *ECOLOGICAL ENGINEERING*

### The role of ecological engineering in the removal of contaminants from alkaline mine waste water: A sustainable decommissioning technology using charophytes.

In 1982, Margarete Kalin founded Boojum Research Limited in Toronto, Canada. Boojum is an R&D company developing ecological and sustainable approaches to mine decommissioning and remediation. Ecological engineering, applied ecology was established by Eugene and Howard Odum and promoted by William J. Mitsch mainly for wetland restoration and organic pollutant degradation. Margarete Kalin translated the discipline with her team of scientist to mine waste remediation and water management. Here inorganic contaminants are retained within the wastes and stabilized by microbes as biominerals in sediments. Ecological engineering supports the growth of indigenous microbes, fungi and algae. Ecological engineering works within the wastes altering the extremely harsh ecosystem components and gradually the water quality of the drainage from the wastes is improved.

One of the technologies pioneered by Boojum Research is biological polishing. Here aquatic plants, algae and microbes sequester contaminants through adsorption and absorption. Once removed from the waste water, the contaminants are transported (after death of the organism) to underlying organic sediments. There, other, heterotrophic microbes transform and retain the contaminants. This technology is especially useful in alkaline mine waste waters, where charophytes (green algae) can effectively sequester a wide variety of mine contaminants, such as radium, uranium, selenium, and heavy metals.

We proudly report, that to the best of our knowledge, the transplantation of biomass of *Nitella flexilis* to a lake void of aquatic vegetation and its expansion has negated the need for the construction of a chemical treatment plant to remove Ra226 from the waste water of a uranium mine in northern Saskatchewan, Canada. In constructed ponds *Chara vulgaris* was seeded treating discharge of an underground inactive mine effectively. The feasibility of using charophytes in a number of other alkaline mine systems has been evaluated. These reports along with those from the Canadian project are electronically available at the Laurentian University Library. These reports may be of interest to members of the IRGC. If more information is needed, please contact Margarete Kalin, margarete.kalin@utoronto.ca

**The reports are listed below with a short commentary on the content**

**A feasibility investigation of the potential use of the "Chara Process" and indigenous biota as passive polishing agents for cyanide in waste liquors at Arvida by M. Kalin, 1985.**
File CH001: https://zone.biblio.laurentian.ca/handle/10219/3049
Commentary: The feasibility study suggested that charophytes would remove cyanide, but further work was hindered due to the business conditions demanded.

**A feasibility study on the use of the *Chara* process and an assessment of the reclamation by ecological engineering for the Levack tailings by M. Kalin, 1985.**
File AR001A: https://zone.biblio.laurentian.ca/handle/10219/2980
Commentary: *Chara vulgaris* grew well, until a truckload of concentrated NaOH solution was dumped into the pond. The mine manager apologized.

**The Chara Process: Biological economization of mill effluent treatment. Potential application and preliminary results by M. Kalin, 1985.**
File CN001A: http://pdf.library.laurentian.ca/medb/Reports/Boojum/Other/CN001A.pdf
Commentary: Interesting growth tests of *C. globularis* and *C. vulgaris*

**Growth dynamics of naturally-colonizing Characeae in abandoned tailings ponds by M. Kalin and M.P. Smith, 1987.**
File CN003A: http://pdf.library.laurentian.ca/medb/Reports/Boojum/FinalReports/CN003A.PDF
Commentary: Interesting field observations on growth characteristics of naturally-colonized alkaline mine tailings areas.

**Ecosystem restoration in the Rabbit Lake drainage basin: Retaining 226Ra and uranium within the waste management area. 2003**
File: https://zone.biblio.laurentian.ca/handle/10219/2916
Commentary: Summary of a twelve year study into the ecology of transplanted *Nitella flexilis* by at a uranium mine in northern Saskatchewan, Canada.

**Chara Process: Biological polishing of alkaline effluents by M. Kalin and M.P. Smith, 1988**.
File CN004: http://pdf.library.laurentian.ca/medb/Reports/Boojum/FinalReports/CN004.PDF
Commentary: Introductions of *Chara vulgaris* biomass to limnocorrals set up in many alkaline tailings areas and first tests of germination of oospores in the field.

**Ecological engineering and the Chara Process applied to the Rabbit Lake drainage basin by M.P. Smith and M. Kalin, 1992.**
File CA009: http://pdf.library.laurentian.ca/medb/Reports/Boojum/FinalReports/CA009.pdf
Commentary: The first observations leading to the application of the *Chara* process to prevent the construction of a chemical treatment plant for Ra226.

**Unterstützung bei der Ansiedelung von Characeen (*Chara*/*Nitella*-Arten): Bericht 4, 2002.**
File GM005: https://zone.biblio.laurentian.ca/handle/10219/2924
Commentary: *Chara vulgaris* oospores were transplanted from a Canadian gold mine tailings seepage to a biological polishing system at WISMUT in Germany. According to personal communication of the attendant, the oospores germinated and charophytes flourished in the ponds.

**Propagation of *Chara vulgaris* using sediment seed bank oospores and vegetative biomass 2003**.
File GM006: https://zone.biblio.laurentian.ca/handle/10219/2925
Commentary: The backup work to provide the ponds with suitable oospore concentrates.

**Selenium removal from coal mine valley fill effluents using *Chara*, 2013**.
File ZZ009: https://zone.biblio.laurentian.ca/handle/10219/2909

Commentary: The geochemical characteristics of Se in coal mine effluents suggest that it might be removed by charophytes. The University of Kentucky provided a contract to Boojum to investigate coal valley seep ponds in West Virginia, U.S.A. This scoping study revealed that the pond with a high biomass of *Chara vulgaris* had discharge water with the lowest Se concentration.

## *OOSPORE STUDIES IN LITHUANIA*

### Introduction

As for many charophytes species, the dispersion, colonization and maintenance of populations depend entirely on the oospore bank, it is important to know about the distribution of oospores, their dependency on environmental factors and which of these influence the current status of the population. Therefore, our research in 2018 was focused in the mapping of the distribution of oospores in the Curonian lagoon (Lithuanian part) and testing experimentally how the germination of oospores responds to burial in the sediment.

### Mapping of oospore distribution

During autumn and early spring, we performed field studies to map oospore distribution in order to understand their spatial patterns, how far and deep oospores are distributed from the stands of charophytes. Preliminary results suggest that abundance of oospores is highly related to the coverage of charophytes and extent of their stands. However, oospores were also recorded in the areas where no charophytes were found (i. e. mainly in the middle part of the study area and in >1.5 m depth). This suggests that light availability due to low water transparency and sedimentation (most likely burial by sediments) may limit the germination and/or development of charophytes under such estuarine environmental conditions.

### Testing effects of sediment burial on germination of oospores

In order to test the impact of different amounts of cover by sediments to germination of *Chara contraria* oospores (a dominant charophyte in the Curonian lagoon), oospores with sediments were collected in the lagoon at the end of the vegetation season in 2017 and stored at 4-5 °C in the dark for a month before experimentation. We selected 50 viable calcified oospores and buried them in tubes with sediments at depths of 1, 5 and 10 cm (3 replicates for each depth). The experiment lasted 60 days. Oospores germinated in the all experimental set ups, but emergence time for germlings was different. First germlings were observed after 12 days from 1 cm sediment depth, after 21 days in the 5 cm treatment and after 49 days from 10 cm sediment treatment. Germlings developed only from 1 cm buried oospores, whereas shoots stopped growing after germination in the other (5 and 10 cm) treatments. Results indicate that there is a likely impact of burial by sediments and oospores buried deeper than 5 cm may exhibit delayed development and can later be out competed by macrophytes that have germinated earlier.

**Martynas Bučas, Vaiva Stragauskaite (Lithuania)**

## *PhD THESIS COMPLETION*

**Anne Herbst**, Aquatic Ecology, Faculty of Mathematics and Natural Sciences, University of Rostock. Supervisor: Hendrik Schubert

PhD thesis title: **Encrustation of charophyte species – seasonality and habitat specificity.**

On October 19, 2018, Anne Herbst defended her PhD thesis at the Faculty of Mathematics and Natural Sciences, University of Rostock. The PhD thesis has been reviewed by Hendrik Schubert (University of Rostock, Germany) and Mariusz Pełechaty (Adam Mickiewicz University, Poland).

In this thesis the encrustation and elemental content of different charophytes were studied in order to identify the main factors that determine extracellular carbonate precipitation. The hypotheses were that carbonate precipitation is 1.) dependent from seasonality, 2.) species-specific and, 3.) influenced by water chemistry parameters.

Charophyte species growing in different habitats (freshwater, marine-brackish water, and brackish water sites with strong ion anomalies) were studied.

For resolving seasonality of encrustation, six charophyte species from two hard-water lakes were investigated monthly for a period of one year. Seasonal patterns were analysed for the interaction with water chemistry. Encrustation followed a seasonal pattern for *Chara contraria*, *C. subspinosa* and *Nitellopsis obtusa* in Krüselinsee and for *C. globularis* and *C. tomentosa* in Lützlower See. However, no seasonality in the precipitated $CaCO_3$ was observed for *C. subspinosa* in Lützlower See or for *C. tomentosa* in Krüselinsee, indicating a lake-specific dependency. Seasonal encrustation patterns of charophytes were species-specific and correlated negatively with the concentration of total inorganic carbon of both lakes. Seasonality and TIC were the most important parameters determining the element composition of investigated charophytes.

A comparison of encrustation and element content across species growing in freshwater and brackish water was conducted. Significant differences in encrustation of charophytes were found between FW and BW sites. Individuals from FW had a far higher carbonate content based on dry weight than individuals from BW. In BW, *C. tomentosa* was less encrusted than *C. aspera*. The effect observed was caused by physico-chemical characteristics and physiological mechanisms, the latter being species-specific and consequently leading to species-specific differences in encrustation of *C. aspera* and *C. tomentosa* under BW conditions. The K/Na ratio differed between FW and BW in a species-specific manner. Elemental composition was habitat-specific for Ca and Mg, species-specific for K, and habitat- and species-specific for Na. P contents showed no particular pattern.

In brackish waters with a strong ion anomaly, ion composition rather than ion concentration, and especially the $Na^+$ ratio to other ions, influences the encrustation of charophytes. The carbonate composition of charophytes (Ca > K > Mg > Na > P > Mn) was shifted towards Na content when exposed to waters with high $Na^+$ concentration. Charophytes withstand the heavy metal concentrations of the Schlüsselstollen (adit) water when diluted. Cd, Cu and Zn were co-precipitated in the carbonate crust of charophytes. Pb was not detected in the carbonate crust, probably having been deposited in the sediments. Charophytes can be used for bioremediation in $Na^+$ depleted water by co-precipitation of Cd, Cu and Zn.

**Anne Herbst (Germany)**

**Sara Calero**, Cavanilles Institute for Biodiversity and Evolutionary Biology, University of Valencia. Supervisor: María A. Rodrigo Alacreu

PhD thesis title: **The phenology of submerged macrophytes from Mediterranean wetlands as a sentinel of climate change.**

On 28th November 2018, Sara Calero defended her PhD thesis at the Cavanilles Institute for Biodiversity and Evolutionary Biology (University of Valencia) in front of the jury composed by Dominique Auderset Joye (University of Geneva), Eduardo M. García-Roger (University of Valencia) and Susanne C. Schneider (Norwegian Institute for Water Research).

The dissertation was compiled of 8 papers, 5 of them previously published in international peer-reviewed scientific journals.

The study of phenology, *i.e.* the timing of recurrent biological events, is being used to track climate-change effects on organisms. Although submerged macrophytes play a key role in structuring shallow ecosystems, little information about their phenology is available. This thesis presents the first data (from 2014 to 2016) of a desirable long-term study. The main aims were: (i) to establish a methodological basis for the phenological study of submerged macrophytes, (ii) to describe the reproductive phenology of six species (*Chara hispida*, *C. aspera*, *C. canescens*, *Nitella hyalina*, *Stuckenia pectinata* and *Utricularia australis*) in two Mediterranean brackish ponds; and (iii) to unravel if their phenology might act as a tracker of climate change.

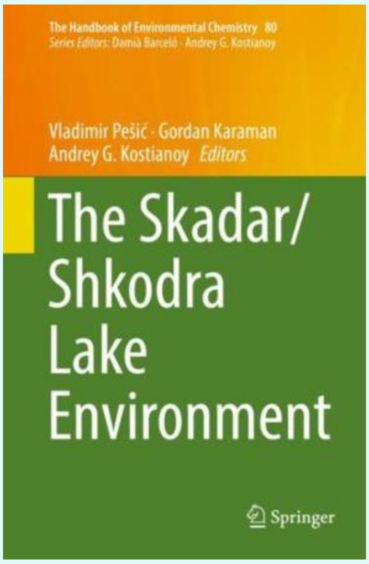
A huge sampling effort and thorough observation, plant by plant, were performed to detect the presence and production intensity of gametangia/oospores and flowers/fruits. The size of gametangia from each charophyte species was conscientiously measured to design a quantitative cost-effective method to differentiate phenophases. Different physical and chemical features of water (temperature, light, water level, conductivity, pH, etc.) were also monitored where the plants grew. Several approaches and analysis methods were used to describe and compare the data. The thermal time model, using the growing degree-days parameter, was applied to understand the reproductive onsets, peaks and periods. Circular statistics, a developing, powerful tool in phenological studies, was applied to test the species-specific seasonality in reproduction.

Aquatic angiosperms reproduced mainly vegetatively, while charophytes showed a high intensity of sexual reproduction and a long fertile period with a strong peak in spring-summer and occasionally a weak one in autumn, depending on the rainfall maximum. Each species of submerged macrophytes showed distinct phenological patterns, depending on its life-history strategies and the species-specific responses to interacting environmental factors. Even variations within a same ecosystem, *e.g.* related to water depth, affected the reproductive timing of individuals from the same population. Underwater temperature, water level and salinity were the factors altered by climate change that most affected the ripening of gametangia/oospores and the flowering/fruiting of submerged macrophytes. Charophytes, particularly, have shown themselves to be good candidates for tracking variations in climate change factors.

Accurate forecasts on shallow ecosystems require more detailed knowledge of the responses of submerged macrophytes throughout their whole life cycles and across latitudes. Phenological variables can be applied to the conservation and management of declining populations and habitats. This thesis has laid the foundation for the establishment of a realistic design of a long-term data series and will hopefully inspire more long-term, inter-site and multi-latitude studies of macrophyte phenology.

**Sara Calero (Spain)**

***BOOK REVIEW***




**The Skadar/Shkodra Lake Environment**

The book "The Skadar/Shkodra Lake Environment", edited by Pešić, V., Karaman, G. and Kostianoy, A. G., has recently been published by Springer as a Part of the The Handbook of Environmental Chemistry book series (HEC, volume 80).

This book reviews the unique ecosystem of the Lake Skadar/Shkodra and its basin and discusses the latest advances made in this region to face the impact of climate change. In more than 20 chapters the book deals with different topics related to Skadar/Shkodra Lake, such as basic physical, geographical and hydrological characteristics of the lake, water and sediment chemistry, various groups of organisms (phyto and zooplankton, zoobenthos, molluscs, water mites, batrachofauna, herpetofauna, ichthyofauna, ornithofauna, flora and vegetation, charophyte algae), as well as changes in chemistry and biota related to climate change and other anthropogenic influences, giving newest management approaches and the environment perspectives of this region.

The chapter particularly interesting for IRGC readers is surely a chapter related to ecology and distribution of charophyte algae in Skadar/Shkodra Lake, authored by Blaženčić, J. and associates. The paper summarizes charophyte research in the area of Skadar/Shkodra Lake from charophyte first findings at the beginning of the XX century up to present day, gathering all available literature, herbarium data and authors' own field investigations. Also, the data were compiled for the entire Skadar/Shkodra Lake basin, covering Montenegrin and Albanian parts of the lake. Altogether, 30 taxa (25 species) were recorded, accounting for 40% of the charophyte flora of Europe and 53% of the charophyte flora of the Balkans, making Lake Skadar/Shkodra "the most significant charophyte diversity centre in the Balkan Peninsula". Representatives of four charophyte genera are present in the lake, *Chara*, *Nitella*, *Nitellopsis* and *Tolypella.* The reasoning behind such a high diversity of charophyte algae lies in the specific geomorphological and climatological characteristics of Skadar/Shkodra Lake (shallow, highly productive, polymictic with significant annual water level fluctuations, etc.) resulting in the properties of an oligotrophic lake in what is basically a eutrophic lake. In this chapter the authors summarized taxonomic and ecological features of this group of algae in the Skadar/Shkodra Lake, gave distribution data and reviewed threat factors for charophyte species and their habitats. They also proposed protective activities be undertaken urgently in the future to preserve such a high diversity.

We are sure the IRGC readers and charophyte lovers will find this work interesting to read. The chapter related to charophyte algae:

Blaženčić, J., Kashta, L., Vesić, A., Biberdžić, V., & Stevanović, B. (2018). Charophytes (Charales) of Lake Skadar/Shkodra: Ecology and Distribution. *The Skadar/Shkodra Lake Environment*, *80*, 169.

can be found following next link: https://link.springer.com/chapter/10.1007/698_2018_265

The whole book can be found following next link: https://link.springer.com/book/10.1007/978-3-319-99250-1

**Aleksandra Marković, Jelena Blazencic (Serbia)**

## *CHAROPHYTE DISCUSSION FORUM*

List is currently not working due to the infrastructure problems of host university. We will announce when the problem is solved.

## *IRGC HOMEPAGE*

IRGC homepage is available: http://www.sea.ee/irgcharophytes/ Members are welcome to send relevant information to Kaire Torn (kaire.torn@ut.ee).

## *IRGC IN FACEBOOK*

We have created group in Facebook – International Research Group on Charophytes. This is an unofficial group for IRGC members to share information. The group is closed, so only IRGC members can see the posts.

You are welcome to share your photos, field works, research questions etc. among our community. We are looking forward to see your photos from the past meetings or getting information/photos about your current activities.

We created a shared account for members who are not interested to have their own personal account in Facebook, but would like to visit the IRGC group. Please contact Kaire Torn (kaire.torn@ut.ee) for details.

## *MEMBERSHIP FEES*

Please do not forget to send your membership fee for 2019. Multiple year payment is encouraged to reduce banking costs.

**INTERNATIONAL RESEARCH GROUP ON CHAROPHYTES**

**Membership fee annual amount – € 20**
Multiple-year payment is encouraged to reduce mailing and banking costs.
Any questions about membership fees should be addressed to:
IRGC Treasurer Emile Nat, e.nat@kranswieren.nl

**Bank to bank transfer**
Please pay to the IRGC account at Banque La Poste, France, and then send the receipt of your payment to Dr Emile Nat (The Netherlands), IRGC Treasurer, for our records (e-mail address: e.nat@kranswieren.nl)
When doing the bank transfer please ensure that your name and years of membership paid are included in the payment form.
To do the bank transfer, please give the following information to your bank:

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## *E-MAIL ADDRESSES OF IRGC MEMBERS*

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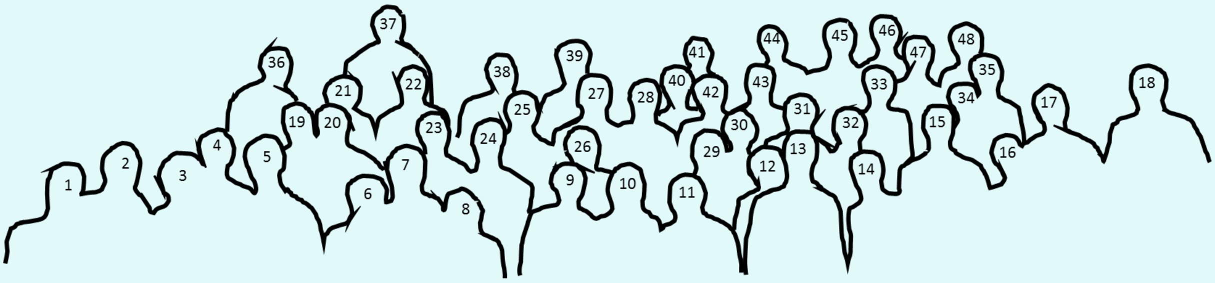
## GROUP PHOTOGRAPH 2018

**22nd GEC Meeting, Palermo, Italy**



1. Dario Salemi 2. Elke Naumer-Bernhardt 3. Michelle Casanova 4. Irmgard Blindow 5. Anthony Casanova 6. Małgorzata Strzałek 7. Adriana García 8. Elvan Demirci 9. Sara Calero 10. Maria Rodrigo 11. Aizhan Zhamangara 12. Zhanslu Inkarova 13. Angelo Troia 14. Teresa Napolitano 15. Michał Brzozowski 16. Sha Li 17. Carles Martín-Closas 18. Jean Nicolas Haas 19. Deborah Isocrono 20. Sherim Tulegenov 21. Nadia Abdelahad 22. Sophia Barinova 23. Allan Chivas 24. Khaled Trabelsi 25. Jordi Pérez-Cano 26. Ingeborg Soulié-Märsche 27. Eric Puche 28. Bruno Lambert 29. Zofija Sinkevičiėne 30. Anna Millozza 31. Anna Maria Mannino 32. Mariusz Pełechaty 33. Anja Holzhausen 34. Roch-Alexandre Benoit 35. Susi Schneider 36. Roman Romanov 37. Karl-Georg Bernhardt 38. Egbert Korte 39. Frank Pätzold 40. Elisabetta Oddo 41. Rosario Schicchi 42. Elisabeth Lambert 43. Anna Geraci 44. Laura Guglielmone 45. Ralf Becker 46. Malte Weber 47. Josep Sanjuan Girbau 48. Riccardo Guarino