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Tolypella nidifica (O.F.Müller) Leonhardi

EDITORIAL

Dear IRGC members,

Another year has passed, in which we have not been able to meet in person. We hoped that the Covid-19 pandemic would soon be over, and that we again would be able to meet, laugh, and discuss the very many interesting aspects of charophytes. Unfortunately, however, the virus objected to our plans. We have not been able to organize the international IRGC symposium in Gammarth, Tunisia, which originally was scheduled for March 2020. When Covid struck, we postponed the symposium, first by half a year, then a year, and later by another year. By now, we unfortunately have realized that we must cancel this symposium. The organizers are still trying to reimburse the payments which were made in connection with the IRGC symposium in Gammarth. This process seems very complicated and very bureaucratic. In February 2022, we sent an email to the organizers, and asked for the current status with respect to the reimbursement. We were informed that the reimbursement was blocked due to a double transfer which was made, that they were waiting for re-authorization from the central bank, and that they will start the transfer of the money again, once the authorization was ready. Since then, no further news has reached us.

But there are new meetings to look forward to! I am really glad to announce that our colleagues from Latvia, Egita Zviedre and Laura Grīnberga, have started preparations for the next GEC meeting which will be held in Riga, Latvia, in August 2022. I hope to see many of you again and look very much forward to intensive discussions on charophyte ecology, physiology, palaeoecology and species determination! After the meeting in Riga, the next IRGC symposium is planned for 2024, in Australia, organized by Michelle Casanova.

It is very sad that, on top of the Covid-19 pandemic, also the political situation has made international meetings more complicated. The IRGC has members from many countries in the world, and we, over the last 30 years, have become a "charophyte family". The IRGC is much more than a professional group. We are not only colleagues, we are friends, and we have understood the immense benefit of working across political borders. The European charophyte flora which soon will be published and to which 60 authors from 25 countries around the world have contributed, is proof of this. I sincerely hope that all IRGC members that wish and find the time, no matter from which country they are, will be able to leave their home country to attend the GEC meeting in Latvia, and be able to safely return home.

The IRGC will continue to work across borders, and I am glad and proud of every contribution made by you. I am looking forward to seeing all of you again. Do not underestimate the value of charophytes for peace and reconciliation!

Susanne Schneider

IN MEMORIAM

Professor S. B. Bhatia (1930 – 2021)

It is with sadness that we report that our colleague and faithful member of the IRGC, Professor Sashi Bhushan Bhatia passed away in Panchkula, India on May 2021 at the age of 91.

After his early studies at the Lucknow University, Sashi Bhushan Bhatia obtained his Diploma in 1953 at the Imperial College London, and his Ph.D degree from the London University. He co-founded the Geology Department, at Panjab University, Chandigarh in 1959, aged 29, where he acted as Professor until retirement and then continued long after as an Emeritus Professor. His last cooperative research publication was edited in 2018.

In 1989, he was among the founders of the IRGC and remained an active member of our charophyte community over 20 years. Since the 1st IRGC in 1989, in Montpellier until 2008 in Rostock, he attended the IRGC Symposia regularly (Nanjing, Robertson) and presented interesting talks.

Professor Bhatia was an accomplished geologist with specialisation in micropalaeontology. His contributions to the Indian geology cover a vast time span encompassing most geological ages from the late Palaeozoic to the Quaternary He worked mainly on the biostratigraphy and palaeoecology of microfossils and published also a number of important papers, not only about charophytes, but also dealing with many other groups such as foraminifera, ostracods, molluscs or bryozoans.

His research led to the discovery and study of fossil charophytes from India, which were largely unknown at the time when he began his studies. As a result, India is now a reference region for all fossil charophyte specialists (see selected list of publications below). His studies on the charophytes of the Dekkan intertrappean beds were particularly outstanding. The famous Dekkan Trapps were ejected around the Cretaceous-Palaeogene boundary, when India passed on his journey to the North, above a thermal hotspot in the middle of the Indian Ocean. These volcanic rocks, thousands of meters in thickness, have been considered as one of the possible causes of the Cretaceous mass-extinction. He was interested to show that charophytes were useful for characterization of the age of these intertrapps and he also explored the extent to which charophyte floras from that time experienced the effects of insularity or, in contrast, were similar to the charophytes from the Asian mainland (i.e. China).

A second subject in which Prof. Bhatia excelled was in the study of Neogene and Quaternary charophytes from India, some of them associated with fossils of hominid ancestors, such as those from the Siwalik Group. He not only provided data to better understand the palaeoenvironment of these important palaeontological sites, but also a fascinating biogeographic history of one important extant species, *Lychnothamnus barbatus*.

Additional significant contributions of Prof. Bhatia deal with the still poorly known charophytes from the Early and Middle Jurassic, including the characterization of the first gyrogonites with affinities to the family Characeae in the Lower Jurassic of India.

The legacy of Prof. Bhatia continues in India with several colleagues continuing to develop the school of micropalaeontologists he left behind, and publishing on fossil charophytes. We will remember Prof Bhatia as an extremely friendly and communicative person, ready to collaborate with other colleagues and to help with his outstanding knowledge about palaeontology. We would like to express our condolences to his family on behalf of the IRGC.

Ingeborg Soulié-Märsche (Montpellier) and Carles Martín-Closas (Barcelona)

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WHAT'S NEW ABOUT CHARA?

A brief overview of interesting charophyte studies published in 2021

Susanne Schneider (Norway)

We have put yet another year with more or less intense Covid-restrictions behind us. The Covid-restrictions certainly were quite boring, but maybe there were some exciting developments with respect to charophytes? In order to find this out I searched ISI Web of Science on January 10, using the search terms “Chara” and “2021”. The search resulted in 114 hits. This is quite a bit more than last year, but of course not all these 114 papers dealt with «our» charophytes. Nevertheless, many papers indeed were both relevant and interesting!! There simply were too many interesting papers, such that there was no way I could include all of them in this brief overview. I am really sorry for all those whose interesting paper I could not include here, but I just had to select. The papers I mention below were selected exclusively based on my personal interest, and are not in any way a judgement of scientific quality.

One issue which I noticed over the last years is that we, slowly but steadily, increase our knowledge on charophytes from what I would like to call “somewhat exotic” regions of the world. Khuram et al. did a study in a beautiful area that faces a challenging political situation, the Peshawar Valley through which the Kabul river flows. It is situated in the Khyber Pakhtunkhwa province in Pakistan. Khuram et al. found charophytes at 41 sites in the Peshawar valley, and identified *C. braunii*, *C. connivens*, *C. contraria*, *C. globularis*, *C. vulgaris* and *Nitellopsis obtusa*. They also measured some water quality parameters, to provide ecological background information for each species.

I am also really glad that more and more studies, from many different areas of the world, publish phylogenetical data of charophytes along with morphological descriptions. Saber et al. studied charophytes in aquatic biotopes across the Egyptian Western-Desert oases and Sinai Peninsula, and not only did they determine the charophytes morphologically, but also included a phylogenetical characterization in their study. Along with other, more «common» species they also found *Chara globata*, and a *Tolypella* taxon which did not cluster together with any of the known species in the phylogenetic analysis. In my view, it is very important that the barcodes of more species, also from «exotic regions» are being published, such that we eventually will have a chance to increase our knowledge on the genetic and morphological variability within, and differences among, charophyte species. In this way, we can also collect better information on changes in the distribution of individual species. *Chara zeylanica*, for example, has never been found in Europe before. Becker et al., however, recently found it on the island of Sardinia, Italy, and confirmed the morphological identification with phylogenetic analyses. This means that the number of charophyte species described from Europe is increasing, and determination of *Chara* in Europe becomes an even greater challenge. Romanov et al. also added a significant contribution to this “challenge”: they indeed described a new *Chara* species! It was found in rice fields in the European Mediterranean area, and for this reason, the new species was called *Chara oryzae*. It is not only morphologically different from other known *Chara* species, but also phylogenetically. An unknown factor, however, is that *Chara oryzae* likely is not native for Europe, because it only was found in rice fields which have been cultured for many decades. Nevertheless, congratulations to Romanov et al. for finding a new *Chara* species, and for providing the charophyte community with a new challenge: who will be the first to find *C. oryzae* in its native habitat, wherever this may be??

I also discovered that our charophytes are being used for some really «different» purposes, i.e., purposes that at least I never ever thought of. Some years ago, silver nanoparticles became very popular, because they have antimicrobial properties. Unfortunately, the production of these nanoparticles usually involves a chemical process, and this process might be harmful for the environment (silver nanoparticles are not completely harmless for us humans either; but this is a different issue which we shall not discuss here). So, Hassan et al. wanted to develop a «green synthesis» of silver nanoparticles. And guess what? They used an aqueous extract of *Chara vulgaris* (produced from dried and ground *Chara* material) together with $AgNO_3$ and managed to produce silver nanoparticles. A similar production process has successfully been tried with marine algae before, but it seems that charophytes never were tested. The mechanism works because the algal material provides Cl^- ions, which interact with the $AgNO_3$ to form AgCl. The AgCl then is partly reduced to Ag with «phytochemicals», i.e. organic molecules that are present in the *Chara* extract. In this way, Ag/AgCl nanoparticles are formed. I do not really understand the benefit of using *Chara* instead of marine algae (which have been tested abundantly before), but I nevertheless found this an interesting and very «different» use of charophytes.

A possibly even more "exotic" topic was studied by Badshah et al. They assessed the suitability of *Chara vulgaris* for bioenergy production via pyrolysis. Pyrolysis is the heating of an organic material, here *Chara* biomass, in the absence of oxygen, and it is one of the technologies available to convert biomass to an intermediate liquid product that can be refined to hydrocarbon biofuels, oxygenated fuel additives and petrochemical replacements. I do not understand the thermodynamics presented in this study, but the authors – indeed – conclude that, based on thermodynamic aspects, *C. vulgaris* is particularly interesting for use as a raw material to produce biofuels and bioenergy. Imagine driving your car with *Chara vulgaris*!!!!! I must admit that I find it difficult to imagine that we can cultivate sufficient *Chara vulgaris* for production of biofuel in a reasonable scale. But maybe somebody soon develops a method how to get around this problem? Personally, I would find it quite spectacular if I could drive my car from Oslo to Munich on *Chara vulgaris*!

Most publications, however, were on ecological topics which probably are more familiar to us. Van Onsem and Triest asked themselves what happens to charophytes in a pond which gets overgrown by dense mats of *Lemna minor*. Will the charophytes rush towards the light or rather speed up reproductive efforts and "escape using propagules"? Van Onsem and Triest did a mesocosm experiment using *Chara globularis* and, maybe not surprisingly, found that *C. globularis* lost biomass and developed longer internodes (i.e., they stretched towards the light). This type of reaction has been observed earlier (not at least in some of my own experiments some 20 years ago). In addition, it turned out that *C. globularis* produced fewer oospores when shaded by *Lemna*. This matches nicely with many observations that charophytes produce fewer propagules in deeper water, where there is little light. Overall, duckweed dominance clearly suppressed the overall reproductive performance of *C. globularis*. This means we should pay attention that not too many of our charophyte ponds get overgrown by *Lemna* in the future.

Not all of the future is bleak, however. Brzozowski et al. looked at the development of *Lychnothamnus barbatus*, a rare charophyte species, in Lake Kuznickie. They took sediment cores, dated them, and looked for *Lychnothamnus* oospores. Brzozowski et al. demonstrated that *Lychnothamnus barbatus* has been present in the lake since the beginning of the 16th century, and its abundance increased in the 19th century, particularly during climate warming at the end of the Little Ice Age. This means that the species could benefit from climate warming! Given the *Lemna* results described above, however, we should better make sure that the ecosystems do not become too polluted while they get warmer.

Not all charophytes, however, are «wanted» in all places. Pelechaty et al. had a closer look at the biodiversity in stands of *Nitellopsis obtusa*, a species which is red-listed in many countries in Europe but considered invasive in North America. They found that *Nitellopsis obtusa* can produce dense stands in what they call “less mineralised” and “less fertile” waters. At the same time, biodiversity declined with increasing *Nitellopsis obtusa* biomass, probably because other species were outcompeted. This indicates that *Nitellopsis obtusa*, in certain conditions, can be a superior competitor, which may explain why the species can form nuisance stands in North America. Sleith and Karol did some detective work to find out who actually brought *Nitellopsis obtusa* to North America! They sequenced abundant material from both the native and invasive range, including 100-year-old herbarium specimens! And they found evidence that the species was introduced from Western Europe! Maybe some of you now start feeling guilty and nervous, because Sleith and Karol are on your heels?!? 😉 But Sleith and Karol also found a single nucleotide transversion in the plastid genome, that separated a group of five samples from Michigan and Wisconsin from all other samples. This transversion either resulted from introductions of two closely related genotypes (i.e., the species was introduced two times), or alternatively, a mutation that has arisen in the invasive range. No matter what, this transversion can serve as a useful tool to understand how *Nitellopsis obtusa* moves across the landscape in North America.

Kotta et al. had a look at photosynthesis and growth of *Chara aspera* in the Baltic Sea. They measured production and growth of *Chara* individuals and of dense monospecific stands and found that growth was largely determined by temperature and light, both for the individuals and the dense stands. However, algal production was systematically lower in the dense stands, than for the measured individuals, suggesting that self-shading and processes in the sediment affected production and growth. Simply speaking, this means that 100 *Chara aspera* individuals do not produce 100 times more oxygen than one individual. Or, even simpler: one plus one is **not** two when measuring photosynthesis of charophytes!

Rodrigo et al. studied how charophytes affect their ecosystem, specifically the upper sediment underneath charophyte meadows. They did an outdoor experiment, where they compared mesocosms with and without charophytes (using *Chara vulgaris* and *Chara hispida*) and found that there were four times as many cladoceran ephippia, i.e., winter or dry-season eggs, underneath charophyte meadows than in mesocosms without charophytes. In addition, the biomass of diatoms was 10 times higher underneath charophytes, than in mesocosms without charophytes. Rodrigo et al. not only saw a difference between mesocosms with and without charophytes, but also between *C. hispida* and *C. vulgaris*. Overall, the study of Rodrigo et al. shows that charophytes make a big difference for the organisms living in aquatic habitats.

Owens et al. were interested in how ecosystem processes are affected by charophytes, and they did a study on the exchange of nitrogen and phosphorus between sediment and water in estuarine lakes situated between the freshwater Everglades and marine Florida bay. In these lakes and adjacent shallow water Florida Bay environments it is expected that the restoration of hydrological flows will lead to an expansion of lower salinity environments. This is very interesting but what has it to do with our charophytes? Well, Owens et al. found that the largest difference between light and dark effluxes of NH_4^+ from the sediment occurred in lakes during periods of low cover of

Chara hornemanni. Efflux of NH_4^+ was less when there was more *Chara*. The authors of the study expect that the expansion of lower salinity environments due to hydrological flow restoration will lead to an expansion of *C. hornemannii*. In view of the results explained above, this should decrease the efflux of NH_4^+ from the sediment, and potentially lead to fewer algal blooms. This means that our charophytes have a significant effect on nutrient cycling in lakes! Apart from that, I take the results also as support for my own old hypothesis that charophytes prefer to take up nitrogen in the form of NH_4^+ from the sediment!

The results of Rodrigo et al. and Owens et al. underline why the re-establishment of charophyte vegetation often is an important goal in lake restoration projects. But how do you re-establish charophytes? Some species may re-appear spontaneously, if viable oospores are in the sediment, and the conditions are «right». But often only the "common" species re-appear spontaneously, while rare and red-listed species do not appear on their own, even if apparently suitable habitats are available. In such cases you may have to transplant the charophytes. Perennial species can relatively easily be transplanted, because it often is possible to find sufficient amounts of biomass elsewhere. With annual species, however, this might be more difficult. Blindow et al. review these and other challenges in their paper. I can say that it makes very interesting reading!

Charophytes are often seen as typical inhabitants of oligotrophic ecosystems. However, very many species also thrive in eutrophic habitats, and some species seem to be able to survive in both. Politi et al. wondered how charophytes can survive in eutrophic environments. Why are they not outcompeted by other, faster growing species? They measured benthic primary production and respiration, and inorganic nitrogen fluxes in a *Chara contraria* stand in the Curonian Lagoon, a eutrophic estuarine system. They found high primary production and respiration within charophyte stands, resulting in pronounced daily O_2 variations in the overlaying water. However, it turned out that epiphytes were responsible for a major fraction of the benthic primary production! On a daily basis, the charophyte stand was a sink for inorganic nitrogen via assimilative NH_4^+ uptake during the day, and denitrification during the night. Interestingly, active NH_4^+ excretion by amphipods supported nearly 40 % of the nitrogen uptake by the primary producers! The authors therefore speculate that amphipods keep feeding on epiphytes that grow on charophytes, thus keeping *C. contraria* «clean» and recycling large amounts of nitrogen via herbivory and excretion that can immediately be re-used by benthic primary producers.

But have you ever wondered how complicated the life of a charophyte actually is? Adapting to changing salinities, for example, is more complicated for a water plant than you might think. When salinity in the water changes it will affect the cell turgor. This means that there is a risk for the plant to either collapse (when salinity of the water increases, and water flows out of the cell) or explode (when salinity decreases, and water flows into the cell). At the same time, cell membranes function as resistors, leading to a slightly negative charge inside the cell. This is the reason why cations, such as Na^+, can enter the cell relatively easily, while this is a challenge for anions, for example Cl^-. But when you only allow cations into the cell, then the cell inside will lose its negative charge, which in turn will make the uptake of nutrients and carbon more complicated. So, our *Chara* cell has a lot to think about, when salinity changes! An additional problem is that Na^+ often is a little toxic, because it affects the functionality of enzymes that depend on K^+. For this reason, charophytes need to kick the Na^+ out again. In other words: salinity is quite a big challenge when you are a charophyte! Phipps et al. studied, in two related papers, the evolution of salt tolerance in *Chara*, by comparing salt-tolerant *Chara longifolia* with salt-sensitive *Chara australis*. Very briefly, there are different transporters which charophytes use to kick the Na^+ which enters into the cell out again. Phipps et al. showed that both the salt-tolerant *Chara longifolia* and salt-sensitive *Chara australis* have genes coding for a Na-H antiport, i.e. a channel that uses the energy of one H^+ flowing into the cell to kick one Na^+ out. In addition, however, the salt-tolerant *Chara longifolia* has genes coding for a so-called Na-ATPase, i.e. a channel which can kick Na^+ directly out of the cell, instead of using the detour via H^+. The Na-ATPase is more effective in kicking the Na^+ out than the Na-H antiport, probably because it works independently of water pH (while the effectiveness of the Na-H antiport is poorer at both high and low pH). This seems to be (one of) the reasons why *Chara longifolia* is more salt-tolerant than *Chara australis*. If you are interested in salt-tolerance, then we will soon provide you with more information. Mary Beilby, Mary Bisson and I are currently busy with a manuscript with the tentative title "ecophysiology for ecologists", and salt-tolerance is an important aspect we are trying to explain.

References (all years are 2021; for a complete list of co-authors and page numbers, please check the publications)

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Becker et al., *Chara zeylanica* J.G. Klein ex Willd. (Charophyceae, Charales, Characeae): First European Record from the Island of Sardinia, Italy. Plants (Basel) 10(10):2069.

Blindow et al., Re-Establishment Techniques and Transplantations of Charophytes to Support Threatened Species. Plants (Basel) 10(9):1830.

Brzozowski et al., Preliminary evidence of an endangered species benefiting from moderate climate warming: A palaeolimnological study of the charophyte *Lychnothamnus barbatus*. Aquatic Conservation – Marine and Freshwater Ecosystems 31(10).

Hassan et al., Facile green synthesis of Ag/AgCl nanoparticles derived from Chara algae extract and evaluating their antibacterial activity and synergistic effect with antibiotics. Journal of Environmental Chemical Engineering 9(4).

Khuram et al., Effect of water quality on the spatial distribution of charophytes in the Peshawar Valley, Khyber Pakhtunkhwa, Pakistan. Oceanological and Hydrological Studies 50.

Kotta et al., Scale-Specific Patterns of the Production of the Charophyte *Chara aspera* in the Brackish Baltic Sea: Linking Individual and Community Production and Biomass Growth. Frontiers in Marine Science 8.

Owens et al., Controls on Nutrient Cycling in Estuarine Mangrove Lake Sediments. Journal of Marine Science and Engineering 9(6).

Pelechaty et al. 2022, Impact of Nitellopsis obtusa (Desv.) J. Groves, a regionally alien and invasive charophyte, on macrophyte diversity in the species native range. Hydrobiologia 849(1).

Phipps et al., Salinity-induced Changes in Gene Expression in the Streptophyte Alga Chara: The Critical Role of a Rare Na+-ATPase. Journal of Phycology 57.

Phipps et al., The role of ion-transporting proteins in the evolution of salt tolerance in charophyte algae. Journal of Phycology 57.

Politi et al., Amphipods' grazing and excretion loop facilitates *Chara contraria* persistence in a eutrophic lagoon. Aquatic Botany 171.

Rodrigo et al., Sediment underneath charophyte meadows is enriched in viable ephippia and enhances the benthic periphytic biofilm. Hydrobiologia 848(21).

Romanov et al., New species *Chara oryz*ae and a new section *Corillionia* of *Chara* (Charales, Charophyceae) from European Mediterranean rice fields. European Journal of Phycology (online first).

Saber et al., Integrative Taxonomic, Ecological and Genotyping Study of Charophyte Populations from the Egyptian Western-Desert Oases and Sinai Peninsula. Plants (Basel) 10(6).

Sleith and Karol, Global high-throughput genotyping of organellar genomes reveals insights into the origin and spread of invasive starry stonewort (*Nitellopsis obtusa*). Biological Invasions 23(11).

Van Onsem and Triest, Trading offspring for survival: high duckweed cover decreases reproductive potential and stimulates elongation in the submerged

macrophyte *Chara glob*ularis Thuillier. Hydrobiologia 848(11).

STUDY ON AND ABOUT CHAROPHYTES

Andrzej Pukacz (Poland)

Below you will find a list of publications that appeared in 2021 that deal with charophytes. The list is based on the publications which you sent to us and searches on databases (Web of Science, Scopus, Google Scholar as well as ResearchGate, performed in February 2021, using the terms: charophyte, stonewort, gyrogonite, Charophyceae, Charales, Characeae, Chara, Nitella, Tolypella, Nitellopsis and Lychnothamnus). Of course, you will not find here those publications that Susi described above. We hope that each of you will find something interesting in this list. For a complete list of co-authors, please check the databases.

Baktiyarovna et al., Variety of Chara algae in the Talgar river and its pond. Reports of the National Academy of Sciences of the Republic of Kazakhstan 1:67−73.

Barinova, S., Plants, Mosses, Charophytes, Protozoan, and Bacteria Water Quality Indicators for Assessment of Organic Pollution and Trophic Status of Continental Water Bodies. Transylvanian Review of Systematical and Ecological Research 23(3):17−36.

Bellini et al., Responses to cadmium in early-diverging streptophytes (charophytes and bryophytes): current views and potential applications. Plants 10(4):770.

Brzozowski et al., Transformation and simplification of aquatic vegetation structure along with re–oligotrophication of the lake during the last 40 years. Acta Societatis Botanicorum Poloniae 90:905.

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EUROPEAN CHAROPHYTES – STATUS OF THE PROJECT

Emile Nat (The Netherland)

Last year Hendrik Schubert described the status of the project to publish a book about the fossil and extant charophytes of Europe. A year later we have a contract with the publisher Springer. We hope to publish the book in the coming spring.

The pandemic still prevented us from meeting in person, but several online meetings of the editors and authors and hard work helped us to nearly achieve our goal. Interesting group discussions about for example niche dimensions, ontogenesis, systematics and taxonomic concepts made us realize scientific research on charophytes is very much alive!

The editorial team has not changed since last year. We are proud and happy to have worked with more than sixty authors and we hope to create a book not only for the professionals but also for all people who are interested in nature.

PhD THESIS COMPLETION

Reported by Alba Vicente (Spain)

Jordi Pérez Cano, Department of Earth and Ocean Dynamics, University of Barcelona

Supervisors: Carles Martín Closas and Telm Bover Arnal

PhD thesis title: **Barremian charophytes from the Maestrat Basin: taxonomy, palaeoecology, palaeobiogeography and biostratigraphy.**

On November 25th, 2021, Jordi Pérez Cano defended his PhD thesis at the Aula Magna from the Faculty of Earth Science (University of Barcelona) in front of an international jury composed by the president, PhD Ramón Salas i Roig (University of Barcelona, Catalonia, Spain), the spokesperson, PhD Khaled Trabelsi (University of Viena, Austria), and the secretary, PhD Alba Vicente Rodríguez (National Autonomous University of Mexico, Mexico).

The dissertation was composed of a large and very complete English volume of 244 pages, with a very useful index of figures and tables that helps the reading of the thesis. The volume already included the results of two papers published in international peer-reviewed scientific journals, along with unpublished new data.

Pérez-Cano, J., Bover-Arnal, T., Martín-Closas, C. (2020). Barremian charophytes from the Maestrat Basin (Iberian Chain). Cretaceous Research 115:104544.

Pérez-Cano, J., Bover-Arnal, T., Martín-Closas, C. (2022). Barremian–early Aptian charophyte biostratigraphy revisited. Newsletters on Stratigraphy 55(2):199–230.

The thesis presents an overview and new results about the sedimentology and mostly the charophyte palaeontology of the well-known Lower Cretaceous (145–100 millions of years, Ma) deposits of the Maestrat Basin (eastern Iberian Chain, Spain), including new taxonomic and biostratigraphic contributions, but also propose some new insights on Lower Cretaceous charophyte palaeoecology and palaeobiogeography.

The results were obtained after an intensive fieldwork that was done mainly on two stratigraphic sections from the northern area of the Morella Sub-basin, i.e. Fredes and Herbers-Mas de Petxí. These sections were measured and intensively sampled for micropalaeontological analyses, including marl and siltstone samples to disaggregate, limestones useful to microfacies studies, and finally, oyster shells to Sr-isotope dating methods.

A very rich and diverse charophyte assemblage was described by Pérez Cano composed by thirty-four charophyte taxa, including fructifications and thalli. Three different families were reported co-existing during the Early Cretaceous in the Maestrat Basin, i.e., the Porocharaceae, the Characeae, and the Clavatoraceae. The vast majority of the assemblage was composed by clavatoracean utricles, from which twenty-six taxa (from different six genera) were described. The richness and diversity reported in the studied sections have no precedent in other areas which highlight the relevance of this thesis and also confirmed that the Maestrat Basin is an important hotspot for charophyte evolution and distribution during the Lower Cretaceous.

A meticulous taxonomic study was made during the thesis resulting in a better understanding of the Cretaceous flora. In sum:

- *Clavator grovesii* var. *jiuquanensis* was described for the first time in the Iberian Chain.
- *Echinochara lazarii* was reinterpreted after new characters were observed at the utricles and thalli. Moreover, the fructifications of *Echinochara* were found attached to the, *Charaxis spicatus* thalli enabling the reconstruction of the whole plant, a milestone difficult to reach studying solely the fossil record. The cortication of this thallus is a new type of cortication, named double triplostichous cortication, which is unique of this taxon.
- A gradualistic evolutionary lineage was proposed for *Clavator calcitrapus*. The lineage includes two anagenetic varieties, *C. calcitrapus* var. *jiangluoensis* and *C. calcitrapus* var. *calcitrapus*, including intermediate morphotypes that link each variety. This lineage has important biogeographic implications since the oldest variety (i.e. *C. calcitrapus* var. *jiangluoensis*) had a sub-cosmopolitan range, while the youngest variety (i.e. *C. calcitrapus* var. *calcitrapus*) was endemic to Iberia.
- Finally, a previously unknown centripetal calcification pattern was found in the internodal cell of genus Munieria. This type of calcification is reminiscent of the one observed in the clavatoroid gyrogonites, providing further support to the hypothesis that this thallus belonged to the Clavatoraceae.

During the thesis, a broad sedimentological study was done, enabling the author to propose a comprehensive reconstruction of the environments and hence, a complete description of the charophyte paleoecology. Five charophyte assemblages were distinguished in a number of environments depending mainly on the salinity, depth and clastic influence of the water bodies.

- Freshwater lakes with low clastic input: *Atopochara trivolvis* var. *triquetra*, *Clavator harrisii*, *Ascidiella stellata*, and *A. triquetra*. Besides, *Hemiclavator*-rich populations were locally dominant.
- Freshwater lakes with high clastic input: *Echinochara lazarii*, *Globator maillardii* var. *trochiliscoides*, *Atopochara trivolvis* var. *triquetra*, *Clavator harrisii*, *Hemiclavator neimongolensis* var. *neimongolensis*, and occasionally also *Clavator calcitrapus*.
- Brackish settings with low-clastic-influence: Porochara maestratica.
- Brackish settings with marked clastic-influenced: *E. lazarii*.
- Coastal mudflat to floodplain settings: *E. lazarii*, *A. trivolvis* var. *triquetra* and var. *trivolvis*, and *C. harrisii* var. *harrisii* and var. *reyi*.)

All the efforts and results in the fields of taxonomy, tafonomy, and paleoecology enable the description of a new Barremian–early Aptian (130.8–123.0 millions of years) charophyte biostratigraphic proposal, which will be very valuable for many researchers focused on understanding the Lower Cretaceous non-marine deposits worldwide. The biozones proposed were calibrated to the Geological Time Scale by means of strontium-isotope stratigraphy, enabling their correlation with the coeval marine realm. Two biozonations (European and Eurasian), were distinguished and correlated. The European biostratigraphy is formed by two partial range biozones (i.e. *Globator maillardii* var. *trochiliscoides* (base early Barremian) and Ascidiella cruciata-Pseudoglobator paucibracteatus (base late early Barremian–early Aptian) zones. The Eurasian biozone is composed of three partial range biozones (i.e. *Atopochara trivolvis* var. *triquetra*, *Hemiclavator neimongolensis* var. *neimongolensis* (base late early Barremian), and *Clavator grovesii* var. *jiuquanensis* (base at the late early Barremian).

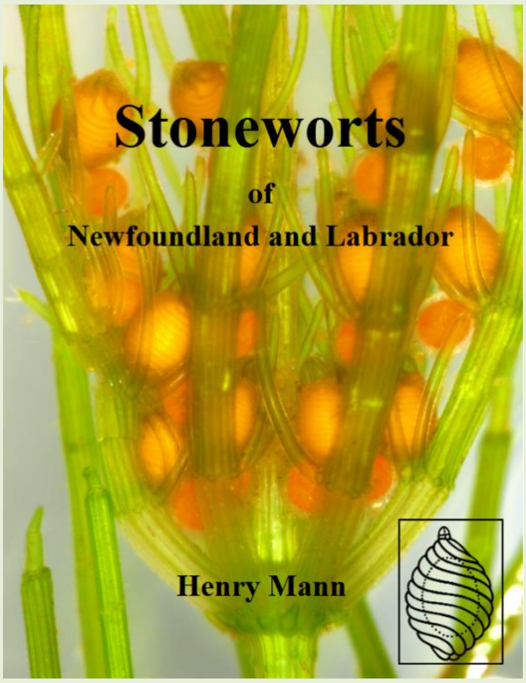
The results presented by Jordi Pérez Cano are very valuable for all the charophyte community and show a clear understanding of the extinct family Clavatoraceae. Significant results are shown, specially referring the taxonomy and biostratigraphy of the charophyte flora from the Lower Cretaceous which for sure, will be extensively used and cited in the future.

NEW E-BOOK

Henry Mann (Canada)

A recently completed e-book is available. The book is entitled "Stoneworts of Newfoundland and Labrador: An Introductory Guide", designed for students and naturalists having no previous knowledge or experience with charophytes. It is not intended for already knowledgeable charophytologists but may provide some insight into the Newfoundland and Labrador conditions.

The e-book is a 216 page PDF file (287 MB or 63 MB compressed version) privately published, photographically illustrated, and freely downloadable from the newly formed SWGC Herbarium website, https://www2.grenfell.mun.ca/herbarium/download.html or upon request (hmann@grenfell.mun.ca) via Dropbox.



NEWS FROM SWITSERLAND

Arno Schwarzer (Switzerland)

In Kt. Zürich we have published an Action plan for *Nitella hyalina*, with a long-term perspective (> 10 years). In former times, *N. hyalina* was regularly found in the great lakes of Switzerland. A total of 130 sites from 5 Swiss lakes are known, but only until the 1920s. After that, no evidence can be found in the herbaria. The species is considered extinct throughout Switzerland and no evidence has been known in the canton of Zurich for almost 100 years. It is therefore listed in the Red List of Charophytes of Switzerland with RE (extinct) and in the list of priority species for Switzerland *Nitella hyalina* is listed with priority level 1 (= very high national priority).

The aim of the action plan is to establish new populations in the vicinity of the known former and other suitable places. These new populations are to be preserved in their inventory and significantly enlarged. For this purpose, plants were removed from the nearest occurrence in the Vosges for a multiplication culture and transported to the cantonal facility for breeding of endangered plant species. There, the plants are temporarily kept and then applied at suitable locations.

Link (in German): https://www.zh.ch/content/dam/zhweb/bilder-dokumente/themen/umwelt-tiere/naturschutz/artenschutz/aktionsplaene-flora/armleuchteralgen/nitella_hyalina_ap.pdf

This year, more action plans for the following species will be published: *Chara filiformis*, *Chara intermedia*, *Nitella gracilis*.

NEWS FROM POLAND

Michał Brzozowski (Poland)

In December 2021 I was granted an 8-month research stay in the research group of Sabine Hilt at Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB, https://www.igb-berlin.de/en/profile) in Berlin, where I will be involved in the realization of the project entitled "Lower periphyton biomass following fish removal facilitates the restoration of charophytes in oligo- and mesotrophic temperate hard water lakes". I will be realising my research stay from March to November 2022 (http://envbiol.home.amu.edu.pl/en/2021/12/scholarship-of-the-bekker-nawa-program-for-michal-brzozowski/). My research stay at IGB will be financed by Polish Agency for Academical Exchange from the NAWA Bekker program (https://nawa.gov.pl/en/scientists/the-bekker-programme).

From November 2021 I am a scholar of Adam Mickiewicz University Foundation (http://envbiol.home.amu.edu.pl/en/2021/11/scholarships-of-the-foundation-of-adam-mickiewicz-university-of-in-poznan-for-michal-brzozowski/). AMU Foundation awarded the best Ph.D. students whose studies were a significant impact on sustainable development. The Scholarship Committee decided that my research has a significant impact on sustainable development due to its application nature through the potential use of research results in bioindication and protection of waters against the negative effects of climate warming.

FORTHCOMING MEETINGS

GEC and IRGC meetings

16–19 August 2022
23rd Meeting of the Group of European Charophytologists (GEC)
Riga, Latvia
Organizers: Organizers: Egita Zviedre, Laura Grīnberga, contact: egita.zviedre@lu.lv

September-October 2024
9th International Symposium on Extant and Fossil Charophytes
Ballarat or Melbourne, Australia
Organizer: Michelle Casanova

Other meetings

16-20 May 2022
Joint Aquatic Sciences Meeting
Grand Rapids, Michigan
https://jasm2022.aquaticsocieties.org/

7-11 August 2022
36th Congress of the International Society of Limnology
Berlin, Germany
https://www.sil2022.org/

24-28 October 2022
International Symposium on Aquatic Plants
Belgium
http://www.internationalaquaticplantsgroup.com/

4-9 June 2023
ASLO Aquatic Sciences Meeting
Palma de Mallorca, Spain
https://www.aslo.org/meetings/

2-7 June 2024
ASLO Summer Meeting
Madison, Wisconsin, USA
https://www.aslo.org/meetings/

26-31 March 2025
ASLO Aquatic Sciences Meeting
Charlotte, North Carolina, USA
https://www.aslo.org/meetings/

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.

Please contact Kaire Torn (kaire.torn@ut.ee) for details.

MEMBERSHIP FEES

Please do not forget to send your membership fee for 2022. 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
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E-MAIL ADDRESSES OF IRGC MEMBERS

Please **send any address changes (both surface mail and e-mail)** to the IRGC-Secretary, Kaire Torn (kaire.torn@ut.ee) to ensure you receive forthcoming information. Updated March 2022.

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