IRGC NEWS

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

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Group photo of the first IRGC in Montpellier, 1989.

EDITORIAL

The Corona virus pandemic has been with us for more than one year. It is a great pity that we were not able to meet each other for the 8th international symposium on extant and fossil charophytes in Gammarth, Tunisia. The symposium was originally scheduled for the end of March 2020 and was postponed to September 2020 due to the pandemic. Since the situation did not improve, we had to postpone a second time, and we hoped it would be possible to organize the meeting in autumn 2021. However, with time going by and the new virus mutations gaining importance, it is increasingly unlikely that we will manage to keep this promise. The organizers of the symposium are following the Corona situation closely and will decide in April/May 2021 if it will be possible to organize the symposium in autumn 2021, or if we must postpone an additional time, possibly to March 2022. We will inform the IRGC members by email about the decisions taken. The timing of the IRGC symposium also affects other meetings which we already have planned, i.e. the next GEC meeting in Latvia, and the 9th IRGC symposium which is planned to be held in Australia. I am sorry that we cannot give definite dates for these yet, but I feel that we just must wait and see when we will be able to have the symposium in Gammarth. As soon as we can be sure that travel and physical meetings again are safe, we will make new plans. I want to thank all organizers of the forthcoming meetings for their patience, and for their willingness to make the best of an unfortunate situation!

On the plus side, we organized the IRGC General Assembly successfully online, with 25 participants from all over the world. I am happy that this worked so nicely, and I was glad to see so many of you online! In the future, we will try to organize more online meetings, to discuss charophytes and just chat with each other. Online meetings cannot fully replace physical meetings, but they are certainly better than having no meetings at all.

In these NEWS, you will find – amongst other items - an extensive list of “charophyte-related” papers published in the last year. We hope you will find this list interesting and useful. If you want to volunteer making such a list for the next IRGC NEWS, please contact us. We aim at providing a complete list, but for this we are entirely dependent on your help (for example, please send your charophyte publications to us). Another “innovation” is that we decided to include small contributions on charophyte findings, offer the possibility for researchers to shortly present their work on charophytes - particularly in understudied regions of the world -, and open for discussions about topics which are generally relevant for charophyte research. But please be aware that the NEWS is not peer-reviewed! This means that mistakes may occur (although we did our best to remove them), and an article in the NEWS does not count as peer-reviewed publication on your CV. The NEWS are not intended as a scientific journal, but as a platform for the exchange of information on charophytes. This also means that we are happy to receive feedback: do you find the contributions useful? Which type of information would you prefer to have in the NEWS? The IRGC is alive through the activity of its members! A big “thank you” goes to all who actively contribute to the NEWS, organize meetings, post on our Facebook page, engage in discussions or promote charophyte research in other ways.

Susanne Schneider

MINUTES OF THE 2020 GENERAL ASSEMBLY

Reported by Andrzej Pukacz

The 8th General Assembly of the IRGC was held online, on 19th October 2020. The meeting was attended by 25 members of the association.

IRGC's President's report

The IRGC President Susanne Schneider welcomed everybody and presented the agenda of the meeting. As there were no comments on the proposed agenda the President proceeded to present the minutes of the previous IRGC General Assembly in Astana 2016, published in the IRGC News 2017. After the presentation all participants approved the minutes.

Susanne Schneider then reported about the activities of the association during the previous 4-year period. In addition to the general assembly in Astana during these last four years, the IRGC supported two GEC meetings (European branch of the IRGC) which were held in Valencia (Spain) in 2017 organized by Maria Rodrigo and in Palermo (Italy) in 2018, organized by Angelo Troia. The president dedicated special thanks to all organizers for the fruitful and well-organized meetings.

All the information about our activities has been published regularly within the IRGC News. Moreover, Susanne Schneider reminded those present that the NEWS is also published on our website and Facebook, where our group is active.

IRGC Treasurers report

The IRGC balance was presented by Emile Nat, who reported on the financial situation of the association (Table 1). As it was assumed, we

Table 1. IRGC balances of the years 2016 - 2019.

	2016	2017	2018	2019
Bank credit on January 1st	€ 3701.50	€ 3640.60	€ 5642.91	€ 7296.60
INCOME				
Individual membership fees	€ 1176.58	€ 3080.00	€ 2907.00	€ 380.00
Total income	€ 1176.58	€ 3080.00	€ 2907.00	€ 380.00
EXPENDITURES				
IRGC-News copies & mailing costs	€ 429.78	€ 430.58	€ 282.10	€ 614.69
Subscription La Banque Postale	€ 107.70	€ 141.30	€ 177.60	€ 148.60
Contribution to IRGC meeting Astana	€ 600.00			
Students Award	€ 100.00			
Contribution to GEC meeting València		€ 500.00		
Contribution to GEC meeting Palermo			€ 500.00	
PayPal costs		€ 5.81		
Special Issue Botany Letters			€ 293.61	
Total expenditures	€ 1237.48	€ 1077.69	€ 1253.69	€ 763.29
Yearly balance	€ 60.90	€ 2002.31	€ 1653.69	€ 383.29
Total credit on December 31st	€ 3640.60	€ 5642.91	€ 7296.60	€ 6913.31

had a negative balance with 2016, which is related mostly to the scientific meetings (two GEC meetings and one general assembly). Despite this, we are in a stable financial situation (almost € 7000 is now in the account) which is based solely on membership fees and is still the only income of our association. Emile Nat encouraged members to pay the fee regularly, as it is very important in keeping the society in financial liquidity.

Susanne Schneider opened a discussion about the report.

Ingeborg Soulié-Märsche expressed thanks to Emile for being Treasurer for so many years (more than 20!) and watching over our finances.

Then, the costs of IRGC News were discussed. In response to a question from Carles Martín-Closas about the increase in the costs of IRGC News publication, Kaire Torn explained that this was due to the fact that in previous years it was supported by the one of the co-editor's University. Carles Martín-Closas suggested that he can cover part of the shipping costs, but Susanne Schneider thanked him, assuming that there is no need for it so far - we can consider it in the future.

The last topic on finances was membership fee. Due to the impossibility of a direct meeting this year, the only solution to avoid transfer costs is for the money to be transferred by someone or sent by post. However, we should remember not to send bank cheques.

All the assembled agreed to keep the fee of 20 Euros/year. We also agreed to keep the rule that non-payment of membership fees for more than two years will result in the removal from our association.

Next IRGC Symposium

In a four-year sequence, the next IRGC meeting shall be organized in 2024. Susanne Schneider suggested to organize the Symposium in Australia. Michelle Casanova showed a short picture presentation on Australia, as a very interesting place to organize our meeting. Mary Beilby offered her help to organize the meeting. There are two cities to be considered as a place for the venue: Ballarat or Melbourne. The proposed time is autumn 2024 in the northern hemisphere, which will be the beginning of spring in Australia - an excellent time to look for charophytes in shallow brackish water and temporary ponds.

General issues

The problem we had to deal with this year, in connection with the COVID-19 pandemic, was the postponement of the conference planned for Tunisia in the spring. Unfortunately, despite the great willingness and efforts of the organisers, we did not manage to meet personally this autumn either.

Khaled Trabelsi has described to us the current situation in Tunisia, which is not good. Just as in Europe, there are more and more infection cases in Tunisia. In this situation, it will probably not be possible to organise the IRGC meeting in the coming spring (2021). It is quite possible that costs will increase, and not everyone will be able to get their money back for booking flights and hotels. So, Khaled Trabelsi has offered that he can provide us with an appropriate cover letter which can make it easier to apply for a refund.

We have agreed together that the best solution will be to observe the global trends of COVID-19. If the pandemic stops and other circumstances allow it, Khaled Trabelsi will try to organise the meeting in autumn 2021. Susanne Schneider expressed our thanks to the Tunisian Team directed by Khaled Trabelsi for their efforts in organizing the meeting and support.

If we manage to meet next year in Tunisia, we will have to postpone the GEC conference in Latvia scheduled for 2021. Egita Zviedre confirmed that this would be possible, but suggested to meet at the end of August 2022. This will be much better for planned field trips in searching of charophytes. Everyone agreed to this and we thanked for the commitment to prepare our meeting in Latvia.

We also briefly discussed the possible organisation of an online conference, proposed by Michał Brzozowski, but we came to the conclusion that it is worth waiting for a face-to-face meeting. Our meetings are always accompanied by joint field trips and exchange of practical experience and research materials. So, we will wait!

There was a discussion about the activities of regional groups. Kaire reported very little activity in recent months by our regional correspondents. There is a little activity and reports from Asia and America. This also applies to the so far most active GEC members. Hendrik Schubert suggested that we contact people outside the IRGC who deal with charophytes if we know them personally. Susanne Schneider offered to try to contact some people in person.

At the end of this part of the meeting, our President mentioned that our association is changing continuously but keeps a quite regular pool of about 100 members. Unfortunately, in recent years, some very good charophytologists have passed away: Dr. Micheline Guerlesquin, Prof. Maria Kwiatkowska, Prof. Huang Renjin. Obituaries have been published in the IRGC News.

Election of Officers and the Executive Committee

The IRGC President announced the elections and informed that the voting material has been sent with the last IRGC News in order to give all members the opportunity to vote and suggest the candidates. Voting was possible both by traditional means and by e-mail. Maria Rodrigo organized the voting procedure and collected all the information.

All the previous members had been nominated for the committee: Susanne Schneider (Norway), Emile Nat (Netherlands), Kaire Torn (Estonia) and Andrzej Pukacz (Poland).

After all the votes had been counted, Maria Rodrigo read out the results: 94 members were entitled to vote, 57 voted, of which 54 were considered valid. The new Executive Committee was elected as follows:

Susanne Schneider (President) 53 votes

Andrzej Pukacz (Vice-President) 54 votes

Kaire Torn (Secretary) 54 votes

Emile Nat (Treasurer) 54 votes

After approving the voting Susanne Schneider thanked all the committee members for their cooperation so far. She also expressed her thanks to the former Executive Committee and to the audience for their votes and their confidence in the years to come.

At the end of the formal part, we took the opportunity to discuss together and find out what is new in various parts of the world. At least this way we were able to meet and talk for a while in these strange and difficult times.

HISTORY OF CHAROPHYTE MEETINGS

Ingeborg Soulié-Märsche (France)

Past-President of the IRGC (2000-2008)

The First IRGC was convened in 1989 by the palaeobotanical team of Montpellier (Table 2). More than 60 charophyte researchers from 17 countries in Asia, America and Europe came together for this meeting. The meeting was in response to a rising interest in the need for exchange between Charophytologists who study extant species and Palaeontologists. Prof. Vernon Proctor, Prof. Jelena Blaženčić, Prof. Maria Kwiatkowska and also Irmgard Blindow and Aizhan Zhamangara were among the early attendees. Dr. Liu Juning from Beijing travelled for 10 days by train to join us. I still remember Vernon Proctor's presentation about herbivory on charophytes showing a slide where Gammarus picked the starch out of oospores "like pop-corn" he said. The Assembly then decided to create the IRGC as an official scientific Society. The statutes, inspired by those of other similar societies, were adopted by voting.

The 2nd IRGC-Symposium, originally planned for 1994 in China, had to be postponed and was finally organised in 1996 in Madison (Wisconsin, USA) by Prof. Linda Graham and Monique Feist, the president of the IRGC at that time. Prof. Proctor had organised a fascinating overnight excursion to the Lakeside Laboratory at Lake Okoboji, and we visited a quarry containing Devonian charophytes, as well as ponds that had been studied in the 1960s.

Since 1996, the IRGC-Symposia have been held in a quadrennial rotation (i.e. every 4 years).

Table 2. List of International and European charophyte meetings. *Year may change. GEC = European branch of IRGC

Year	**Meeting**	**Country/continent**	**Town**	**Organiser(s)**
1987	GEC	Switzerland	Lausanne	Jean-Pierre Berger
1988	GEC	France	Montpellier	Ingeborg Soulié-Märsche
1989	IRGC	France, EUROPE	Montpellier	Monique Feist, Ingeborg Soulié-Märsche, Nicole Grambast-Fessard
1990	GEC	France	Paris	Janine Riveline
1991	GEC	Germany	Berlin	Michael Schudack
1992	GEC	France	Angers	Micheline Guerlesquin Elisabeth Lambert-Servinen
1993	GEC	Poland	Lodz	Maria Kwiatkowska Januz Maszevski
1994	GEC	Spain	Barcelona	Carles Martin-Closas
1996	IRGC	USA, NORTH AMERICA	Madison	Monique Feist, Linda Graham
1997	GEC	Germany	Bremen	Ursula Winter
1998	GEC	The Netherlands	Amsterdam	Jan Simons
2000	IRGC	China, ASIA	Nanjing	Lu Hui-nan Wang Qi-fei
2002	GEC	Greece	Athens	Ingeborg Soulié-Märsche Carles Martin-Closas
2003	GEC	Germany	Iffeldorf	Susanne Schneider, Michael Bögle, Arnulf Melzer
2004	IRGC	Australia, OCEANIA	Wollongong	Adriana Garcia
2006	GEC	Spain	Barcelona	Núria Flor-Arnau Jaume Cambra Sánchez
2007	GEC	Serbia	Belgrad	Jelena Blazencic, Branka Stevanović Jasmina Šinžar-Sekulić
2008	IRGC	Germany, EUROPE	Rostock	Hendrik Schubert Irmgard Blindow
2009	GEC	Macedonia	Ohrid	Sasho Trajanovski Sonja Trajanovska
2010	GEC	Estonia	Tallinn	Kaire Torn, Georg Martin, Anastasiia Kovtun-Kante
2011	GEC	Poland	Poznan	Mariusz Pełechaty Andrzej Pukacz
2012	IRGC	Argentina, SOUTH AMERICA	Mendoza	Adriana Garcia Eduardo Musacchio
2014	GEC	Lithuania	Vilnius	Sofija Sinkevicenie
2015	GEC	Switzerland	Geneva	Dominique Auderset Joye Aurélie Boissezon
2016	IRGC	Kazakhstan, ASIA	Astana	Aizhan Zhamangara Raikhan Beisenova
2017	GEC	Spain	Valencia	Maria Rodrigo
2018	GEC	Italy	Palermo	Angelo Troia
2021*	IRGC	Tunisia, AFRICA	Gammarth	Khaled Trabelsi Yassine Houla
2022*	GEC	Latvia	Riga	Egita Zwiedre
2024*	IRGC	Australia, OCEANIA	Ballarat/Melbourne	Michelle Casanova

Each of the seven previous IRGC-Symposia was different but each one was a success and played an important role in connecting people and in exchanging results and ideas about charophytes. The field trips differed as much as the landscapes they occurred in. Accommodation arrangements varied from simple rooms in student residences to a comfortable resort in Robertson (Australia). Mostly, we were all together in a convenient hotel proposed by the organisers …. so that nobody could get lost.

The scientific sessions always represented an interesting mixture of different types of charophyte research. Some of the time slots were devoted to the fossil charophytes whose evolution has produced an incredible variety of forms over millions of years. The large spectrum of topics concerned with the living charophytes was developed in oral and poster presentations and generated fruitful and vivid discussion.

To conclude, I would say that, up to present, the IRGC has fulfilled its initial aim in bringing people together to progress the knowledge of the charophytes. The IRGC allowed the establishment of new, long-lasting connections and collaborative work between researchers of living and fossil charophytes worldwide.

WHAT'S NEW ABOUT CHARA?
A short overview over some interesting charophyte studies published in 2020

Susanne Schneider (Norway)

This year I searched Web of Science on January 20, using the search terms "Chara" and "2020", and I got 79 hits. This is a bit more than last year, but less than the years before. Not all of them dealt with «our» charophytes (I found, for example, a paper describing research at a site called Nunia chara in Bangladesh 😉). I was quite outside my "comfort zone" with the papers describing physiological experiments on *Chara* cells, and I also found that I was unable to really judge the significance of the papers on paleoecology. Below I give an overview on 18 papers, which - as always - only represent my personal interests, not scientific quality. But I must admit that I kicked out some publications from this overview because I found their scientific quality a little dubious.

In the last few years, ecosystem restoration has become a "hot topic" not only in nature management, but also in science. If one wants to restore a freshwater ecosystem, it is important to know how long plant seeds and spores are viable. Kelleway et al. took soil samples from a lake bottom (Ita Lake, NSW, Australia) after a long period of drought (10 years). The samples were taken from two distinct zones within the lake, one of which was subjected to historical grazing and the other to lakebed ploughing and cropping. They then inundated the samples, to see which species germinated. Among the species which germinated were *Ricciocarpus natans*, *Chara* spp., *Nitella* spp., *Alternanthera denticulata* and *Eleocharis acuta*. It is good to know that ephemeral wetland plant communities indeed are resilient, even if they "only" tested a time period of 10 years (many freshwater ecosystems have fallen dry for a much longer time period). However, the authors conclude that intensive land uses such as ploughing and cropping will limit the availability of seeds to germinate, and the inundation regime will influence species composition and therefore the outcome of restoration projects. Nevertheless, I think it generally is a good idea to use local seed material for ecosystem restoration, if possible.

Iron chloride has often been used for restoration of eutrophic lakes (the idea is that the phosphorus which is present in the lake water binds to the iron, and the iron-phosphate then settles in the sediment; because of this, the lake is expected to shift towards clear water and a macrophyte dominated state). When added in excess, however, iron could also negatively affect organisms because iron in high doses can be toxic. Rybak et al. continue to investigate the effect of iron chloride on charophytes (they have published papers on this topic before in the last years). In two papers they describe the effect of iron chloride on *Chara hispida* and *Chara tomentosa*. Not surprisingly, the addition of iron chloride caused short-term acidification, increased salinity and deterioration of light conditions in the water. *Chara tomentosa* could **not** outgrow these adverse conditions, developed chlorotic and necrotic spots and finally died. *Chara hispida*, in contrast, elongated and therefore managed to survive. I still do not really understand the relevance of these studies for practical applications. In my experience, iron chloride is only applied to highly eutrophic lakes. Highly eutrophic lakes, however, do not typically have large stands of *Chara tomentosa* or *Chara hispida*. This is why I do not really understand how the application of large amounts of iron chloride in lakes could come in conflict with existing populations of *Chara hispida* and *Chara tomentosa*. But maybe we should just see these experiments as interesting pieces of information, despite their uncertain practical use.

When cleaning water from toxic substances, the first step is acquiring knowledge how much of these substances actually is in the river. This is more complicated than it might seem, because the concentrations of toxic substances in rivers often are highly variable. This is because river discharge varies, leading to more or less dilution of the substances at different points in time. But another reason is that discharges of toxins into rivers often are discontinuous, for example when there is an accident, or when a company cleans their tanks every second week and discharges the "cleaning water" into a river. Monitoring concentrations of toxins directly in water samples therefore is challenging, because you would need to take a lot of samples in order to minimize the risk that short periods with high concentrations are overlooked. Therefore, biomonitors are often used, and aquatic mosses (for example *Fontinalis antipyretica*) have traditionally been used as biomonitors for metals. This means the mosses were exposed in the river for a certain period of time (for example some weeks), and during this time they accumulated the toxins which "passed by". After some weeks, the mosses were sampled, and the amount of metals accumulated on the moss surface was measured. From this measurement you get information about the amount of metals in the river water during the entire period the moss was exposed in the water. Bellino et al. studied if charophytes can also be used as biomonitors of potentially toxic metals in rivers. They put bags with *Chara gymnophylla* and bags with *Fontinalis antipyretica* into 41 stream sites in two rivers and measured 19 potentially toxic metals in the species. They found that *Chara gymnophylla* accumulated the metals in a similar way as *Fontinalis antipyretica* and concluded that *Chara gymnophylla* may also be used as a biomonitor. These results certainly are interesting. However, I do wonder why using *Chara* for biomonitoring instead of *Fontinalis* should be an advantage. Maybe in areas where there is little natural *Fontinalis*?

Mahajan and Kaushal wanted to directly use charophytes to clean water. They studied if *Chara vulgaris* can be used to remove a red dye (acidic azo dye methyl red) from water. They did a series of experiments with *C. vulgaris* to determine the influence of contact time, initial dye concentration, the amount of *Chara vulgaris* used, and pH on the removal efficiency, i.e. how efficient the dye was removed from the water. Maybe not so surprisingly, the decolorization percentage declined with increasing initial dye concentrations. This means: the higher the concentration of the dye, the less effective was its removal by *Chara vulgaris*. Maximum decolorization was achieved after a contact time of approximately 48 h. Interestingly, the highest decolorization was found at pH 5. I find it hard to imagine that *Chara vulgaris*, which often is incrusted with lime, can stay in shape for 2 days at such a low pH. Nevertheless, they successfully re-used the same *Chara vulgaris* for eight cycles in batch experiments! These results are generally interesting, and I agree that using "biological wastewater treatment" makes a lot of sense, particularly in developing countries. However, before this method can be used on a larger scale, I think the authors need to work on additional issues. For example: (a) Where can the *Chara* biomass which has been used for the dye removal, be disposed? I assume that the biomass has accumulated quite some dye, and you should not just throw this back into the environment; (b) Where do you sustainably harvest larger amounts of *Chara vulgaris*, which can be used for the dye removal? The charophytes can only be used 8 times, so you must repeatedly harvest *Chara* biomass from somewhere. And not at least: you need to ensure that the negative consequences the harvesting has at the site where the biomass is harvested (reduced biodiversity, reduced carbon and nutrient retention, etc.) do not outweigh the benefits of cleaning the water from the dye.

Indeed, charophytes provide several ecosystem services, and one of them is the storage of carbon and nutrients. Kufel et al. did a very interesting study on the transfer of carbon and nutrients from aquatic plants to lake sediments. In many studies of nutrient deposition in lakes, only the deep profundal sediments are considered, while littoral sediments are not taken into account. Kufel et al. sampled sediments from the profundal and littoral zones of different lakes, the latter divided into sediments overgrown by charophytes and others covered by vascular submerged macrophytes, and measured carbon and nutrient concentrations. They found that charophyte-dominated littoral sediments contained significantly more inorganic carbon than other littoral and profundal sediments. This means that the sediment underneath charophytes contains more calcium-carbonate than other lake sediments. Interestingly, the sediment underneath both charophytes and vascular macrophytes had a higher nitrogen content than the plant biomass covering the sediment. Both, charophytes and vascular macrophytes had higher organic carbon to total nitrogen ratios than the sediment directly underneath the plant patches. This may mean that more organic carbon was released during decomposition of the plant biomass than nitrogen. Also, calcium-bound phosphorus in the sediment underneath charophytes was 17-19 % of the total phosphorus pool while in profundal sediments it was 42 % of the total P. This difference suggests that calcium carbonate settling during algal blooms in a eutrophic lake may be more effective in P trapping than calcite encrustations covering charophytes in the littoral. Kufel et al. did not, however, quantify how much material naturally settles to the sediment within a year.

In order to draw conclusions how effective phosphorus removal within charophyte beds is compared to phosphorus removal by phytoplankton, you also must know how much “new” sediment is produced within a year. Generally, inorganic carbon may become dominant in the sediment underneath *Chara* meadows if the lake water has high enough alkalinity, pH and calcium concentration to prevent the dissolution of calcium-carbonates with CO_2 released during the decomposing of plant material. Otherwise the $CaCO_3$ would react with the CO_2 and form dissolved HCO_3^-. If these conditions are met, however, carbonates and not organic carbon may become a more permanent deposit of carbon in littoral sediments.

In this respect, it is important to know how much carbon, nitrogen and phosphorus is present in living plant biomass (because this sets the stage as to how much of these elements can potentially be stored in the sediment, may be decomposed, or eaten by a grazer). Rojo et al. did a very interesting overview of charophyte carbon, nitrogen and phosphorus content. They found that charophytes had an intermediate carbon content, but lower nitrogen and phosphorus contents than other aquatic plants. Therefore, their C:N and C:P ratios were generally higher than those of other submerged plants. A higher P content in the charophyte biomass was related to an increased growth rate, and maximum growth rates occurred at charophyte C:N:P ratios of 343-759:18-44:1, higher than the well-known Redfield values for optimal growth in other algae. While PAR irradiance partly controlled charophyte nitrogen content and the C:N ratio, UV-B radiation increased C and N content, but did not affect nutrient ratios. The authors also found that increasing temperatures by global warming could decrease charophyte P content, thereby reducing the C:P ratio.

Such numbers raise the question how long it takes before the biomass of submerged macrophytes is decomposed. Yang et al. compared the decay rate of four different macrophyte species: *Hydrilla verticillata*, *Najas guadalupensis*, *Potamogeton illinoensis*, and *Chara* spp. They incubated biomass of the four species in water at 40 degrees C for 126 days. 40 degrees seems a little warm to me, but we can probably assume that the relative decay rates, i.e. the differences among the species, will be similar at lower temperatures. Yang et al. found that *Hydrilla* had the highest decay rates, i.e. decomposed fastest, while *Chara* had the lowest. *Chara* also had the highest carbon concentrations in the biomass, high C/N and C/P ratios, and high concentrations of Ca and Al in the biomass. These results agree nicely with the work by Rojo et al. described above, and they probably mean that the carbon in the *Chara* biomass was at least partly inorganic carbon, i.e. calcium-carbonate.

The papers described above show that charophytes interact with the water and the sediment underneath the charophyte patches. Puche et al. aimed to take this one step further by studying how the ecological network in shallow freshwater lakes works. They did mesocosm experiments in which they reconstructed three habitats: the pelagic, the habitat around charophyte meadows and the periphytic community living on charophytes. Climate change may lead to reduced abundance of charophytes, so Puche et al. also wanted to find out what happens to the system if the charophyte biomass is reduced. They found that a decrease in charophyte abundance will cause a major direct damage to the meadow and to the periphyton (this is maybe not so surprising), but also that charophytes play a central role in the network, and that high-mobility large planktonic herbivores living within the charophyte meadow «connect» the charophyte meadow with the pelagic. Puche et al. thereby contributed to explaining how changes in an ecosystem are «transferred» to other compartments through the ecological network.

Also Pelechata et al. analysed interactions between charophytes and plankton. They studied relationships between charophyte biomass in lakes and the biomass and species composition of phytoflagellates (this is a group of phytoplankton algae). They found that cryptophytes (this is a group of phytoflagellates) were related to anthropogenic pressure on one hand and to the cover of charophyte vegetation on the other hand, and concluded that the use and type of catchment area probably were the main factors influencing the biomass and the structure of phytoflagellate assemblages. In my view, these results show that the catchment of a lake affects both the macrophyte vegetation (including the charophytes) as well as the phytoplankton which grows in the lake.

Torn et al. looked into the future by predicting the impact of climate change on the distribution of macrophytes and macroalgae in the north-east Baltic Sea. They found that the main predictors of charophyte distribution were water depth and temperature. Interestingly, while *Zostera*, *Furcellaria* and *Fucus* were predicted to decline (to a different extent) with climate change, charophytes turned out to be potential winners of climate change, and their distribution may actually increase in the future. However, charophytes cannot replace the other species, because they have different preferences with respect to substrate, wave exposure and salinity.

Some authors also described rare charophytes, or charophytes from understudied regions of the world. Some of my colleagues at NIVA provided new information on the distribution and species composition of charophytes in Myanmar. From this country, little information on charophytes exists. Only a few studies on charophytes in ponds were conducted at the end of the 19th and first half of the 20th century, while lakes have not been studied before. Mjelde et al. collected *Chara* spp. from seven lakes and reservoirs in Myanmar. Using morphological traits and DNA barcoding, the specimens were identified as *Chara zeylanica* and *Chara fibrosa* (*sensu lato*). *Chara zeylanica* was the most common of the two species found in Myanmar and was observed in five lakes, while *Chara fibrosa* was only found in three lakes. *Chara zeylanica* seemed to prefer calcareous lakes while *C. fibrosa* was found in both highly and moderately alkaline lakes. Both species were recorded in low-impacted lakes only, with total phosphorous concentrations below 20 µg L^{-1}. Increased human impact on freshwater habitats is therefore likely to reduce *Chara* biodiversity also in Myanmar.

But there are many understudied regions in the world. Zalat et al. described charophytes from streams on Socotra Island in the Indian Ocean (part of Yemen). They found *Chara braunii*, *C. globularis*, *C. hispida* and *Lamprothamnium papulosum* and briefly described some basic water chemistry in the habitats where they found the charophytes. The Netherlands are not exactly an understudied region of the world, but for some reason *Chara papillosa* (formerly known as *Chara intermedia*) has not been found in the Netherlands since 1920. Bruinsma and Leurs rediscovered this species in the Netherlands in a ditch in a nature reserve. *Chara papillosa* was found in three consecutive years, and was accompanied by *Potamogeton alpinus*, *P. mucronatus*, *C. virgata*, *C. globularis*, *Sparganium emersum*, and *Myriophyllum verticillatum*.

Chara baueri was considered extinct in Europe for more than a century, from the 1870s to 2006, when it was rediscovered in Germany. The species is currently known from a few localities in Europe (Germany, Poland and Russia), and one locality in Asia (Kazakhstan). Trbojevic et al. present a new finding of *Chara baueri* in Serbia, where they found the species in both 2018 and 2019. The population in Serbia is the first verified record of *Chara baueri* in southern Europe, and Trbojevic et al. described the morphology of the species, as well as the associated macrophyte vegetation and water quality parameters.

Some charophytes have a tough life, and this may be particularly true for those that survive on frozen ground. Chemeris et al. collected information on charophytes from permafrost areas in Yakutia, the Magadan Region, and the Chukotka Autonomous Area belonging to Russia. Even if the deeper ground is permanently frozen, freshwater ecosystems exist during summer. The authors found records of *Chara contraria*, *C. globularis*, *C. strigosa*, *C. virgata*, *Nitella flexilis*, *N. opaca*, *N. wahlbergiana* and *Tolypella canadensis*, mostly in areas with calcareous rock. They found that the number of species and their records decreased towards north and east, probably due to the short vegetation period in that area. Many species were found in river valleys, where the topography and heating effect of the river water mitigates the influence of climate and permafrost. Interestingly, also perennial species such as *C. strigosa* and *Tolypella canadensis* occur in permafrost areas, but only in deep lakes where there is less temporal variation in environmental conditions.

Despite being quite far north of the polar circle (on Svalbard, Spitsbergen), the Troll springs do not have frozen ground. This is because they are heated by underground volcanoes. It is very difficult to get to the Troll springs, because there are no roads, but quite a few polar bears. Nevertheless, some brave people collected charophytes in the Troll springs, for the first time in 1910, and then again in 1912, 1958, 1992/1993, and 2018. Since the charophytes had very strange morphological characteristics, people were uncertain which species the collected specimen would belong to. They were first described as a form of *Chara aspera*, but later as a form of *Chara canescens*. Anders Langangen realized in 1992/1993 that there actually were two different forms. He thought they would both belong to *Chara canescens*. Langangen et al. now did barcoding of newly collected samples and one sample of the older collections, and could show that actually two species occur in the Troll springs: it was *Chara aspera* and *Chara canescens,* even though both looked really “weird” and it was hardly possible to determine them by morphological traits! It is quite remarkable that there are two *Chara* species in the Troll springs, because the closest known habitat with charophytes is approximately 900 km further south, across the Barents Sea!

But, as we all know, charophytes sometimes may look a little “weird” to the outsider (of course to IRGC-members charophytes only look “cute” and never “weird”). Nevertheless, this makes determination of *Chara* species sometimes very difficult. Trbojevic et al. collected *Chara contraria* with an unusual set of morphological characteristics, and specimens morphologically resembling *Chara connivens* in Serbia. They described their morphological traits and analysed matK barcodes. Their results indicated that dioecious *Chara* specimens, tentatively determined as *Chara "connivens"* based on morphological traits, were genetically more closely related to

C. globularis. These *Chara "connivens"* specimens formed a sister group to a monophyletic *C. globularis* cluster, suggesting that it may be neither *C. connivens* nor *C. globularis*. This means that barcoding of more *C. "connivens"* samples from freshwater would be really interesting, in order to find out if there are consistent genetic differences between the dioecious freshwater *C. "connivens"* and monoecious *C. globularis*. If this was the case, we could have an additional *Chara* species in Europe! I hope that some of the IRGC members will be able to present some interesting results on *Chara "connivens"* in the future. But things can be even more complicated with species which we commonly think are "easy". Barcoding of matK placed the monoecious *Chara* specimens, which based on morphological characteristics initially were determined as *C. virgata*, into the *C. contraria* group. This indicates that the microscopic traits which commonly are used for *Chara* species determination are sometimes misleading. I am afraid we will need the help of barcoding also in the next years, to evaluate the validity of morphological characteristics of the plant thallus for *Chara* species delineation.

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Kufel et al. Carbon and nutrients transfer from primary producers to lake sediments - A stoichiometric approach. Limnologica 83: 125794.

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STUDY ON AND ABOUT CHAROPHYTES

Andrzej Pukacz (Poland)

In addition to a brief overview over some interesting charophyte studies done traditionally by Susi Schneider, this year we decided to go a step further. Below you will find a list of publications that appeared in 2020 that deal with charophytes, or devote significant attention to them ... in a very broad terms. The list is based on the publications which you (i.e. the IRGC members) sent directly to me. Thank you all for helping us in making the list as complete as possible! In addition, I added English-language publications from a search in: Web of Science, Scopus, Google Scholar as well as ResearchGate, performed in February 2021, using the terms: charophyte, stonewort, gyrogonite, charophyceae, Chara, Nitella, Tolypella, Nitellopsis and Lyhchnothamnus. 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. All years are 2020; for a complete list of co-authors, please check the publications.

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EUROPEAN CHAROPHYTES – STATUS OF THE PROJECT

Hendrik Schubert (Germany)

Irrespective of the obstacles caused by the recent pandemic, compilation of the chapters for the planned publication has been progressing in the past months. Meanwhile all but one of the main chapters are submitted for final review, the last pending one (Red List and threats) being worked on by Nick Stewart intensively.

With respect to the species chapters substantial progress has been made, just 9 out of 71 taxa in total are still pending, most of the submitted drafts have passed the internal review and are being amended now by the authors. For this, it would have been great to have a direct exchange as it was planned by a workshop on Sicily – this had to be cancelled, unfortunately.

Another obstacle is that check of type material and doubtful records in herbaria can't be done at the moment. So several species chapters are still incomplete; the same applies for detailed photographs, which could not be made by means of fresh material the last year.

On the other hand a number of interesting group discussions have helped to shape the taxonomic concept. Namely within the tricky Hartmannia-group, taken care of by Irmgard Blindow and the *Chara vulgaris*-related morphotypes, where Luc Denys guided a team of specialists to an agreement about delineation, progress was made. In addition, a number of surprises resulted from genetic analysis, and these results are going to be published soon, as well as some new species descriptions; so the book hopefully can refer to them soon.

Something unforeseen was the need for a glossary, because all of us thought the terms they used are well-defined and commonly accepted. However, when going into detail a number of terms popped up that appear to be problematic, either because they are used differently between genera or within different fields of expertise. Great thanks to John Bruinsma who initiated the compilation of a glossary, hopefully sorting out most of the problems. It would be good if as many as possible will comment on the draft version that has been sent around.

And it should be noted that the team of editors has been enlarged. Dealing with all the cross-communication of about 70 authors became impossible for the small team that initiated the project and several "core partners", responsible for central questions as, e.g. nomenclature, distribution and determination keys, needed to be involved directly, as well as some lead authors being responsible for large groups of taxa. So the recent team of editors, which also started to negotiate with publishers, are: Irmgard Blindow, Michelle Casanova, Luc Denys, Thomas Gregor, Heiko Korsch, Emile Nat, Roman Romanov, Hendrik Schubert, Nick Stewart and Klaus van de Weyer.

DIVING FOR CONSERVATION PROJECT

Suddenly digital! – A webinar series goes viral and attracts hundreds to Charophytes

Silke Oldorff & Rainer Stoodt (Germany)
Coordinators of „Diving for Conservation"

Many citizen science projects have faced, and still continue to face, the great challenge of implementing events originally planned as on-site (face-to-face) offerings in the digital world. This is especially true for projects that conduct so-called field research, i.e. where knowledge transfer and exchange, collaborative species identification, species monitoring, walk-throughs, dives, etc. traditionally take place out in the wild.

From the beginning of February until the end of April 2021, the German "Diving for Conservation" project will offer webinars on aquatic plant identification for interested recreational scuba divers. In this project, started in 2008, recreational scuba divers are first trained to identify typical aquatic plants, e.g. the stoneworts, freshwater macroalgae and macrophytes. Afterwards, they can independently identify and map these species during their dives in the lakes, measuring the lower macrophyte extent and determining coverage of macrophyte species and assemblages on a Braun-Blanquet scale. This enables trained scuba divers to help with lake monitoring in the formal NATURA 2000 habitat type 3140 scheme and determine the conservation status. The data produced by trained scuba divers are easy to use for the administrators responsible for lake meetings, the team has moved the training sessions online since early February 2021, with a total of seven units through to April 26 (https://www.nabu-naturschutztauchen.de/). The webinar series was facilitated by the Hessen Branch of the Scuba Divers Association (HTSV) and NABU. Knowing the sometimes limited attention that „regular" scuba divers have for macrophytes and charophytes, we expected an audience of a few dozen participants. However, from the opening session "The fantastic world of aquatic plants - how can recreational divers and nature lovers distinguish individual species" held by Silke Oldorff, more than 230 people have participated. The number of participants had to be limited. At the second event „Introduction to Charophytes" held by Dr. Thomas Gregor, more than 220 recreational divers participated and had a lively discussion after the talk. Some of them will probably start collecting samples of charophytes and provide them to scientific collections, or even start to establish their own herbaria. Thomas Gregor limited himself to present only those species that occur in diving waters like larger lakes. To cope with the high number of participants, a team of 4 biologists accompanied the lectures, summarizing and answering the questions in the chat and ensuring the correct technical procedure. Among the participants are recreational divers who have been already trained special course "Diving for Conservation" as a refreshment of their abilities, but also many interested people and diving instructors. The latter are important multipliers for lake management and conservation.

management, landowners and stakeholders, and are exact, comparable and could help identifying trends or even causes of environmental changes. Establishing an official cooperative training course between the German Recreational Scuba Divers Association (VDST) and the Nature and Biodiversity Conservation Union (NABU), has resulted in „Diving for Conservation" becoming a network of more than 400 trained conservation divers in about 25 local groups across Germany.

Due to the COVID-19 pandemic situation and uncertainties with holding face-to-face

„Diving for Conservation" is becoming a popular movement in Germany and can start to increase the level of identification skills among the public for certain taxa, in a time where universities cannot. It also increases awareness and creates a supportive public in relation to the conservation status of lakes of the habitat type 3140, where, in Germany, more than 90 % are in an unfavourable conservation status according to both the habitats directive and the water framework directive of the EU. Trained scuba divers across Germany can raise their voices and speak out against the trend of more and more excellent diving spots turning into turbid carp sanctuaries. In the long run, we also hope to create a source of new charophyte enthusiasts, eventually joining IRGC one day.

EXTANT CHARALES FROM THE CALCAREOUS TROPICAL STREAMS OF CENTRAL MEXICO

Mariana Guadalupe Cartajena Alcántara (Mexico)
mcartajena@ciencias.unam.mx

Characeae from Mexican aquatic environments have been poorly analysed in Mexico. During the last 20 or so years, only a few works were published, enabling the description of 27 extant characean species, i.e. 18 species belonging to *Chara* and 9 taxa of *Nitella* (Ortega 1984, Valadez et al. 1996, Montejano et al. 2000). To improve the charophyte knowledge of North American extant charophytes, six calcareous streams located in the Central region of Mexico were sampled during the dry season, between November 2004 and June 2005 as part of the Master's degree project of the author.

Specimens and oospores of *Chara* and *Nitella* species were collected from streams in two states. The streams Itzamitlán, Los Manantiales and Salado stream are located in Morelos State while the streams Micos, El Meco and El Salto were located in San Luis Potosi state (Fig. 1).

Temperature, pH, and specific conductance (K_{25}) of the water were measured in each river segment with a Conductronic PC-18 conductivity meter (Table 3).

Microhabitat variables such as depth, substratum, current velocity, and irradiance were also measured *in situ* at the centre of each sampling area as close as possible to the charophyte meadows using a Swoffer 2100 current velocity meter and a Li-Cor Li-1000 quantum meter with a flat subaquatic sensor of photosynthetic active radiation (PAR). Portions of sediment were processed, silt and clay were analysed for pipette analysis (Folk 1974), and the organic matter content was evaluated via a loss on ignition method (Heiri et al. 2001). Dissolved nutrients were filtered in situ with 0.45 and 0.22 µm pore diameter membrane, preserved with chloroform and then frozen. These samplings were measured in the laboratory with a multichannel analyser (Results summarized in Table 1 of Cartajena & Carmona 2009).

Twelve populations were analysed enabling the collection of five to ten samples that were later preserved in 2.5% glutaraldehyde. Morphological features considered to be of taxonomic importance of both thalli and oospores were measured in each thallus (Wood & Imahori 1965, Proctor et al. 1971, Cáceres 1975, 1978, Soulié-Märsche 1999). From the collected samples, five species were identified: *Chara haitensis* Turpin, *Chara vulgaris* var. *nitelloides* Wood, *Chara zeylanica* var. *diaphana* Wood, *Nitella furcata* var. *sieberi* Wood, and *Nitella tenuissima* var. *tenuissima* Wood.

Chara haitensis was the most common species found in the studied tropical streams of central Mexico since it occurred in 6 of the 12 sampled localities. A detailed analysis of *C. haitensis* indicates that this species shows wide morphological variation and several ecological constraints. The environmental data suggest that *C. haitensis* has low tolerance to variation

Fig. 1. El Meco stream located in San Luis Potosí state.

Table 3. Microhabitat characteristics of streams with Charales in calcareous tropical streams in Mexico. Average values (n=10) are shown.

Site	Taxa	Current velocity (cm s^{-1})	Irradiance (µmol photons m^{-2} s^{-1})	Depth (cm)
Itzamatitlán	*C. haitensis*	5	1148	41
Los Manantiales	*C. vulgaris*	5	340	16
	C. zeylanica var. diaphana	0	2029	10
Río Salado	*C. haitensis*	1	2029	0
Micos	*C. haitensis*	1	932	24
	N. furcata var. sieberi	10	25	34
El Meco	*C. haitensis*	30	702	18
	C. vulgaris	5	340	27
	N. tenuissima var. tenuissima	1	2234	5
El Salto	*C. haitensis*	0	5	8

in current velocity, depth, and substratum type, and tolerates only medium irradiances (i.e. 340-1000 µmol photons m^{-2} s^{-1}). In comparison, *N. furcata* var. *sieberi* was found in a stream with lower irradiances (25 µmol photons m^{-2} s^{-1}) and *N. tenuissima* var. *tenuissima* was found in localities with high irradiances (2000-2234 µmol photons m^{-2} s^{-1}) (Fig. 2).

Wide morphological variation has been described in characean species and we found it to be so for populations of *Chara haitensis* in different sites. This led us to ask: Are these the same or do they represent cryptic species? This question could form a hypothesis that could be the basis of future systematic studies using molecular characters.

Figure 2. *Chara haitensis* Turpin of Itzamatitlán stream.

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Ponderful
PONDS FOR CLIMATE
Funded by the European Union

A new European research project assessing role of ponds in ameliorating the impact of climate change

Led by the University of Vic in Spain, Ponderful's overall aim is to develop better methods for maximising the use of ponds and pondscapes in climate change adaptation and mitigation, biodiversity conservation and the delivery of ecosystem services.

Because of their small size, the significance of ponds has long been underestimated. They are, for example, largely excluded from Europe's most important water legislation, the Water Framework Directive in Europe, even though the Directive is actually intended to protect 'all waters'. However, research over the last 10-15 years has shown that, because of their abundance, heterogeneity, exceptional biodiversity, inherent naturalness and biogeochemical potency, ponds play a role in catchments, landscapes, and potentially at continental scale which is completely out of proportion to their small size, and there is growing awareness amongst researchers and others of their importance .

The main aims of the research in PONDERFUL will be to increase understanding of the ways in which ponds, as a Nature-Based Solution, can help society to mitigate and adapt to climate change, protect biodiversity and deliver ecosystem services. The project started in December 2020, and will run for 4 years.

This continent-wide project's five main components are:

1. Developing a strategic approach to engagement with stakeholders, to ensure that they are able to effectively implement the benefits of ponds as Nature-Based Solutions
2. Through the generation of extensive new biodiversity and ecosystem services datasets, to better establish the relationship between pond biodiversity and the delivery of ecosystem services
3. Establish models that enable us to test and optimise practical scenarios for the use of ponds and Nature-Based Solutions
4. Create a set of demonstration sites across Europe which show to practitioners and policy makers how ponds can help to mitigate and adapt to the effects of climate change
5. Ensure that the project's outputs are widely known to policy makers, practitioners and other stakeholders.

The project brings together experienced researchers from nine European states and from Turkey and Uruguay.

The consortium is building the standardised research protocol that will be applied to the collection of new data related to pond biodiversity and pond ecosystems (during 2021 and 2022 and in 8 countries throughout Europe, Turkey and Uruguay).

I have underlined the importance to determine stoneworts to the species as far as possible and we are discussing finding a realistic solution for stonewort storage and determination, considering that each of the partners will have to assess a wide range of parameters (macrophytes, macroinvertebrates, zooplankton, fishes, amphibians, GHG emission, carbon sequestration, etc…) and that not so many are able to determine stoneworts to the species at the moment.

Hence, if some expert would be interested to help us with the determination work (at least for tricky taxa) please contact me using this email address: aurelie.boissezon@hesge.ch.

Thanks to those who already proposed suggestions and help!

Aurélie Boissezon (Switzerland)

P.S. On February 25, we organized an online meeting, to discuss the importance of charophytes in ponds, how we could contribute to the Ponderful project, and other issues related to charophytes, for example red lists. Even though it was very early in Mexico and the US, and very late in Argentina, 27 IRGC members participated in the meeting!!! See group photo on last page! Thanks a lot for very interesting discussions, and very nice chats! We will try to organize online discussion meetings more often, because people seemed quite happy to see each other, if only virtually, and discuss charophytes. So: if you have a topic you would like to discuss within the IRGC, please let us know.

Susanne Schneider (Norway)

LOOKING FOR FOSSIL CHAROPHYTES IN THE MIDDLE EAST

Josep Sanjuan Gribau (Spain)

A new episode of my personal life and scientific career started four years ago when I gained a tenure track position in the Geology Department of the American University of Beirut (AUB) in Lebanon. Founded in December 1866 as a Syrian Protestant college, the AUB represents the oldest university in the region which bases its educational philosophy on the American liberal arts model. Today the university has 6 faculties, 130 undergraduate and postgraduate degree programs, and up to 8000 students. AUB is considered one of the top private universities in the Middle east and holds the position number 220 of the QS world university ranking. The AUB´s campus is located on a hill overlooking the Mediterranean Sea in the neighbourhood of *Hamra* (Fig. 3). Majestic tropical and local trees grow among historical buildings within the campus. *Hamra* (red color in Arabic) is one of

Figure 3. View from the historical AUB´s campus overlooking the Mediterranean Sea (looking towards the north). 3rd May 2019

the most vibrant and diverse neighbourhoods of the Lebanon´s capital Beirut. Founded by the Phoenicians, Beirut is one of the largest cities of the eastern Mediterranean coast. Beirut´s golden legacy includes archaeological sites of several civilizations (Phoenicians, Greeks, and Romans), Ottoman palaces and *art nouveau* buildings from the French mandate (1923–1946). These treasures can be found surrounded by modern skyscrapers in the city´s downtown and nearby neighbourhoods such as *Hamra*, *Ain al Mraiseh*, and *Asharfieh* (Fig. 4).

The once jewel of Mediterranean during the fifties, sixties and seventies, Beirut is now a city of contrasts, with visible signs of its turbulent past such as the civil war (1975–1990) and the very recent port´s explosion. Beirut is always

Figure 4. Modern buildings rise in *Ain al Mraiseh* (Beirut). 18th September 2019.

emerging from its ruins and never loses its color and dynamism. Restaurants, cafes and nightclubs characterizes Beirut lifestyle what makes it one of the most liberal cities in the Arab world. I´ve always found strong similarities between Beirut and my hometown Barcelona. Both cities are located in opposite shores of the same Mediterranean Sea, sharing similar weather and the ancestral sailing culture. Always shiny, Beirut is a symbol of diversity and religious coexistence, a mix of eastern and western traits, smells and flavours.

My research during these years in the Middle East has been focused in a wide range of geological topics. One of my main research goals was the study of fossil charophytes from two well-exposed continental rock units: 1) the Early Cretaceous deltaic/estuarine Chouf Formation located in Mount Lebanon and 2) the Miocene lacustrine deposits of the Zahle Formation in the fertile Bekaa Valley. Every fieldtrip was a new adventure where I met incredible people and breath-taking views surprised me.

1) Mount Lebanon.

The Mount Lebanon is the western mountain range of the country extending 170 km parallel along the Mediterranean coast (Fig. 5).

Figure 5. Landscape photo of Mount Lebanon during a fieldtrip. May 2018.

This mountain range (highest peak at 3088 m) has provided protection for the local communities for centuries and has represented a valuable source of goods for their trade and economy. The Phoenicians and successive civilizations exploited the endemic Cedar forests (*Cedrus libanii*) growing on the slopes of Mount Lebanon to build their naval fleet and to trade with their neighbour cultures. The magnificence of these old trees can still be appreciated in two protected reserves (*Bsharri* and *Barouk*). Despite part of the Mount Lebanon has been extensively exploited, some regions are still intact representing a Mediterranean hotspot for plant diversity.

Five fossil charophyte taxa were identified in the estuarine deposits of Mount Lebanon (Fig. 6): two species of Characeans (*Sphaerochara asema* and aff. *Mesochara harrisii*), three Clavatoraceans (*Atopochara trivolvis* var. *trivolvis*, *Ascidiella reticulata*, and *Clavator ampullaceus*) and one species of charophyte thalli (*Munieria martinclosasi*). This fossil charophyte assemblage and its associated ostracods suggest that the studied rocks are late Barremian/early Aptian in age (~125 million years old). Species of the extinct family Clavatoraceae were found associated to dasycladalean and foraminifera indicating that they were euryhaline able to thrive in a wide array of coastal waterbodies (Sanjuan et al., under revision).

2) The Bekaa Valley.

The Bekaa Valley is a tectonic basin located in eastern Lebanon covered by beautiful vineyards stretching as far as the eye can see. Excellent wines are being produced in the region. This basin is 120 km long and 16 km wide on average. Late Miocene (~10 million years old) lacustrine sediments outcrop in the valley´s western margin (Fig. 7).

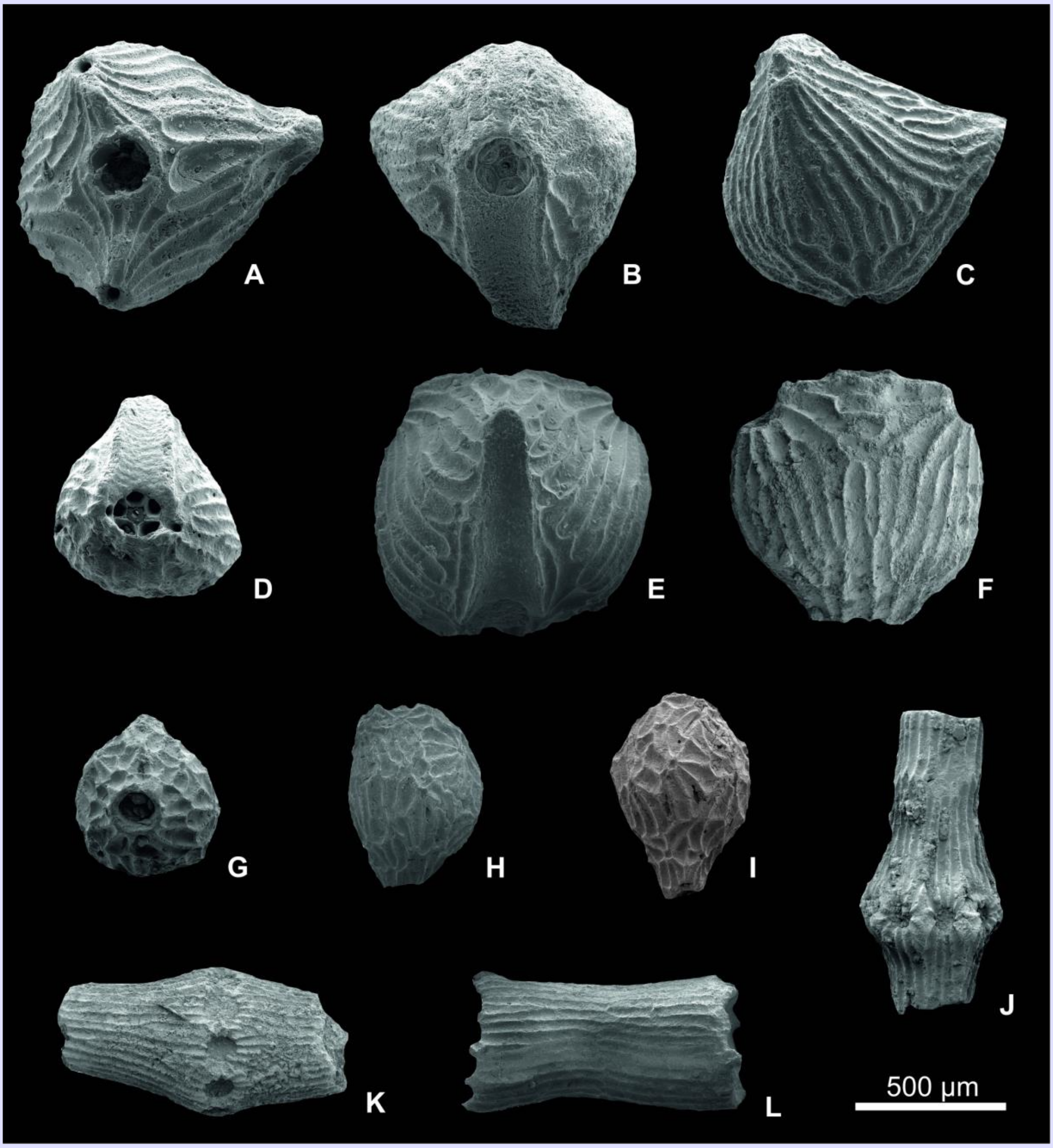

Figure 6. Charophyte utricles and thalli from the Lower Cretaceous of Lebanon. A–F. *Clavator ampullaceus* (A. apical view, B and D. basal views, C. lateral view, E. posterior view, F. anterior view). G–I. *Ascidiella reticulata* (G. basal view, H and I. lateral views). J–L. *Munieria martinclosasi* (J and K. nodes, L. internode). Sanjuan et al., under revision.

Five Characeae species have been found within this sedimentary sequence (Sanjuan and Alqudah 2018, Sanjuan et al. 2019). A well-preserved gyrogonite assemblage of *Nitellopsis* (*Tectochara*) *merianii*, *Lychnothamnus barbatus* var. *antiquus*, *Chara microcera, Chara globularis*, and *Sphaerochara miocenica* has been described and illustrated for the first time in the region (Fig. 8). Interesting palaeolimnological characteristics were inferred to these lacustrine deposits based on charophytes and their associated fauna (ostracods and gastropods) and facies. The presence of this charophyte taxa in the Middle East sheds new light about the palaeogeographic distribution of some living charophyte species as well as the better understanding of their biogeographic history.

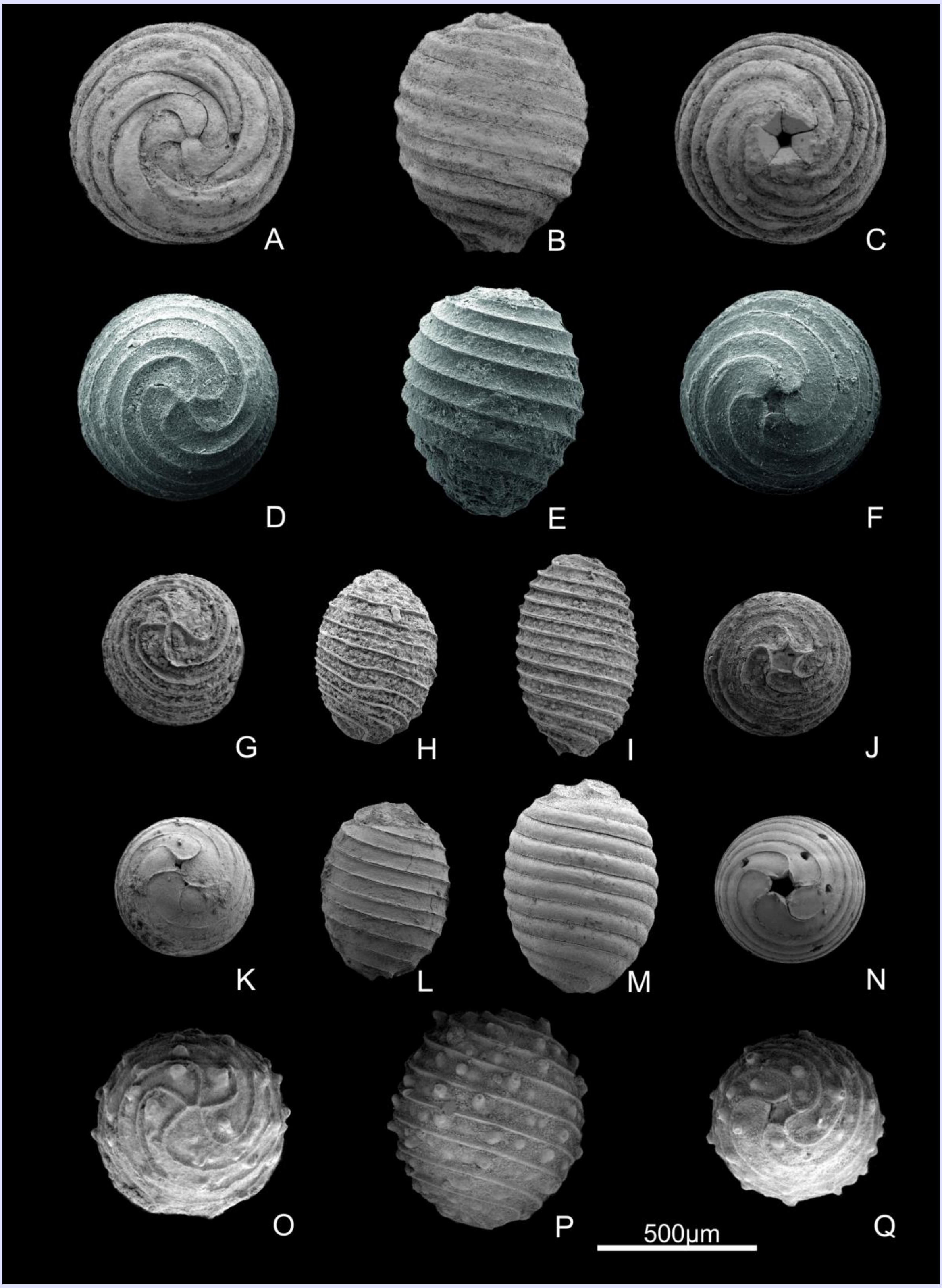

Figure 8. Gyrogonite assemblage from the Miocene of the Bekaa Valley at Zahle. A–C. *Nitellopsis* (*Tectochara*) *merianii* (A. apical view, B. lateral view, C. basal view). D–F. *Lychnothamnus barbatus* var. *antiquus* (D. apical view, E. lateral view, F. basal view). G–J. *Chara microcera* (G. apical view, H. lateral view, I. lateral view, J. basal view). K–N. *Chara globularis* (K. apical view, L and M. lateral views, N. basal view. O–Q. *Sphaerochara miocenica* (O. apical view, P. lateral view, Q. basal view). Sanjuan et al. (2019).

Figure 7. Outcrop photo of the charophyte-rich Miocene lacustrine deposits at Zahle (Bekaa Valley).

During these years in the Middle East I´ve tried to disseminate the value and interest of our beloved charophytes. Also, I´ve set up strong links with geologists and botanists from several institutions in Lebanon and Jordan that will be essential for the development of future projects involving fossil and living charophytes. The Lebanon´s heritage, landscapes and sunsets are now part of my identity and clearly enriched my living experience (Fig. 9).

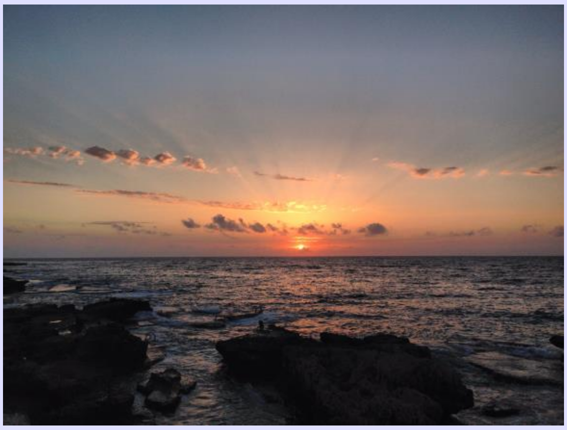

Figure 9. Sunset in Beirut. 19th May 2017

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Josep Sanjuan Girbau currently works as a lecturer professor in the Department of Earth and Ocean Dynamics, University of Barcelona. He is actively involved in teaching undergraduate and graduate courses focused on Paleontology and Paleobotany. His research focuses on six going on topics about fossil charophytes taxonomy, paleoecology, paleobiogeography and biostratigraphy: 1) Early Cretaceous Clavatoracean biogeography of the Tethyan Realm; 2) Early Cretaceous (Barremian) of Mount Lebanon (Lebanon); 3) Paleogene (Eocene-Oligocene) of SW Utah (North America); 4) Paleogene (Eocene-Oligocene) of Zaysan and Kolpakov basins (Kazakhstan); 5) Neogene (Miocene) of Ilgın and Yalvaç basins (Central Turkey), and 6) Neogene (Miocene) of Vallès-Penedès and Ebro basins (NE Spain).

FOSSIL CHAROPHYTES IN ALGERIA AND MOROCCO

Studied by Fateh Mebrouk (Algeria)

Since 1993, my research has been devoted to fossil charophytes from Algeria and Morocco. Systematic study, mainly of rich Eocene floras from western Algeria and the desert areas in the south (Fig. 10) provided a large spectrum of Charophyte genera and species.

The Eocene floras of about 20 fossil sites are composed of ca. 15 species. Most of the species were originally defined in Europe and allow for dating of the deposits. The diverse localities cover the time period from Thanetian to Early Lutetian, corresponding approximately from 60 to 45 million years. The most important and characteristic species belong to the family Raskyellaceae (*R. peckii meridionale*, *R. sahariana*). Typical ornamented gyrogonites of *Nitellopsis* (*Tectochara*) *thaleri* were present in sites of equivalent age both in Algeria and Morocco.

Upper Cretaceous sediments contained gyrogonites of very different genera such as *Feistiella,* a member of the Porocharaceae family, *Platychara* and *Microchara* previously described in Europe. All these sites have also yielded ostracods, freshwater gastropods and vertebrates; the results were published in a number of collaborative papers. Research on fossil charophytes is still ongoing with our PhD students and in national research projects.

For details and references see:

https://www.researchgate.net/profile/Mebrouk_Fateh

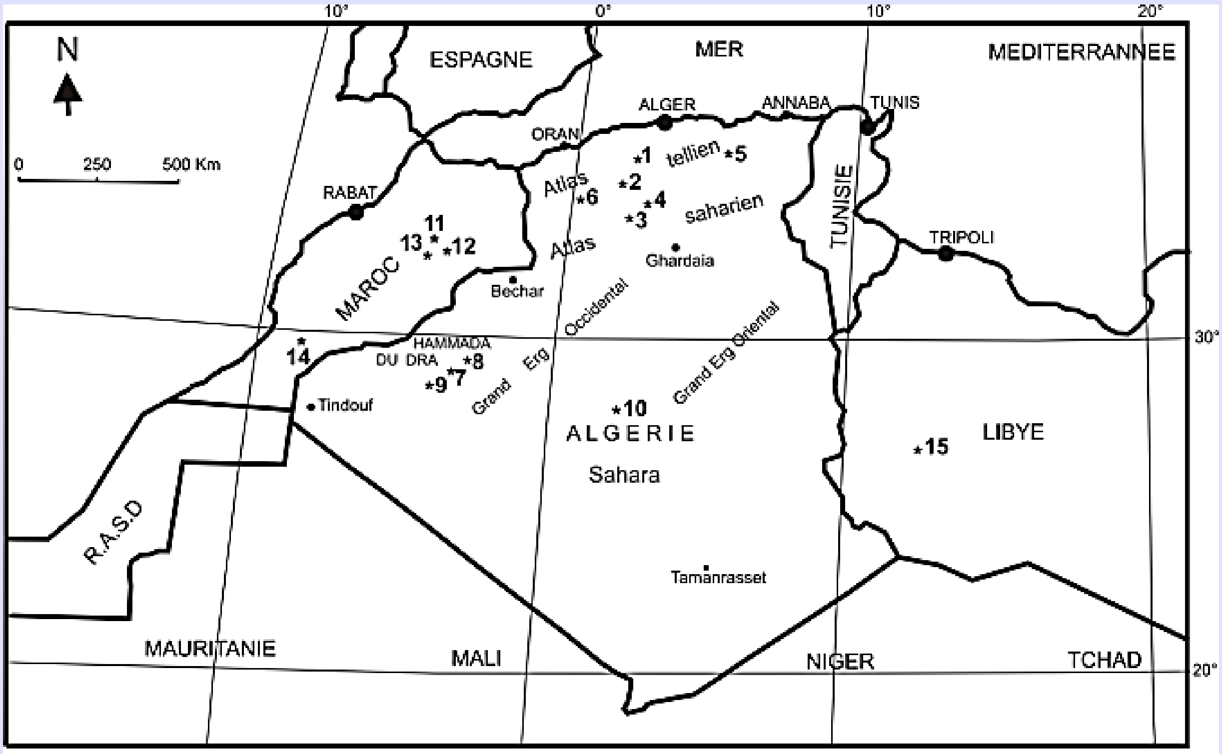

Figure 10. Location of the various continental deposits studied: **Algeria**: Hammada du Dra (7,8,9); Saharan Atlas (3,4); high plateaux (1,2,5,6) and Sahara (10) **Morocco**: Achlouj (11); Saf (12); El-Koubbat (13) and N'Tagourt (14) (in Mebrouk, 2011).

PhD THESIS COMPLETION

Eric Puche, Integrative Ecology laboratory, Cavanilles Institute of Biodiversity and Evolutionary Biology, University of València. Supervisors: María A. Rodrigo Alacreu and Carmen Rojo García-Morato.

PhD thesis title: **Submerged macrophytes as key players in aquatic ecosystems under global change: a multiscale experimental approach.**

On 18th December 2020, Eric Puche defended his PhD thesis at the Cavanilles Institute of Biodiversity and Evolutionary Biology (University of València) in front of the jury composed of Presentación Carrillo (University of Granada), María José Carmona (University of València), and David G. Angeler (Swedish University of Agricultural Sciences).

The thesis compiles 8 papers, 6 of them previously published in international peer-reviewed scientific journals.

Current global change is imposing alterations in the ecosystems worldwide through interactive changes in main environmental factors (e.g. temperature, nutrient concentration and ultraviolet radiation). Freshwater ecosystems are highly vulnerable to these changes and, specifically in the Mediterranean region, the situation is worse since the majority of them are shallow, exposed to environmental and anthropogenic disturbances. The meadows of submerged macrophytes, and particularly, charophytes, are a conspicuous element of these systems with a crucial role for their functioning. They provide habitat for both planktonic and benthic organisms and maintain water quality by limiting phytoplankton growth, reducing nutrient loading and preventing sediment resuspension. However, these meadows are declining critically due to current global change and this thesis addresses the performance of charophytes and the foreseeable impacts in the ecosystems they inhabit in the context of a changing world. The main aims were i) to investigate the specific and infraspecific responses of charophytes facing the interactive effects of global change-related factors, ii) to elucidate the propagation of these effects through the meadow-associated biological community, emphasizing the relevance of non-trophic relationships, and iii) to disentangle the role of charophytes in the functioning of Mediterranean shallow lakes facing the foreseeable changes and focusing on the sediment microbial community.

These goals were addressed through microcosm experiments with a common garden approach with coastal and high-mountain populations of two charophyte species, laboratory mesocosms simulating macrophyte-dominated shallow systems and field in-lagoon mesocosms with macrophytes meadows in a coastal ecosystem. We found both species- and population-specific patterns in the response of charophytes to concomitant environmental changes regarding growth, morphologic and metabolic variables. The coastal populations came up as those with the greatest phenotypic plasticity to overcome the expected environmental changes. On a community scale, through a network approach, a charophytes-zooplanktonic herbivores tandem emerged as crucially important for the structure of the aquatic community. Furthermore, contrasting configurations (phytoplankton and charophyte-dominated) were achieved by subjecting the communities to ultraviolet radiation and warming scenarios, respectively. Transferring this approach to natural ecosystems allowed the emergence of different patterns of benthic-pelagic coupling between ponds and lakes. Finally, we assessed how charophytes meadows influence the sediment microbial community by favouring denitrification, thus, impacting the functioning of aquatic ecosystems.

This thesis has contributed to depicting the complex puzzle of shallow freshwater ecosystems placing charophytes meadows as a central piece in their structure and functioning within the current global change context.

The thesis can be downloaded from the following website:

https://roderic.uv.es/handle/10550/76679

Khadijeh Arab Salmani, Shahid Beheshti University. Supervisors: Hossein Riahi, Akram Ahmadi, Zeinab Aghashariatmadari. PhD defence September 7, 2020.

PhD thesis title: **Systematic and phylogenetic study of some Chara species (Characeae) based on morphological and molecular data.**

The morphological diversity of Chara species is very high due to the diversity in their habitat and intraspecific genetic variation in this genus. Characeae family members are of great environmental importance due to their role in conservation of aquatic environment and absorption of pollutants. Charophytes are susceptible to environmental conditions such as increased levels of nitrogen and phosphate in the water (eutrophication) and are therefore endangered. So the first step is to identify exactly the species that exist. Due to the overlap of morphological traits and the phenotypic flexibility induced by the environment, species boundary boundaries are complex. Today's DNA analysis is a well-known method for investigating and developing accurate species identification. In this study, 20 populations of herbarium species and species collected from the environment were analyzed. Samples were collected from different parts of Iran, especially central parts (Isfahan, Tehran, Markazi, Qom, Yazd, etc.). Collected populations were analyzed for morphological parameters. Three individuals or thalli were isolated from each population and were cleaned of other epiphytic algae. Matk marker was used to study the kinship relationships of the species under study. Then, using the PAUP software, the phylogenetic tree was plotted that the tree derived from matk molecular marker showed that this marker was able to show the position of most species well. Low levels of diversity among species indicate that the species have almost a common ancestor and may have undergone an incomplete species process.

FORTHCOMING MEETINGS

May-August 2021
International Society of applied phycology
Online conference
https://www.appliedphycologysoc.org/event-3502372

22–27 June 2021
ASLO 2021 Aquatic Sciences Meeting
Online meeting
https://www.aslo.org/2021-virtual-meeting/

13–17 June 2022
16th International Symposium on Aquatic Plants
Aarhus, Denmark
http://www.internationalaquaticplantsgroup.com/introduction.html

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 2021. 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)
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To do the bank transfer, please give the following information to your bank:

Account-holder: Int Research Grp on Charophytes
Dr Emile Nat
Grote Ruwenberg 17
1083 BS Amsterdam
Netherland
Name of bank: BANQUE LA POSTE
Address of Bank: Centre Financier, 13900 Marseille Cedex 20, France
BIC (International ID of Bank): PSSTFRPPMON
IBAN: FR 76 20041 01009 0350328M030 21

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 2021.

Abdelahad, Nadia	nadia.abdelahad@uniroma1.it
Ahmadi, Akram	ahmadi2002fr@yahoo.com
Akbayeva, Lyailya	akbaeva659@mail.ru
Alix, Mitchell S.	malix@pnw.edu
Azzella, Mattia M.	mattia.azzella@gmail.com
Auderset Joye, Dominique	Dominique.Auderset@unige.ch
Barinova, Sophia	sophia@evo.haifa.ac.il
Båstrup-Spohr, Lars	lbaastrupspohr@bio.ku.dk
Becker, Ralf	becker.r@posteo.de
Beilby, Mary Jane	m.j.beilby@unsw.edu.au
Beisenova, Raikhan	raihan-b-r@yandex.kz
Bengtsson, Roland	Roland.bengtsson@mikroalg.se
Benoit, Roch-Alexandre	roch-alexandre.benoit@laposte.net
Bernhardt, Karl Georg	karl-georg.bernhardt@boku.ac.at
Bisson, Mary A.	bisson@buffalo.edu
Blazencic, Jelena	jelenablazencic@gmail.com
Blindow, Irmgard	blindi@uni-greifswald.de
Boissezon, Aurélie	aurelie.boissezon@hesge.ch
Borysova, Olena	oborysova@yandex.ru
Breithaupt, Christian	Christian.breithaupt@gmx.de
Bruinsma, John	michal.b@amu.edu.pl
Brzozowski, Michał	jhpbruinsma@gmail.com
Bučas, Martynas	martynas.bucas@jmtc.ku.lt
Calero Cervera, Sara	sara.calero@uv.es
Casanova, Michelle T.	amcnova@netconnect.com.au
Chivas, Allan R.	toschi@uow.edu.au
Christia, Chrysoula	xchristia@gmail.com
De Sosa Tomas, Andrea	adesosatomas@gmail.com
Demirci, Elvan	elvandemirci@hacettepe.edu.tr
Feist, Monique	mjcfeist@hotmail.fr
Flor-Arnau, Nuria	nurnu@yahoo.es
Foissner, Ilse	ilse.foissner@sbg.ac.at
Garcia, Adriana	garciaguidobono@gmail.com
Gottschalk, Stephen	stephen.gottschalk@gmail.com
Grillas, Patrick	grillas@tourduvalat.org
Grinberga, Laura	laura.grinberga@gmail.com
Haas, Jean Nicolas	Jean-Nicolas.Haas@uibk.ac.at
Hannibal, Joseph	jhannibal@cmnh.org
Herbst, Anne	anneherbst@gmx.de
Holzhausen, Anja	anja.holzhausen@uni-rostock.de
Hutorowicz, Andrzej	a.hutorowicz@infish.com.pl
Inkarova, Zhanslu	inkarzh@mail.ru
Kalin, Margarete	margarete.kalin@utoronto.ca
Karol, Ken	kkarol@nybg.org

Kirschey, Tom	Tom.Kirschey@NABU.de
Koistinen, Marja	marja.koistinen@helsinki.fi
Kozlowski, Gregor	gregor.kozlowski@unifr.ch
Kyrkander, Tina	tina.kyrkander@ornborgkyrkander.se
Lambert-Servien, Elisabeth	eslbl@wanadoo.fr
Li, Sha	shali@nigpas.ac.cn
Mann, Henry	hmann@grenfell.mun.ca
Marković, Aleksandra	gmvalex@gmail.com
Martin, Georg	georg.martin@ut.ee
Martin-Closas, Carles	cmartinclosas@ub.edu
Mebrouk, Fateh	mebrouk06@yahoo.fr
Meiers, Susan	st-meiers@wiu.edu
Millozza, Anna	anna.millozza@uniroma1.it
Nat, Emile	e.nat@kranswieren.nl
Nowak, Petra	petra.nowak@uni-rostock.de
Pełechaty, Mariusz	marpel@amu.edu.pl
Pérez-Cano, Jordi	Jordi_perez-cano@ub.edu
Popłońska, Katarzyna	katarzyna.poplonska@biol.uni.lodz.pl
Pronin, Eugeniusz	eugeniusz.pronin@ug.edu.pl
Puche Franqueza, Eric	eric.puche@uv.es
Pukacz, Andrzej	pukacz@europa-uni.de
Raabe, Uwe	uraabe@yahoo.de
Ribaudo, Cristina	cristina.ribaudo@ensegid.fr
Rodrigo, Maria	maria.a.rodrigo@uv.es
Romanov, Roman	Romanov_r_e@ngs.ru
Romo, Susana	susana.romo@uv.es
Sakayama, Hidetoshi	hsak@port.kobe-u.ac.jp
Sanjuan Girbau, Josep	josepsanjuan@ub.edu
Schneider, Susanne	susi.schneider@niva.no
Schubert, Hendrik	hendrik.schubert@uni-rostock.de
Schwarzer, Arno	arno.schwarzer@aschwarzer.net
Scribailo, Robin W.	rscrib@pnw.edu
Simons, Jan	Jan.Simons@gmx.com
Sinkevičienė, Zofija	zofijasin@gmail.com
Sleith, Robin	robinsleith@gmail.com
Soulié-Märsche, Ingeborg	insouma43@gmail.com
Stewart, Nick	nfstewart@freeuk.com
Strzałek, Małgorzata	malgorzata.strzalek@uph.edu.pl
Sugier, Piotr	piotr.sugier@poczta.umcs.lublin.pl
Torn, Kaire	kaire.torn@ut.ee
Trabelsi, Khaled	trabkhalfss@yahoo.fr
Trbojević, Ivana	ivanatrbojevic@yahoo.com
Troia, Angelo	angelo.troia@unipa.it
Tulegenov, Sherim	sh_tulegen@mail.ru
van de Weyer, Klaus	klaus.vdweyer@lanaplan.de
Vicente Rodríguez, Alba	albavicenterodriguez@ub.edu
Wang, Qi-Fei	qfwang@nigpas.ac.cn
Wojtczak, Agnieszka	agnieszka.wojtczak@biol.uni.lodz.pl
Zhamangara, Aizhan	kashagankizi@mail.ru
Zviedre, Egita	egita.zviedre@ldm.gov.lv

GROUP PHOTOGRAPH 2021

Online meeting: discussion about charophytes, February 25