Atti e Convegni

22nd Meeting of the Group of European Charophytologists (GEC)

Palermo, Italy
17-21 September 2018

Programme & Abstracts

edited by
Angelo Troia

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PRESS

22nd Meeting of the Group of European Charophytologists (GEC)
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Convened by
The International Research Group on Charophytes (IRGC)

Organised by
Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STEBICEF) of the University of Palermo, Italy, in collaboration with the CIRITA (Interdepartmental Research Centre on Technology-Environment Interaction) of the same University, and FORUM PLINIANUM onlus, a non-profit organisation.

With the contribution of
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Società Siciliana di Scienze Naturali onlus
Parco dei Nebrodi
Comune di Palermo

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Angelo Troia (chair), Rossella Barone, Anna Geraci, Riccardo Guarino, Anna Maria Mannino, Elisabetta Oddo, Rosario Schicchi

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The abstracts have been evaluated by the Scientific Committee with the help of some referees

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WELCOME

On behalf of the Organising Committee, I am very happy to welcome you to the 22nd Meeting of the Group of European Charophytologists (GEC), held in Palermo, Italy from September 17 to 21, 2018.

The 22nd GEC Meeting is convened by the International Research Group on Charophytes (IRGC) and organised by the Department of Biological, Chemical and Pharmaceutical Sciences and Technologies (STEBICEF) of the University of Palermo, in collaboration with the Interdepartmental Research Centre on Technology-Environment Interaction (CIRITA) of the same University, and FORUM PLINIANUM onlus. The lectures and poster presentations will be held at the Botanical Garden, part of the University Museum System.

As far as I know, this is the first GEC meeting in Italy, so I am particularly proud of this, but also hopeful that this meeting can contribute to attract more attention from researchers, field biologists and politicians (s. l.) on this particular group of plants: they are in fact so important from several points of view, from evolutionary studies to applied ecology, from palaeontology to physiology.

We thank all the people and institutions that made this Meeting possible.

We hope you enjoy the programme, and find the time to enjoy Palermo and Sicily as well.

Angelo Troia

GENERAL PROGRAMME

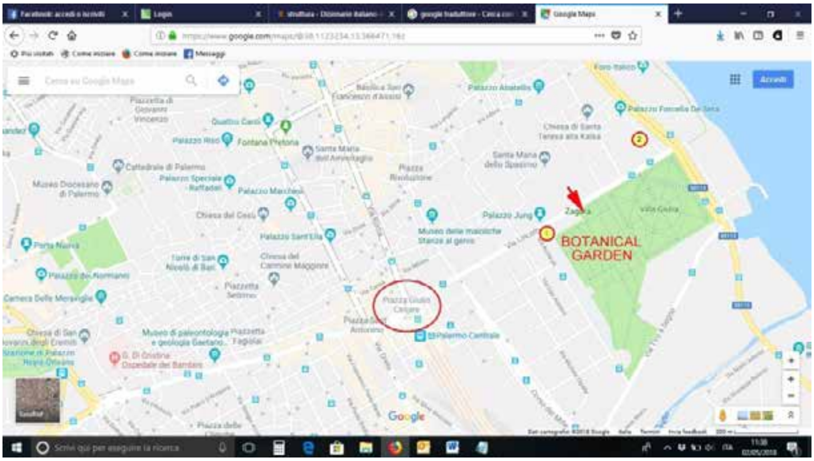
16 September (Sunday): late afternoon: informal meeting in Palermo Old Town.

17-18 September (Monday and Tuesday): registration, oral and poster sessions at the Botanical Garden of the University of Palermo.

19 September (Wednesday): One-day field trip to "Lago Preola & Gorghi Tondi" Nature Reserve (W Sicily), with charophytes collection; visit to the "Saline di Trapani e Paceco" Nature Reserve.

20 September (Thursday): University of Palermo, morning: identification of the charophytes collected in the field trip; after lunch: departure for the 2-day field trip to Nebrodi Mts Natural Park (NE Sicily); dinner and accommodation in a hotel in Cesarò, a small town in the heart of the Nebrodi Mts.

21 September (Friday): field trip to visit Nebrodi Mts Natural Park; visit to some small mountain lakes and ponds; packed lunch; back in Palermo at around 8 p.m.



Above: Location of the Palermo Botanical Garden with its entrance (arrow) (address: via Lincoln 2). (1) Hotel Villa Archirafi; (2) NH Hotel.
"Piazza Giulio Cesare" (in front of the Main Railway Station, "Stazione Centrale") is the terminal of the bus-shuttle from/to the Palermo Airport (PMO) (see http://www.prestiaecomande.it/).

PROGRAMME

SUNDAY, 16 SEPTEMBER	
19:30	**Informal (icebreaking) meeting at city centre**

MONDAY, 17 SEPTEMBER	
9:00-9:30	**Registration and fixing of posters:** Lecture room (or nearby), Orto Botanico (Botanic Gardens)
9:30-9:45	**Opening and Welcome:** in the lecture room

Lecture Session I: Fossil charophytes

Chairperson: **Ingeborg Soulié-Märsche**

9:45-10:10	**Middle Jurassic charophytes from southern Tunisia (North Gondwana): new data on the evolution of Jurassic charophytes** Lassad Tiss, Khaled Trabelsi*, Fekri Kamoun, Mohamed Soussi, Yassine Houla, Benjamin Sames, Carles Martín-Closas
10:10-10:35	**Charophyte bioprovincialism in the Early Cretaceous Central Tethyan Archipelago** Carles Martín-Closas*, Jordi Pérez-Cano & Josep Sanjuan
10:35-11:00	**Diverse brackish charophyte assemblages in the Lower Cretaceous of the Iberian Chain** Jordi Pérez-Cano*, Telm Bover-Arnal & Carles Martín-Closas
11:00-11:30	**Coffee break**

Chairperson: **Carles Martín-Closas**

11:30-11:55	**Charophytes from the Upper Cretaceous of Provence (South-East France)** Roch-Alexandre Benoit*, Alba Vicente & Carles Martín-Closas
11:55-12:20	**Filling a gap: Turonian–Santonian charophytes from the Songliao Basin (Northeastern China) with a cladistic analysis of the *Perimneste-Atopochara* lineage** Sha Li*, Qifei Wang, Haichun Zhang, Zhang Yiyi, Xiaoqiao Wan

12:20-12:45 **Fossil charophytes from the Claron Formation (Southeastern Utah, USA). Biostratigraphic and paleobiogeographic implications**
Josep Sanjuan*, Alba Vicente & Jeffrey Eaton

13:00-14:30 Lunch break

14:30-14:55 **Charophytes of a key geological section of non-marine Cenozoic deposits in the Aktau Mountains (Southeast Kazakhstan)**
Aizhan Zhamangara*, Josep Sanjuan, Saida Nigmatova, Bolat Baishashov

14:55-15:20 **Significance of Cenozoic fossil charophytes from Turkey**
Elvan Demirci*, Cemal Tunoğlu

15:30-16:00 Coffee break

POSTER Session

Chairperson: **Mariusz Pełechaty**

16:00-18:00 10 min/poster. The posters will be exhibited during the whole meeting in the lecture room or nearby

1. Charophytes and macrofossils from the Mid- to the Late-Holocene Lake Afourgagh (Middle Atlas, Morocco): preliminary results
Dendievel André-Marie*, Berger Jean-François, Barra Adrien, Dabkowski Julie, Degeai Jean-Philippe, Dezileau Laurent, Segaoui Fatima, Boudad Larbi & Limondin-Lozouet Nicole

2. Upper Cretaceous charophytes from the Cabullona Basin (northeastern Sonora, Mexico)
Alba Vicente*, Uxue Villanueva & Carles Martín-Closas*

3. Oospores of *Nitella* species, based on an examination of type material
Michelle T. Casanova

4. Evaluating the species boundaries of brackish water *Tolypella* using cpDNA barcoding
Petra Nowak & Ralf Becker*

5. Pre-Linnaean illustrations as original material of Linnaean *Chara* names (*Characeae*)
Angelo Troia

6. The "*Chara hispida* species complex" kept in the Herbarium RO of the Sapienza University of Rome
Anna Millozza*, Mauro Iberite, Nadia Abdelahad

7. Occurrence of *Characeae* in the Herbarium Universitatis Taurinensis (TO)
Laura Guglielmone* & Deborah Isocrono

8. The role of herbaria for taxonomic and distributional studies in *Characeae*: examples from the Herbarium Mediterraneum Panormitanum (PAL) and the Florence Tropical Herbarium (FT)
Angelo Troia*, Lia Pignotti, Teresa Napolitano, Rosario Schicchi, Riccardo Maria Baldini

9. Peculiarities of *Chara filiformis* distribution in Lithuania
Zofija Sinkevičienė

10. From invasive species to charophytes meadows: Impact of the rehabilitation of a French canal
Elisabeth Lambert*, Sylvie Fonteny

11. Carbon sequestration by charophytes and submerged vascular plants: a research project conducted in lakes of climatically different western and north-eastern regions of Poland
Mariusz Pełechaty*, Karina Apolinarska, Marcin Becher, Elżbieta Biardzka, Grzegorz Kowalewski, Lech Kufel, Aleksandra Pełechata, Andrzej Pukacz, Beata Sternal, Małgorzata Strzałek & Michał Woszczyk

12. Differences in charophyte overwintering between mid-western and north-eastern Poland
Małgorzata Strzałek*, Elżbieta Biardzka, Lech Kufel, Mariusz Pełechaty & Andrzej Pukacz

13. Application of geoinformation systems in the study of charophytes
Bazargul Zhapparova, Ainur Omarbayeva, Zharas Berdenov, Sherim Tulegenov, Zhanslu Inkarova, Aizhan Zhamangara*

End of the scientific day

18:30 Guided city centre touristic visit (1½-hour walk)

TUESDAY, 18 SEPTEMBER

Lecture Session II: Extant charophytes – SYSTEMATICS

Chairperson: **Adriana Garcia**

9:30-9:55 **The species complex *Chara hispida*: nomenclature, determination - and WHAT is a species??**
Irmgard Blindow*, Thomas Gregor & Hendrik Schubert

9:55-10:20 ***Chara globularis* – *Chara connivens* – *Chara contraria*: more insights from morphology and genetics**
Susanne Schneider*, Andreas Ballot, Aleksandra Vesic, Ivana Trbojevic

Lecture Session III: Extant charophytes - DISTRIBUTION AND CONSERVATION

Chairperson: **Susanne Schneider**

10:20-10:45 **Charophytes of Australia's Northern Territory, both familiar and foreign!**
Michelle T. Casanova

10:45-11:15 Coffee break

11:15-11:40 **Charophytes from Israel: trends in diversity, occurrence and distribution**
Roman Romanov* & Sophia Barinova

11:40-12:05 **Temporary brackish habitats in Sardinia (Italy) – hotspots for the conservation of *Characeae***
Ralf Becker

12:05-12:30 **New records of *Characeae* for Sicily (Italy)**
Angelo Troia*, Teresa Napolitano, Klaus van de Weyer, Roman Romanov

12:30-13:00 Group photo

13:00-14:30 Lunch break

Lecture Session IV: Extant charophytes – ECOLOGY

Chairperson: **Maria Rodrigo**

14:30-14:55	**Production and morphometry of *Lychnothamnus barbatus* gyrogonites in the context of the depth of the species occurrence: implication for the ecological and palaeoecological research** Michał Brzozowski*, Marcel Palomares Cabanilles, Grzegorz Kowalewski, Mariusz Pełechaty
14:55-15:20	**Examination of north-eastern German lakes – A potential assessment for the reestablishment of *Characeae* (Charales, Charophytes)** Anja Holzhausen*, Ingo Nienhaus, Jens Meisel, Katja Trefz, Kerstin Vasters, Andreas Hussner
15:20-15:45	**The role of *Characeae* in the communities of the vegetation class *Potametea*** Riccardo Guarino*, Vincenzo Ilardi, Anna Maria Mannino, Angelo Troia

15:45-16:15 Coffee break

Chairperson: **Allan Chivas**

16:15-16:40	**The reproductive phenology of charophytes as a tracker of climate change** Sara Calero* & Maria A. Rodrigo
16:40-17:05	**Charophyte performance under different environmental scenarios: final outcome from a mesocosm experiment** Eric Puche*, Noemi Martínez, Raúl Martínez, Álvaro González, Yolanda Picó, Carmen Rojo & Maria A. Rodrigo
17:05-17:30	**Investigating the ecology of *Chara* cf. *baltica* (*Characeae*) in the Lago Preola ecosystem (Sicily, Italy)** Angelo Troia, Anna Geraci*, Elisabetta Oddo*, Salvatrice Vizzini

17:30-18:00 GEC Members Assembly in the lecture room

18:00 Closing ceremony

End of the scientific day

20:30 Conference dinner

WEDNESDAY, 19 SEPTEMBER

POST-CONFERENCE EXCURSIONS

For the excursions, please bring with you trekking shoes, windbreaker, sun-protection cream and sun hat. The technical difficulty of the hikes is not the same: Excursion nr.1 is easier and shorter; Excursion nr.2 can be longer but we will arrange it in such a way that each participant can adapt the trip to his/her own needs.

All the excursions are on hiking trails and cross terrain with exposed rock faces, where falls are possible. Be prepared to spend the whole day outside, including many hours in very sunny places (especially for Excursion nr.1), occasionally windy.

POST-CONFERENCE EXCURSION NR. 1

Presentations will be followed by a one day field trip (19/9) with charophytes collection. The excursion is planned in the Nature Reserve **"Lago Preola e Gorghi Tondi"** (Trapani province, W-Sicily), an interesting karst area with several small lakes not far from the coast. After lunch (including a visit in a winery) we will visit another important Nature Reserve: **"Saline di Trapani e Paceco"**, with the last active saltworks in Sicily. Both reserves, established by the Sicilian Region, are currently managed by WWF-Italia.

08:30 Departure to Mazara
10:30 Visit to Lago Preola with charophytes collection
12:30 Visit in a winery + lunch
15:00 Departure to Trapani
16:30 Visit to Trapani saltworks
18:30 Departure to Palermo
20:00 Arrival in Palermo

During the first excursion we will visit **Lago Preola** (37°37'14" N, 12°38'27" E), a small lake (33 ha; when full, maximum depth = 2 m) located in the Riserva Naturale Integrale "Lago Preola e Gorghi Tondi" (established in 1998), 6 km ESE of Mazara del Vallo, Trapani Province, Sicily, Italy. The study area has a typical subtropical Mediterranean climate, with hot, dry summers and mild, moist winters.

The reserve includes five primary endorheic wetlands and lakes in sinkholes (dolines) formed in collapsed surficial early Pleistocene arenaceous bioclastic limestone known as the "Calcarenite di Marsala". Collapse was induced by partial dissolution of ~50 m of Miocene gypsum that fills a channel formed in late Miocene deltaic sediments (Formazione Terravecchia). A shallow aquifer with relatively low total dissolved solids is associated with the Calcarenite di Marsala, and a deeper, saline aquifer, within the older Miocene units (Cusimano et al., 2006).

The coastal aquifer supplying groundwater to the study area lakes has shown fluctuations in the last decades: in 2000/2001 Lago Preola dried out completely during the summer drought. Irrigation well pumpage was reduced in 2004, and ceased in 2008, which in combination with abundant precipitation has since resulted in high, stable lake levels (Curry et al., 2016, *Quaternary Science Reviews* 150: 67-83).

Aquatic flora and vegetation is scarcely known; in addition, preliminary observations suggest a high species turnover in the last decades, probably linked to climatic and environmental factors. On the shore of the lakes we find a rich vegetation with many helophytes such as *Phragmites australis* (Cav.) Trin. ex Steud., *Cladium mariscus* (L.) Pohl, *Bolboschoenus maritimus* (L.) Palla, *Typha* sp. pl., etc. On the surrounding areas, where not cultivated, a termophilous maquis with *Quercus calliprinos* Webb, *Rhamnus oleoides* L., *Chamaerops humilis* L., *Pistacia lentiscus* L., with woods of the evergreen *Quercus ilex* L. in the fresh slopes.

This is one of the most important wetland areas of south-western Sicily with a relevant importance for resting, wintering as well as nesting aquatic birds. In addition, the area is also important for the presence of the Sicilian Pond Turtle *Emys trinacris*, recently distinguished from the European Pond Turtle *Emys orbicularis*. However, different allochthonous species are reported for this territory like the invasive Red swamp crayfish *Procambarus clarkii*, and the fishes Eastern mosquitofish *Gambusia holbrooki*, Wild common carp *Cyprinus carpio* and the mollusk Fragile ancylid *Ferrissia fragilis* (Marrone F., unpublished data); Red swamp crayfish is widespread in all the basins while fishes are limited only to the Gorghi Tondi Medio-Alto system (Ottonello et al., 2016, *Ecological Research*, DOI 10.1007/s11284-016-1416-1).

Our visit will focus on the recently found population of *Chara* cf. *baltica*, mentioned in two abstracts of Troia *et al.* in this volume (pp. 36 & 42).

One of the lakes of the Reserve "Lago Preola e Gorghi Tondi" (photo V. Ilardi)

THURSDAY, 20 SEPTEMBER

CHAROPHYTE IDENTIFICATION

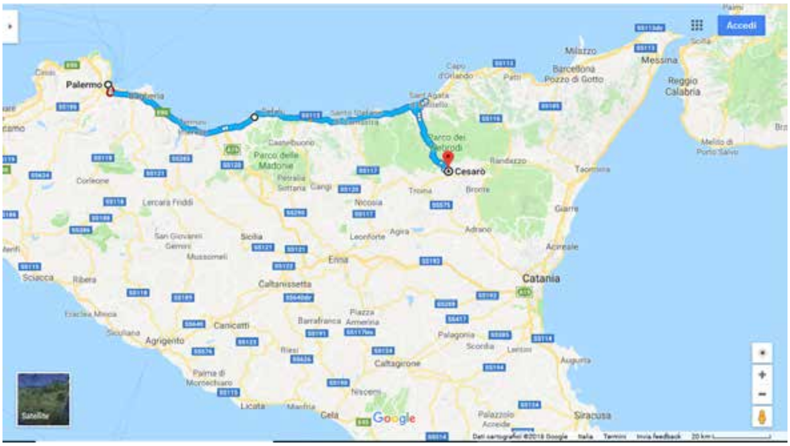
10:00-12:45	After the first field trip, the charophyte identification session will be held in one of the laboratories of the Department STEBICEF, in the building of the former Botanical Institute. Binocular microscopes and identification keys will be available
13:00	Lunch

POST-CONFERENCE EXCURSION NR. 2

After lunch (that is included in the first excursion fee), we shall leave Palermo for the second excursion. In the second field trip to the **Nebrodi** Mountains Regional Park (NE-Sicily), we will visit a small mountain lake in one of the most forested area of the island, a beech woodland at about 1400 m a.s.l. (about 150 km from Palermo).

We will spend one night in a hotel located within the Regional Park.

15:00	Departure
18:30	Arrival in the Nebrodi Park
19:30	Dinner



FRIDAY, 21 SEPTEMBER

(POST-CONFERENCE EXCURSION NR. 2)

09:30	Departure (walking)
11:30	Arrival at lake Maulazzo
12:30	Lunch
14:30	Departure
16:30	Arrival at the bus/Departure to Palermo
20:00	Arrival in Palermo

The **Nebrodi Mts.** represent the central sector of the Sicilian northern belt (Appennino Siculo), that faces the Tyrrhenian Sea. The environmental conditions have been preserved in comparison to other areas of the island: extensive woods, once covering the whole of Sicily in historical periods, have here continued to flourish, and the countryside is still characterised by perennial lacustrine basins and springs, torrents and seasonal ponds. They form important hydrological systems, essential to the flora and fauna, including many endemic species (Cimino *et al.*, 1998, *Environmental Geology* 34(4): 320-328). Geologically it is constituted by sedimentary rocks, mainly marine turbidite successions of quartzitic sandstones and mudstones.

In 1993, the Regional Government instituted the Nebrodi Park (http://www.parcodeinebrodi.it), extending over 85,000 hectares and currently including areas from 24 different towns.

The landscape abruptly changes, within a few kilometres, from sea level to altitudes above 1800 m. Owing to the extent and diversity of its woods, this park represents one of the most important woodlands of the region: we can mention the rare yews (*Taxus baccata*), the beeches (*Fagus sylvatica*), the Turkey oaks (*Quercus cerris*), the holm oak (*Quercus ilex*), the cork oak (*Quercus suber*). The flora has not many endemites (unlike the not-far Madonie Mts), but one botanical jewel: *Petagnaea gussonei* (Spreng.) Rauschert, strictly endemic to the streams in the hilly and submountain belts of this part of Sicily; since the species is the only one in its genus (family *Apiaceae*), also the genus is endemic of this region.

The vascular flora and vegetation of the mountain lakes and ponds have been studied (Brullo et al., 1994, *Fitosociologia* 27: 5-50; Raimondo et al., 2011, *Fitosociologia* 48: 123-128): they include many species not occurring in the rest of the island, and that here have their extreme southernmost populations.

Our visit will focus on the recently found population of *Chara* cf. *conimbrigensis*, mentioned in the abstract of Troia *et al.* in this volume (p. 36).

One of the shallow wetlands along a stream, near the Maulazzo dam (on the right) in the Nebrodi Park (photo A. Troia)

Oral presentations

Middle Jurassic charophytes from southern Tunisia (North Gondwana): new data on the evolution of Jurassic charophytes

Lassad Tiss[1], Khaled Trabelsi[2, 4]*, Fekri Kamoun[1], Mohamed Soussi[2], Yassine Houla[3], Benjamin Sames[5, 6], Carles Martín-Closas[7]

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[7]*Departament de Dinàmica de la Terra i de l'Oceà, Facultat de Ciències de la Terra, Universitat de Barcelona-UB, E-08028 Barcelona, Catalonia, Spain.*

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A rich charophyte flora from the Middle Jurassic is described from the Kef El Anéba section of the Beni Kheddache area, South Tunisian Atlas. This flora contains 12 species, of which two species and one variety are new. The charophyte assemblages from the Krachoua Formation (Bajocian, 170–168 million years ago) are composed of *Porochara fusca*, *P. kimmeridgensis*, *P. westerbeckensis*, *P.* nov. sp., *Auerbachichara* aff. *saidakovskyi*, *Stenochara* sp., *Stellatochara* aff. *kuzuri* and *Aclistochara africana*. On the other hand the assemblage from the Krechem El Miit Member (Upper Foum Tataouine Formation) is Late Callovian in age (166–163.5 million years ago) and includes *Auerbachichara* nov. sp., *Porochara kimmeridgensis*, *P. westerbeckensis*, *P. douzensis*, *P. obovata* nov. var. and *Mesochara voluta*. Taphonomic and palaeoenvironmental data of these Middle Jurassic charophytes suggest they are growing in a brackish lagoon and a temporary freshwater pond from a marginal marine environment. The studied Tunisian charophytes constitute one of the richest assemblages from the Middle Jurassic worldwide. In particular, this flora suggests that in the Middle Jurassic most of the charophyte biodiversity from the Triassic is still conserved, representing an evolutionary intermediate between Late Triassic floras dominated by genera *Stellatochata*, *Stenochara* and *Auerbachichara* and Late Jurassic charophyte floras dominated by genera *Porochara, Aclistochara* and *Mesochara*. Furthermore, this southern Tunisian flora allows for a comparison of North Gondwanan charophyte floras with European and Chinese coeval floras, supporting the current hypothesis of significant biological exchanges between Laurasian and Gondwanan palaeo-continents through intermediate islands.

Acknowledgement. This presentation is a contribution to the Tunisian project "CGSF-CAT" funded by the ONM, the UR11-ES15 Lab., the GEOGLOB Lab., the Spanish project CGL2015-69805-P, and the Austrian ESS programme within the UNESCO-IGCP 632.

Charophyte bioprovincialism in the Early Cretaceous Central Tethyan Archipelago

Carles Martín-Closas[1*], Jordi Pérez-Cano[1] & Josep Sanjuan[2]

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Europe and North Africa were shaped during most of the Cretaceous as an Archipelago of large islands changing their paleogeography mainly due to frequent sea level oscillations. In past years it had been shown that during the Early Cretaceous this archipelago acted repeatedly as a factory of new charophyte species, some of them migrating later to other parts of the Eurasian continent (as far as China and the Western Interior Basins of the United States). A few of them expanded worldwide to become cosmopolitan. The next step in the current research project will be analysis of the internal biogeographic structure of the Central Tethyan Archipelago, based on the occurrence of charophyte endemism. In the fossil record, endemism is far more difficult to document than cosmopolitanism since the local occurrence of a species may be due to gaps in the fossil record, rather than to a limited distribution. In these cases only repeated evidence may provide enough data to support present hypotheses. A large amount of data is gathered for the floras of Barremian and Aptian ages (113–129.4 million years ago), while the biogeograpic study of other Early Cretaceous floras requires more research.

In Barremian–Aptian times two main paleogeographic areas appear to be well separated in the Central Tethyan archipelago by a latitudinal, i.e. climatic boundary. A northern region located north from a palaeolatitude of 10° N approximately, corresponding to present day North Africa and going until a palaeolatitude of 30° N (present day North France), included Tunisia, Morocco, the Iberian Peninsula and smaller European islands), is characterized by a number of endemic clavatoraceans, including *Globator maillardii trochiliscoides* (Gramb.), *Clavator grovesii combei* (Gramb.), *Ascidiella iberica* (Gramb.), *A. triquetra* (Gramb.), *A. cruciata* (Gramb.) or *Pseudoglobator paucibracteatus* (Martín-Cl. and Gramb.-Fess.). It is still unclear if there are species endemic from only one particular island. For instance *Pseudoglobator foucadei* (Gramb.) would seem endemic for Iberia, but its fossil record is still poorly known. South from the 10° N biogeographic boundary another bioprovince comprised the present day Levantine to Middle East region and the NE of Africa (going south to Somalia). There, the clavatoracean assemblages were formed by *Ascidiella reticulata* (Gramb. and Lorch) and *Clavator ampullaceus* (Gramb. and Lorch). The climatic boundary separating the two charophyte bioprovinces was apparently only permeable to cosmopolitan and subcosmopolitan species, such as the clavatoraceans *Atopochara trivolvis triquetra* (Gramb.) and *Clavator harrisii* Peck.

Acknowledgement. A contribution to the Spanish project CGL69805-P 'Biogeoevents'

Diverse brackish charophyte assemblages in the Lower Cretaceous of the Iberian Chain

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During the Early Cretaceous (145–100.5 Ma ago), the Clavatoraceae charophyte family dominated lacustrine freshwater environments in the central Peri-Tethyan region, comprising present Europe and North Africa. In contrast, the Porocharaceae were abundant in brackish coastal environments, where they formed monospecific assemblages. However, recent detailed sedimentological and taphonomic analyses challenge this general viewpoint.

The late Barremian (ca. 128–126.3 Ma old) record from the margins of the Maestrat Basin at Herbers (Eastern Iberian Chain) contains brackish charophyte floras in two specific stratigraphic intervals: (1) In the transition between the lacustrine Cantaperdius Formation and the shallow-marine Artoles Formation, sandy marls contain autochthonous monospecific populations of *Echinochara peckii* var. *lazarii* associated with benthic foraminifera and ostracods attributed to a lagoon with siliciclastic inputs. On the other hand, marls and limestones related to brackish shallow coastal marshes contain *Porochara maestratica*, benthic foraminifera, and ostracods. (2) In the Morella Formation, two associations are described. The first one is observed in thin sections from lacustrine limestones and composed by well-preserved utricles of *E. peckii* var. *lazarii, Ascidiella cruciata* and *Clavator* sp. This is considered as a freshwater association. The second one is composed of abundant and well-preserved utricles of *E. peckii* var. *lazarii, Atopochara trivolvis* var. *triquetra, Clavator harrisii* var. *harrisii* and *C. harrisii* var. *reyi* associated with agglutinated benthic foraminifera, and ostracods. This assemblage would correspond to euryhaline conditions.

These data suggest that the Porocharaceae would prefer brackish carbonate environments, whereas some clavatoraceans (*E peckii* var. *lazarii, A. trivolvis* var. *triquetra* and *C. harrisii*) were growing in brackish to euryhaline waters submitted to increased siliciclastic influence. These results provide the first approach to understand the habitats of *E. peckii* var. *lazarii* and show that the diversity of brackish and euryhaline charophyte floras during the Barremian was higher than previously thought.

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Charophytes from the Upper Cretaceous of Provence (South-East France)

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The Upper Cretaceous of Provence (France) includes the historical sites where many of the European end-Cretaceous (83.6–66.0 million years old) charophytes were first described by Grambast (1971). However, in the last 40 years, few studies were carried out on the fossil charophytes of this area. The role of charophytes across the biotic crisis of the Cretaceous–Palaeogene (K/Pg) boundary has been much debated in other European areas, especially in the Pyrenees, but is still poorly known in the Provence, where the stratigraphic record of charophytes is more developed, since it includes the Campanian stage in addition to the Maastrichtian and Palaeocene stages.

The current research project includes resampling of selected stratigraphic sections in the Upper Cretaceous of Provence that is much better dated now than in the 1970' decade. First data indicate that the flora is much richer than previously thought, especially in minute gyrogonites of genus *Microchara*. The palaeoecology of fossil charophytes in the Provence will be also analysed and compared with that of other end-Cretaceous areas in Europe. The comparison between charophyte floras from the Provence and the Pyrenees (both in the Ibero-Armorican paleo-island) with the coeval charophyte floras from Romania (Hatég paleo-island) could be also very significant. This would inform us whether or not the paleo-insularity effect of the Tethyan Archipelago played a role in the biotic changes which occurred across the K/Pg boundary.

Acknowledgement. Dr. Thierry Tortosa is acknowledged for providing some of the samples studied and for giving access to the charophyte collections of the Museum of Aix-en-Provence (France).

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Filling a gap: Turonian–Santonian charophytes from the Songliao Basin (Northeastern China) with a cladistic analysis of the *Perimneste-Atopochara* lineage

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Turonian–Santonian charophytes are poorly known due to a high sea level occurring globally during this period (Martín-Closas, 2003; Haq, 2014; Martín-Closas & Soulié-Märsche, 2016). Some charophytes were recently found from the Turonian–Santonian Quantou, Qingshankou, and Yaojia formations of SK-1(South) borehole in the Songliao Basin (NE China), filling the gap in the fossil charophyte record. They are studied herein in detail and include *Atopochara trivolvis restricta*, *Microchara* sp., *Songliaochara heilongjiangensis*, *Lamprothamnium ellipticum*, and *Lychnothamnus quantouensis*. The charophyte flora was growing in a freshwater shallow lake. Two sea transgressions occurred during the deposition of the Qingshankou Formation and the Nenjiang Formation respectively, as confirmed by marine biological markers and brackish water dinoflagellates. This resulted in the disappearance of the charophyte flora from the Songliao Basin in late Turonian, early Coniacian and late Santonian. When the flora appeared again with the sea regression, only four species were left. Discovery of *A. trivolvis restricta* in late Aptian to Cenomanian deposits in Europe and in Turonian to Santonian strata in China indicates a possible time lag of biological migration. A cladistic analysis of the two controversial genera *Perimneste* and *Atopochara* reveals two monophylies. *Perimneste horrida*, *P. micrandra*, and *P. ancora* form a monophyletic group with basal cells and many antheridia. *A. trivolvis triquetra*, *A. trivolvis trivolvis*, *A. trivolvis restricta*, *A. trivolvis brevicellis*, *A. trivolvis multivolvis*, and *A. trivolvis ulanensis* constitute the other monophyletic group without basal cells, and whether the antheridium existed on the same plant for the latter 4 species remains an enigma.

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Fossil charophytes from the Claron Formation (Southeastern Utah, USA). Biostratigraphic and paleobiogeographic implications

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The Claron Formation is a famous lithological unit located in southwestern Utah (USA) that forms extraordinary cliffs such as those of Cedar Breaks National Monument and the Bryce Canyon National Park. This non-marine formation is composed of red siltstones and marls related to fluvio-lacustrine deposits.

Charophyte assemblages were mainly found in white and orange siltstones and in pastel variegated mudstones of the Claron Formation and are composed of 6 characean species associated with ostracods, mollusks and mammal remains. *Peckichara torulosa*, *Peckichara* aff. *varians* and *Microchara cristata* represent by far the dominant species of this assemblage. Moreover, a reduced number of poorly preserved gyrogonites of *Microchara* sp., *Dunghiella* sp. and *Lychnothamnus* sp. were also found in rocks from the section. From the biostratigraphical viewpoint, *Peckichara torulosa* shows a restricted stratigraphic distribution appearing in Europe, North America and China in lower Eocene deposits (Sanjuan & Eaton 2017 and references herein). *Peckichara varians* has an extended stratigraphic distribution in Europe and China, occurring in deposits ranging from Paleocene to lower Eocene (Ypresian) (Riveline 1986; Li *et al.* 2016 and references herein). *Microchara cristata* has been reported mainly in several non-marine rocks from Late Cretaceous Euroasiatic localities (Li *et al.*, 2016 and references herein) to lower Paleocene deposits from the South-Pyrenean and France basins, but also in northern, central and southern Chinese basins (Li *et al.* 2016; Vicente *et al.* 2015, 2016). *M. cristata* has also been sporadically documented in early Eocene non-marine deposits from some Chinese basins (Li *et al.* 2016 and references herein).

Taking into account the worldwide biostratigraphic distribution of these species it is suggested that the Claron Formation is upper Paleocene or early Eocene in age (i.e. 59.2 to 47.8 Ma ago), which is in agreement with the mammal remains under study (Wasatchian North American Land-Mammal Age), and the age of the overlying Boat Mesa Conglomerate (upper Eocene, based on U/Pb detrital zircon) according to Biek *et al.* (2015). This study also provides valuable data about the international biogeographic distribution of some Paleogene charophytes which have been recognized for the first time in the North American continent.

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Charophytes of a key geological section of non-marine Cenozoic deposits in the Aktau Mountains (Southeast Kazakhstan)

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The classical stratigraphic section of Cenozoic deposits located in the State National Natural Park "Altyn-Emel" (Ili Basin), Southeast Kazakhstan in the Aktau Mountains has been studied with a paleoenvironmental purpose. This colorful section shows a continuous and well-exposed sequence of non-marine sedimentary rocks ranging in age from Eocene to Pliocene.

Paleogene deposits (i.e. 66.0 to 23.03 Ma ago) are mainly composed of reddish or yellowish conglomerate and coarse-grained sandstone containing abundant sedimentary structures related to water-current, suggesting deposition in a high-energy fluvial system. No charophytes have been recovered from these deposits so far. A dramatic change of facies is observed in the Neogene sequence, dated as late Miocene and Pliocene (11.63 to 2.58 Ma ago). Red claystone and grey marl beds with charophytes represent the dominant lithology suggesting that lacustrine conditions prevailed.

A complete charophyte assemblage has been extracted from Upper Miocene - Lower Pliocene deposits of the Santash Formation and the Pliocene sediments of the Ili Formation. The taxonomy of fossil charophytes of the Aktau Mountains is revised here taking into account the gyrogonite intraspecific polymorphism. Four species have been described from the Santash Formation i.e. *Nitellopsis merianii* (Al. Braun ex Unger) L. Grambast & Soulié-Märsche, *Chara* sp., *Lychnothamnus barbatus* var. *bicarinatus* Soulié-Märsche, and *Hornichara* sp. The Ili Formation, Pliocene in age (5.33–2.58 Ma ago) contains six species i.e., *Lychnothamnus barbatus* (Meyen) v. Leonh., *Chara pappii* Soulié-Märsche, C. *globularis* Thuill., *C. vulgaris* L., *Nitellopsis obtusa* (Desvaux) J. Groves and *N. aubekerovii* Dzham. The assemblages show great affinity to coeval assemblages from Europe, providing valuable data about the palaeogeographic distribution of Neogene lacustrine flora from Kazakhstan and the entire central Asiatic region.

Significance of Cenozoic fossil charophytes from Turkey

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This presentation is a preliminary account of the Cenozoic charophyte fossil record from Turkey. The collision of the Africa-Arabian plate with Eurasia and the rise of Anatolian Peninsula, with the withdrawal of the Black Sea from the Mediterranean, resulted in the origin of numerous Cenozoic basins in Turkey. These basins were infilled with Eocene to Recent terrestrial and/or coastal deposits rich in charophytes. However, the available data are far from giving a reliable knowledge on these charophyte assemblages due to the lack of detailed studies. It is thought that endemic and new fossils species are certainly to be discovered.

Local and foreign researchers, who worked in Turkey, have encountered and identified charophyte specimens from different stratigraphic levels at different localities of this country:

(1) The Çankırı-Çorum Basin encompasses the Cretaceous-Cenozoic boundary and delivered *Nitellopsis (Tectochara) merianii* (Mazzini et al. 2013).

(2) The Eocene of Maraş-Elbistan contains *Nitellopsis (Tectochara) majoriformis* (Papp).

(3) The Upper Oligocene of Denizli contains *Nitellopsis (Tectochara) merianii* (Mädler and Steasche 1979).

(4) Neogene deposits yielded the richest charophyte fossil record known in Turkey to date. Thus, the Miocene of Muğla-Yatağan yields *Nitellopsis (Tectochara) majoriformis* (Papp) (Mädler and Steasche 1979), In the lower to middle Miocene of Kütahya-Altintas-Karadigin *Kosmochara grambastorum* n. sp. (Mädler and Steasche 1979) while in Çankırı *Lychnothamnus barbatus* var. *antiquus* (Mädler and Steasche 1979) and *Chara* cf. *molassica* were recorded (Mädler and Steasche 1979). The upper Miocene of Balıkesir-Köylükköy delivered *Chara* n. sp. 1. (Mädler and Steasche 1979) In the Miocene of Konya-Seydisehir-Kolkuru *Chara multispira* (Papp) (Mädler and Steasche 1979), is recorded. The upper Miocene-lower Pliocene of Yalova contains *Lychnothamnus sp.* (Rückert- Ülkümen and Yiğitbaş 1997). In the Pliocene of Konya-Seydisehir *Nitellopsis (Tectochara) globula* was found (Mädler and Steasche 1979).

(5) Finally the Quaternary fossil record of charophytes includes *Chara* n. sp. 2 in Konya-Karapınar-Beşkuyu (Mädler and Steasche 1979) and in Maraş-Elbistan-Tepebaşı (Plio-Quaternary), *Chara longovata* (Papp) (Mädler and Steasche 1979), in the Pleistocene of Konya-Aksehir-Dipevler and *Chara* n. sp. 3 (Mädler and Steasche 1979) in Aydın-Kızıldere *Chara densospira* n. sp. (Mädler and Steasche 1979), while in Isparta-Şarkikaraağaç *Lychnothamnus* n. sp. 1 was found (Mädler and Steasche 1979).

The species complex *Chara hispida*: nomenclature, determination - and WHAT is a species??

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The "species complex" of *Chara hispida* contains a number of taxa with a high degree of overlap. While some taxa (*C. baltica*, *C. horrida*) occur in brackish water, other taxa (*C. hispida*, *C. subspinosa* = *C. rudis*, *C. aculeolata* = *C. polyacantha*) grow predominantly in freshwater. *Chara papillosa* ("*Chara intermedia*") has been recorded from both freshwater and inland brackish water sites. Another taxon, up to now attributed to the species of *Chara baltica*, occurs in the Mediterranean region. Morphological as well as genetic analyses, however, indicate that this taxon may not be identical with *Chara baltica* collected from the Baltic Sea. Some additional taxa (*C. visianii*, *C. corfuensis*) have a restricted distribution in the Mediterranean region.

An ongoing project includes analyses of morphology, genetics and oospores, and tries to clarify problems of nomenclature and taxonomic rank. We will give an overview of the species complex and the state of this project.

Chara globularis – *Chara connivens* – *Chara contraria*: more insights from morphology and genetics

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Most field charophytologists have experienced that the morphology of *Chara* specimen can be "intermediate" between two different species. We collected a *Chara* sample in lake Sava, close to Belgrade, Serbia. The habitus of this specimen resembled *C. contraria*, but the microscopic details ("spines", stipulodes) resembled *C. virgata*. Preliminary analysis of the matK gene, however, clearly place the sample into *C. contraria*. This means that *C. contraria* sometimes may have stipulodes where only the upper row is elongated.

We also collected a sample which morphologically resembled *C. connivens* in Dulin pond (44°51'11.5" N 21°17'52.2" E), Serbia. The sample was clearly dioecious, and we analysed male and female samples. Preliminary analyses of the matK gene placed this sample into a separate sub-cluster of *C. globularis* (i.e. not together with *C. connivens*, but an own sub-group within *C. globularis*). We will present the most recent results on these specimens.

Charophytes of Australia's Northern Territory, both familiar and foreign!

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The collection of charophytes in tropical Australian regions presents particular dangers, which might explain why the region has not been thoroughly studied in the past. This study documents the occurrence of thirty nine species in four genera, including sixteen previously described species (of which three are new for the Australian flora); as well as eight varieties raised to species, and fifteen entirely new species. Seven previously reported species (*C. fibrosa, C. corallina, N. myriotricha, N. penicillata, N. congesta, N. pseudoflabellata, N. sonderi*) are not known from the Northern Territory and previous records were based on erroneous identifications or localities. It is possible that *Lychnothamnus barbatus* also occurs, as it occurs in Queensland and Papua New Guinea, and a specimen from Timor-Leste has been seen. This study provides the first record of the genus *Lamprothamnium* in tropical coastal wetlands, and the first record of that genus from Northern Territory. The charophyte flora of the Northern Territory can be divided into species that co-occur in South East Asia (e.g. *Chara wightii, C. erythrogyna, C. lucida, C. setosa, C. globularis, C. zeylanica, Nitella tumulosa, N. belangeri*), species restricted to Northern Australian wet-dry tropics (e.g. *C. submollusca*, several new species) and species that inhabit temporary wetlands in arid and semi-arid zones (e.g. *L. stipitatum, C. porteri, N. micklei*). Determination of these species produced several interesting problems related to nomenclatural priority and taxonomic segregation. Evidence is provided for distinguishing new species and raising varieties to species level. The diversity of charophytes in this region can be explained, in part, by regional climatic and habitat diversity, the lack of glaciation or other geographical extinction events, and the relative lack of habitat disturbance by humans and pollutants.

Charophytes from Israel: trends in diversity, occurrence and distribution

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Significant change in frequency of charophytes occurrence and distribution seems to be a common phenomenon recently reported in selected European states as well in China and Japan. We aimed to reveal trends in charophyte species diversity, occurrence and distribution in Israel. During 2001-2018 we surveyed numerous water bodies in 29 river basins, with an emphasis on localities previously known. Our sampling efforts resulted in records of 44 recent localities based on 234 observations of 14 species. We studied TELA collection by Dr. Y. Lipkin. It consisted of 623 herbarium sheets, vouchers for 163 observations from 114 localities in 1924-1992 for 18 species. Some specimens collected in Israel can be stored in other herbaria but at a moment we tried to check them only in LE, B, H, L and W (acronyms of herbaria according to http://sweetgum.nybg.org/ih/) and in database for North American ones (www.macroalgae.org). At least one specimen is stored in BM (J. Wilbraham, pers. comm.).

The major differences between preceding and recent charophyte species diversity, distribution and occurrence can be identified on the base of datasets comparison. We couldn`t find 7 species sampled earlier and 3 species reported earlier. Eleven species collected earlier and 3 species novel for the region were found during our surveys. The difference between localities datasets is more drastic. Some of them can't be located according to brief labels. The others are mostly disappeared due to human activity. Only 9 localities previously known support recent populations and nearly all of them seem to be the most stable and important for charophyte protection. Therefore we found mostly new localities. The loss of some of them during period of our study is notable. Recent increase of proportion of *Chara vulgaris* L., less significant for *C. gymnophylla* A. Braun, slight decrease for *C. globularis* Thuill., nearly the same values for *C. connivens* Salzm., and possibly extinction of 7 species are traceable between datasets of preceding and recent charophyte populations. We may suppose that the variable distribution of charophytes in space and time resulted from the absence of large stable water bodies in this region (except Lake Kinneret unable to support them for a long time), strong variability of natural environment and long-term, persistent, severe human transformation of the environment.

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Temporary brackish habitats in Sardinia (Italy) – hotspots for the conservation of *Characeae*

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Sardinia (Italy) is the second largest island in the Mediterranean basin. Data about occurrence and distribution of charophytes in Sardinia are very poor (Bazzichelli & Abdelahad 2009), and most of them are more than 100 years old. Concerning brackish habitats many lagoons and coastal wetlands have been destroyed throughout the island or were at least heavily modified in the past to eliminate malaria and for agricultural, industrial, military or touristic purposes.

Current studies by the author reveal the occurrence of 26 Characean species in Sardinia. Charophytes were recorded in 212 water bodies throughout the island: 136 of these sites were temporary coastal lagoons and brackish pools. A total of 10 Characean taxa was recorded in these brackish habitats. They belong to the three genera *Chara, Tolypella* and *Lamprothamnium*. Most abundant charophyte species were *Lamprothamnium papulosum, Chara galioides, C. aspera, C. canescens, Tolypella hispanica* and *T. nidifica*. In the course of my research I succeeded in recording *Lamprothamnium succinctum* for the first time in Europe and both *Chara baltica* and *Tolypella salina* for the first time in Italy. In addition, the verification of a new bisexual population of *Chara canescens* in Sardinia is of particular importance. Moreover, current sites of *Lamprothamnium papulosum, Tolypella hispanica, Chara canescens* and *C. galioides* are very rare in Italy. Furthermore, it must be highlighted that in Sardinia the very rare liverwort *Riella helicophylla* is associated with Characean species in several brackish locations. This was the first record for *R. helicophylla* in Italy (Becker & Homm in press).

The results of my studies indicate that Sardinia has a key role to play for the conservation of *Characeae* in the central Mediterranean region. According to Annex I of the Habitats Directive 92/43/EC many Sardinian habitats with occurrence of *Characeae* are of Community Interest. In particular coastal lagoons are encoded as priority habitat type *1150 in the Habitats Directive. Numerous hotspots for the conservation of charophytes with special importance for species of brackish water bodies were identified by the author throughout Sardinia. Ongoing threats and pressures on species and habitats require an immediate implementation of efficient conservation measures and action plans. From both, the Italian and Sardinian perspective, especially temporary brackish water bodies are in need of specific protection measures.

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New records of *Characeae* for Sicily (Italy)

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During the last year, the first two authors continued their survey of the scarcely known *Characeae* flora of the island of Sicily: plants were collected in different periods, habitats and areas of the island, and identifications – made on fresh material – were based mainly on Mouronval *et al.* (2015). We had the opportunity to include here some results deriving from the visit in Sicily made by Klaus van de Weyer in March 2018. Roman Romanov identified some specimens and revised some identifications. Data for Sicily are basically limited to more than one hundred years old reports; data for the national Flora have been completed with recent reports for Sardinia (cf. the work made by Ralf Becker). We present here the main results (in alphabetic order).
1) *Chara baltica* Bruzelius (new for Sicily) – Collected in different seasons in the lake Preola (Nature Reserve near Mazara), where it probably colonises most of the lake bottom, reaching a depth of ca. 2 m. **2) *C. braunii*** C.C. Gmel. (new for Palermo province, new population of a rare species in Italy) – Collected in the small mountain ponds of Rebuttone. **3) *C. canescens*** Loisel. (new population of a rare species in Italy): we found a new parthenogenetic population in the "Margi Milo" (Petrosino, Trapani province), where it grows together with *C.* cf. *aspera* Willd. **4) *C. conimbrigensis*** A.G. Cunha (new for Sicily and Italy) – Collected in June-July in shallow mountain ponds, in the Nebrodi Mts, at about 1400 m a.s.l. It is different from the similar *C. gymnophylla* A. Braun mainly for its tylacanthous stem cortex. Waiting for further studies, we provisionally treat this taxon (as well as the following one) at the species rank. **5) *C. oedophylla*** Feldmann (new for Sicily and Italy) – Collected in mid-April in temporary ponds (in the *locus classicus* of *Isoetes todaroana* Troia & Raimondo near Mazara del Vallo). The taxon is currently known in few sites in W-Mediterranean. **6) *Nitella capillaris*** (Krock.) J. Groves & Bull.-Webst. (species not recently reported for Sicily and Italy) – Collected in the wetlands of Anguillara, near Calatafimi. **7) *N. opaca*** (C. Agardh ex Bruzelius) C. Agardh (new for Sicily) – Collected in the small mountain ponds of Rebuttone (near Piana degli Albanesi) and Coda di Riccio (in the Nature Reserve of Ficuzza). **8) *Tolypella salina*** Corill. (new for Sicily) – Collected in March in a single pond at Margi Milo near Petrosino (Klaus van de Weyer), it probably occurs also in other sites along the western coast of the island.

Mouronval JB, Baudouin S, Borel N, Soulié-Märsche I, Klesczewski M & Grillas P. 2015. *Guide des Characées de France méditerranéenne*. Office National de la Chasse et Faune Sauvage, Paris. 214 p.

Production and morphometry of *Lychnothamnus barbatus* gyrogonites in the context of the depth of the species occurrence: implication for the ecological and palaeoecological research

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The aim of the study was to analyse the production and morphometry of gyrogonites of *Lychnothamnus barbatus*, one of the rarest and most endangered species of charophytes worldwide, in the depth gradient of the species occurrence. Gyrogonites were picked from *L. barbatus* tally (n = 170) collected at three depths (minimum, maximum and mean, n = 3 for each depth) of the species occurrence in a moderately eutrophic lake (Lake Kuźnickie, western Poland). The research was conducted in three permanent transects in four seasons (November 2016, April 2017, July 2017, November 2017). In addition, we analysed subfossil gyrogonites (n = 730) from three cores taken from the minimum, maximum and average depths of *L. barbatus* occurrence in the studied lake.

In the studied lake, modern *L. barbatus* gyrogonites are larger compared to literature data. This applies to both length (longest polar axis, LPA, 750-1012 μm, mean 877 μm) and width (largest equatorial diameter, LED, 604-822 μm, mean 722 μm). The isopolarity index (ISI) is in the range of 111-135 (mean 121). In the case of LED and ISI, statistically significant differences between contemporary and subfossil gyrogonites were found. Subfossil gyrogonites are wider and thus more rounded compared to modern gyrogonites. The largest amount of modern gyrogonites was found in autumn, while the smallest in spring. A statistically significant positive correlation was found between the depth and the number of gyrogonites per square meter (Spearman $r = 0.48$, $p <0.01$). This relationship was much stronger in autumn (in 2016: $r = 0.75$, $p <0.05$ and in 2017: $r = 0.71$, $p <0.05$). Contrary to the number of gyrogonites, their sizes (LPA and LED) showed a statistically significant negative relationship with the depth. However, these relationships were not strong. In the light of the analysis of variance, both the contemporary and subfossil gyrogonites turned out to be statistically significantly narrower and shorter at the deepest sites than those occurring at shallower sites.

The information obtained as a result of the research supplements gaps in the knowledge regarding the life cycle of *L. barbatus* and its habitat preferences. It achieves a full life cycle producing gyrogonites in waters with an increased nutrient content. In addition, *L. barbatus* due to the diversity of the size of gyrogonites in the depth gradient can be used as a bioindicator of the water level fluctuation.

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Examination of north-eastern German lakes – A potential assessment for the reestablishment of *Characeae* (Charales, Charophytes)

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Anthropogenic impacts - as, e.g., eutrophication - have led to derogations of aquatic ecosystems worldwide, resulting also in a decline of charophytes in lakes, ponds and coastal lagoons during the 20th century. As a result, restoration activities started world-wide, attempting i.a. to restore the charophyte meadows. Achieving these purposes of reestablishment of charophytes as well as designing an efficient management plan in the following project progression, the current status of 60 lakes of Mecklenburg-Western Pomerania and Brandenburg was examined. The initial phase contains analyses of the water regime, the periphyton, the diaspore bank composition, eDNA analyses as well as monitoring of the fish and macrophyte composition.

For the internal reestablishment of charophyte meadows, the availability of seed material is crucial. Regarding to long-term resilience, oospores, produced by generative processes, are the elements which stay vital up to centuries. They are protected by a complex system of cell membranes and walls, sometimes even supported by a thick outer layer of calcareous precipitates. Consequently oospore banks offer both, a natural and internal potential for lake restoration processes as well as a useful tool to initiate macrophyte growth in artificial ponds and lakes.

However, the knowledge about the long-term realisation potential of oospore banks in lakes is still scarce. Depth profiles of oospore distribution are rarely investigated; their viability has been tested only sporadically and with methods heavily debated. In order to get a more precise estimation of the restoration potential, 23 lakes of north-eastern Germany were investigated in more detail. The results of this investigation showed that: (1) an internal potential is not given in all aquatic systems although a pristine vegetation of Charophytes is described, (2) a large amount of oospores in soils are damaged and therefore not part of the restoration potential and (3) the vitality test of undamaged oospores with TTC identified that nearly 30% of oospores are not vital. But despite this, the investigations also show that in most cases vital oospores are located at lower layers and have to be transported at the sediment surface if being exploited.

The role of *Characeae* in the communities of the vegetation class *Potametea*

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The stonewort vegetation is commonly classified into the phytosociological class *Charetea fragilis* F. Fukarek ex Krausch 1964; however, the *Characeae* are not exclusively found in vegetation stands ascribed to this class but also in other habitat types. In our preliminary investigations, we draw the attention to the relationship between the classes *Charetea fragilis* and *Potametea pectinati* Klika in Klika & Novák 1941 in some Sicilian biotopes.

In some cases, the *Charetea* vegetation is ecologically and spatially distinct, although close, from that referable to the *Potametea*. In some other cases, one or more species of *Characeae* are structurally intrinsic to the vegetation of *Potametea*: one example is offered by the pools next to the Maulazzo dam [Nebrodi Mts.], where *Chara* cfr. *conimbrigensis* A.G. Cunha enters the *Groenlandietum densae* Segal ex Schipper et al. in Schaminée et al. 1995, growing together with *Groenlandia densa* (L.) Fourr., *Potamogeton natans* L., *Callitriche* sp. pl.

Another relevant case is the relationship of some *Nitella* species, such as *N. capillaris* (Krock.) J. Groves & Bull.-Webst. and *N. opaca* (C. Agardh ex Bruzelius) C. Agardh, with vegetation ascribed to the phytosociological alliance *Batrachion fluitantis* Neuhäusl 1959.
In particular, the occurrence of the two different *Nitella* species goes along with two different species of *Ranunculus* subg. *Batrachium*, i.e. *Ranunculus saniculifolius* Viv. and *R. aquatilis* L., respectively, in two different sites. In these cases, phenology could be an important adaptive trait, with the *Characeae* developing earlier (between the end of winter and the beginning of spring) so to avoid the competition of the angiosperms that progressively develop during the spring months.

Phenology is worth to be further investigated for the interactions not only between *Characeae* and angiosperms, but also between *Characeae* and other freshwater algae, such as the filamentous *Spirogyra* sp. pl., ascribed to the *Zygnematales* order of *Charophyceae*. However, this succession was not observed in pools fed by water springs, that keep the water temperature lower across the season. It is likely that the regression of *Characeae* as water temperature increases is regulated by competition with the vascular plant species and/or other more thermophilous representatives of the algal flora. In small water ponds, the livestock grazing and trampling is another important ecological factor to be investigated, also for its effects on water turbidity and nutrient concentrations.

The reproductive phenology of charophytes as a tracker of climate change

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The study of phenology, *i.e.* the timing of recurrent biological events, is being used to track the climate change effects on organisms. Although submerged macrophytes play a structuring key role in shallow ecosystems, little information about their phenology is available. Here, we present the first three-year data (2014-2016) of a desirable long-term series. We aimed: i) to describe the reproductive phenology of six species of submerged macrophytes (*Chara hispida*, *C. aspera*, *C. canescens*, *Nitella hyalina*, *Stuckenia pectinata* and *Utricularia australis*) in two Mediterranean brackish ponds; ii) to establish a methodological basis for the phenological study of submerged macrophytes, particularly charophytes; and iii) to unravel if their phenology might act as a tracker of the ongoing climate change. A great sampling effort and a thorough observation under a binocular microscope were performed to detect the presence and production intensity of gametangia/oospores and flowers/fruits. Size of gametangia from each charophyte species were conscientiously measured to design a quantitative cost-effective method to differentiate between unripe and ripe gametangia for a detailed description of their phenological dynamics. Different physical and chemical features of water (temperature, light, water level, conductivity, pH…) were also monitored where the plants grew. The thermal time model, by use of the Growing Degree-Days parameter, was applied to understand the onset and peaks of reproduction. Circular statistics, a developing powerful tool in phenological studies, was applied to test the species-specific seasonality of reproduction. Charophytes reproduced almost continuously throughout the annual cycle, but showed a significant seasonality, with all the species having a reproductive peak in spring-summer and occasionally a small one in autumn. Underwater temperature (in accumulated degree days and daily mean values), water level and salinity were the factors altered by climate change that most affected the ripening of gametangia/oospores and the flowering/fruiting of submerged macrophytes. Overall, charophytes sexually reproduced more intensely than angiosperms, but the species responded differently to the environmental factors. Freshwater species, such as *C. hispida*, were negatively affected by higher salinities, while the salt-tolerant *C. aspera* was the most sensitive species to water level fluctuations, showing a sharp reproductive peak when strong rainfall happened. We have demonstrated how charophytes are good candidates, better than angiosperms, for tracking variations in climate change factors. Our work has laid the foundation for the establishment of a realistic design of a long-term data series, based on a reliable and effective methodology to assure the sustainability of the study. We hope this study will inspire more long-term, inter-site and multi-latitude studies of macrophyte phenology, which are needed to unravel the consequences of climate change in aquatic ecosystems.

Charophyte performance under different environmental scenarios: final outcome from a mesocosm experiment

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In the last 21st GEC we presented the preliminary results of an experimental approach using mesocosms to unravel how the affection of charophytes due to global change-related factors could disturb the benthic-planktonic food web related to them and, thus, the structure and function of the ecosystems they inhabit. Now, we have already performed the definitive experiment using a charophyte species from the *Chara hispida* complex collected from a Mediterranean interdunal pond. Twelve 200-L mesocosms, filled with tap water and an inoculum of water from the origin site, and sediment, were used to allow the development of charophyte meadows. Over a "basal" situation, we subjected the mesocosms to a more favourable condition for the charophytes, *i.e.* an increase in temperature –from 21°C (T) to 26°C (+T)–, and to a more detrimental condition, *i.e.* addition of A and B ultraviolet radiation (UVR). The three treatments (4 replicates each one) had a dose of underwater photosynthetic active radiation (PAR) of 89 μmol photons m^{-2} s^{-1} and the UVR-treatment was supplemented by a daily dose of 2.2 W m^{-2}. The experimental set-up was maintained for 75 days, time enough for charophytes to form a dense meadow and for a benthic-planktonic community to be established. The charophytes' state was assessed by analysing biomass, growth, chlorophyll and UVR-absorbing compound concentrations, stoichiometric composition and polyphenol concentrations.

Regarding biomass features, the range of final meadow coverage was 915-2472 cm^2, the final meadow height range was 34-42 cm, and the exponential growth rates for the first month ranged between 0.03 d^{-1} and 0.06 d^{-1}. Chlorophyll *a* concentration in charophyte tissues varied between 295 and 729 μg g^{-1}FW; the ranges of %C, %N and %P were 33-42%, 3-4% and 0.1-0.2%, respectively. The exudate polyphenols were the gallic acid, the quercetin and the caffeic acid, with concentration ranges of 0.01-19.16 ng mL^{-1}, 0.00-2.64 ng mL^{-1} and 0.18-167.98 ng mL^{-1}, respectively. Overall, +TPAR treatment favored charophyte performance. However, TUVR treatment was not as detrimental as expected on charophyte analyzed variables.

The complexity of the responses demands an overall view on the variations in charophyte performance due to interactive factors related to global change. But for the moment, we have been able to relate features of the different charophyte meadows developed under the different conditions to the establishment of distinct "interaction webs".

Investigating the ecology of *Chara cf. baltica* (*Characeae*) in the Lago Preola ecosystem (Sicily, Italy)

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Lago Preola is a small lake, located in SW Sicily, in a karstic depression within the Nature Reserve "Lago Preola e Gorghi Tondi". With about 33 ha (maximum depth: 2 m), it is the widest of the 5 natural lakes occurring in the Reserve. The presence of species of conservation concern (e.g., *Emys trinacris,* the Sicilian Pond Turtle, and several migratory birds), but also of invasive alien species (e.g., *Procambarus clarckii,* the Red Swamp Crayfish), has been reported for the area. The flora of terrestrial habitats surrounding the basins has been studied extensively, while the aquatic flora and vegetation have not been studied in detail.

The coastal aquifer supplying groundwater to the study area lakes has shown fluctuations in the last decades: Curry *et al.* (2016) reported that in 2000/2001 Lago Preola dried out completely during the summer drought. Irrigation well pumpage was reduced in 2004, and ceased in 2008, which in combination with abundant precipitation has since resulted in high, stable lake levels (Curry *et al.* 2016).

The finding of a *Chara*, provisionally identified as *C. baltica* Bruzelius (Troia *et al.* 2018), has led us to study the distribution and ecology of the species in this area.

C. baltica forms a thick monospecific meadow along the shore at the sampling site. In Summer 2018 the water was slightly brackish (conductivity ca. 4 mS/cm) and slightly alkaline (pH ca. 9). At an analogous sampling site in the nearby lago Murana (conductivity ca. 3 mS/cm, pH ca. 8.6), macrophyte vegetation was instead characterized by a monospecific meadow of the angiosperm *Najas marina* L. s.l., not reported up to now for the Reserve.

In the framework of providing an isotopic baseline for future studies on the ecophysiology of these two macrophytes and on trophic relations within the water basins (Rodrigo *et al.* 2016), we have started analysing carbon and nitrogen stable isotope composition.
Macrophytes for these analyses were sampled at ca. 2 m from the shore, at a depth of approximately 0.5 m. Samples were dried to constant weight, powdered, and analysed with an isotope ratio mass spectrometer and an elemental analyser.

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Posters

Charophytes and macrofossils from the Mid- to the Late-Holocene Lake Afourgagh (Middle Atlas, Morocco): preliminary results

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The Middle Atlas Mountains (Morocco) present more than 40 lakes, called "dayats", occupying depressions with fluvial and lacustrine sediments. The study of these archives increased during the last decades (mainly pollen and diatom analyses), however they generally offer a low temporal resolution and/or bathymetric variations have received little attention. An exception is the lake Afourgagh (1380 m a.s.l.), in which *Chara aspera* and *C. hispida* were studied to reconstruct lake levels, but only for the last 2500 years (Détriché *et al.* 2009).

Here, we present the preliminary results of Charophyte and macrofossils analysis of a new core from this lake: the core AF-3 (8500 years), which is a part of a 4 core transect (Paléomex-INEE/INSU project: Berger *et al.* 2017). The chronology is supported, at the moment, by 7 radiocarbon dates (charcoal, macrofossils). The current analysis will integrate pollen, mollusc, microcharcoal, sedimentological and geochemical studies at a high resolution (0.5 to 2 cm).

The macrofossil analysis (70 samples, >500 μm) describes 7 ecological phases. Phase 1 starts between 8500 and 8200 years cal. BP (calibrated Before Present, considered as 1950 AD). It mainly contains charcoals and minerogenic particles, arguing for a low water table, local erosion and fire. In phases 2 and 3, calcified remains of *Chara hispida* and probably *C. contraria*, ostracods and gastropods support wetter conditions and stable lake levels from 8200 to 4200 years cal. BP. In phase 4 – ca. 3100 years cal. BP – *Characeae* remains vanished. Wide-ranging macro-charcoal levels and palaeosoils suggest a lake regression. Phase 5, from 2080 to 1360 years cal. BP, shows a strong increase of fires and erosion. Human impact probably prevails linked with the Roman presence in Morocco. Rooted plants (*Salix* trees, *Potamogeton, Ruppia*) also suggest a drier phase, conductive to a very low water level, in a saline and organic-rich environment, even if short-lived *Chara* phases exist (Détriché *et al.* 2009). Several lacustrine transgressions occurred during the 6th phase (ca. 1200 and then ca. 700 years cal. BP). Finally, in phase 7, wood and charcoal influxes suggest a relative lake lowering since 400 years cal. BP (with a maximum around 200 years cal. BP in core AF-4), amplified by pumping and massive crop irrigation during the XXth century.

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Upper Cretaceous charophytes from the Cabullona Basin (north-eastern Sonora, Mexico)

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Sonoran sedimentary basins are rich in non-marine deposits and have been analysed from a wide array of viewpoints including sedimentology, stratigraphy and palynology during the last years. However, fossil charophytes, which are a useful tool in biostratigraphy, were poorly studied so far in Mexico. In order to improve the knowledge of Sonoran fossil charophytes, a ca. 500 meters section was systematically sampled and analysed near the Fronteras town, located south to Agua Prieta city. The section is mainly composed by fluvial and lacustrine deposits of the Cabullona Group, in turn composed of 4 units called Corral de Enmedio unit (limestone and sandstone), Camas Sandstone, Packard Shale and Lomas Coloradas unit (conglomerate, sandstone and siltstone).

Charophyte assemblages were found after screen-washing grey siltstones and lutites rich in gastropod remains, ostracods and occasionally fish teeth. These assemblages are dominated by medium sized *Lychnothamnus* sp. along with smaller gyrogonites probably belonging to genera *Tolypella* sp. or *Microchara* sp. The dominant *Lychnothamnus* sp. gyrogonites, mainly located in the middle to upper part of the section, suggest growth in freshwater oligotrophic to mesotrophic lakes, by comparison with the preferred habitat of the living representatives of this genus.

The charophyte flora described in the Cabullona Group is similar to some assemblages from the Neuquén Basin (Argentina) dated by biostratigraphic analysis as Coniacian–Campanian. This age is in agreement with the ^{206}Pb/^{238}U isotopic age proposed recently for a volcanic rock (rhyolite) topping the Fronteras section, dated as upper Campanian, 76.7±0.7 Ma ago (González-León *et al.* 2017). This period of time is characterized in Europe by the abundance of *Peckichara pectinata* Grambast, used as an index species to mark the upper Campanian in the European biozonation, however this species is unknown outside Europe. A better characterization of this charophyte assemblage sheds new light on the charophyte taxonomy, taphonomy, palaeoecology and biostratigraphy of the Mexican charophytes and helps understanding the biogeographic differences between American and Eurasian assemblages at the end of the Cretaceous.

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Oospores of *Nitella* species, based on an examination of type material

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Scanning Electron Micrographs of oospores from the type material of approximately 95 species of *Nitella* have been examined, and images are presented here. The oospores of *Nitella* species provide a useful tool in charophyte taxonomy. Nordstedt (1888, 1889) relied on them to distinguish among species, and they were used by numerous subsequent workers for species-level delineation (Allen 1892, 1894, 1896; Groves & Bullock-Webster 1920; Groves & Allen 1935; Zaneveld 1940; Williams 1959; Haas 1994). The differences among oospores of type specimens (John and Moore 1987; Casanova and Karol 2008) and the correlation of oospore characters and particular nucleotide sequences (Sakayama *et al.* 2002, 2004, 2005, 2006) confirm that oospores possess characters that are useful for distinguishing among species. Surveys of oospore variation in species throughout their geographic range (de Winton *et al.* 2007; Casanova 2007) provide evidence that they have stable characters that can be used consistently. Reference to the features of type material is vital for the application of names in the *Characeae*, and in so doing, the potential for erroneous determination is reduced (e.g. Sakayama *et al.* 2006). This study provides further confirmation that many of the so-called *varieties* and *forms* within the Nitellae are more correctly identified as species.

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Evaluating the species boundaries of brackish water *Tolypella* using cpDNA barcoding

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Morphological characters can be variable with much overlap between the brackish water *T. nidifica* (O. Mull.) A. Br., *T. salina* R. Corill., and *T. glomerata* (Desv. in Lois.) Leonh. such that species determination is not always possible. Therefore, regional distribution pattern are additionally included in species delineation. The distribution area of *T. salina* is restricted to isolated sites of France and the Iberian peninsula (Lambert *et al.* 2013). *T. nidifica* is a typical euryhaline species inhabiting the Baltic Sea and is also described from the Mediterranean coast (Italy, Croatia and Greece) to northern Europe (Krause 1979). Usually found in limnic waters from Ireland to Sardinia, *T. glomerata* could also be detected in brackish water sites, which provides further confusions in species delineation (van de Weyer 2016). To clarify the taxonomic relationship of the three species, sequence data of the chloroplast *rbc*L gene was compiled. The study included 18 specimens of *T. glomerata* collected in Germany, Netherland, Great Britain, France, Greece, and Chile together with 17 GenBank individuals from Canada and USA (Perez *et al.* 2014). Four clear *T. salina* specimens were collected in Noirmoutier and on the Isle de Ré (France) and 19 clear *T. nidifica* samples originated from the Baltic Sea. *Tolypella* specimens with ambiguous morphological characters from Sardinia, Greece, Portugal, Austria, and Great Britain were also included. Phylogenetic analysis confirmed *T. glomerata* as a distinct taxon. In contrast, sequence data of *T. nidifica* and *T. salina* were identical and a separation of both taxa was not possible. However, based on *rbc*L sequences, specimens of *Tolypella* collected on Sardinia, in Portugal, Greece and Great Britain appear to be a distinct taxon.

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Pre-Linnaean illustrations as original material of Linnaean *Chara* names (*Characeae*)

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Wood (1960) investigated about the types of the four names of *Characeae* published by Linnaeus (1753) in his *Species Plantarum*. He focussed on the herbarium specimens forgetting the images mentioned in the protologues. Here we list and present the pre-Linnaean illustrations that have to be considered "original material" (according to the International Code of Nomenclature) for the mentioned names.

Chara tomentosa L. - Wood (1960) defined the specimen 1088.1 in the herbarium LINN as "holotype", actually it is a lectotype (as well reported in The Linnaean Plant Name Typification Project, http://www.nhm.ac.uk/our-science/data/linnaean-typification) because of the two different figures cited in the protologue: Plukenet (1691) and Morison (1699).

Chara vulgaris L. - Wood (1960) defined the specimen 1088.3 in LINN as lectotype; the following illustrations are original material: Bauhin & Cherler (1651), Bauhin (1658) (reported also in Bauhin 1671), and Vaillant (1719).

Chara hispida L. - Spencer *et al.* (2009) noted that the type (Herb. Linn. No. 1088.4, LINN) designated by Wood (1960) is identifiable as *C. aspera* Willd.; a proposal for the conservation of *C. hispida* with a conserved type was subsequently made by Gregor *et al.* (2014). The figures in Plukenet (1692) and Vaillant (1719) are original material of *C. hispida*.

Chara flexilis L. (= *Nitella flexilis* (L.) C. Agardh) - Neotype: England. Suffolk, Henly, near Ipswich, Buddle in Herb. Sloane 117: 10 (BM-SL) (Wood 1960). In this case, no images are cited in the protologue.

Bauhin C. 1658. *Theatri botanici* 1(2): 251.

Bauhin C. 1671. *Prodromus theathri botanici... editio altera*, 1: 25.

Bauhin J & Cherler JH. 1651. *Historia Plantarum [...] Tomus III*: 731.

Gregor T, Blindow I, Raabe U, Schubert H, Stewart N. 2014. *Taxon* 63 (4): 933–934.

Linnaeus C. 1753. *Species Plantarum*.

Morison R. 1699. *Plantarum Historiae Universalis Oxoniensis p3*: sect. 15 tab. 4 fig. 9.

Plukenet L. 1691. *Phytographia pars 1*: tab. XXIX, fig. 4.

Plukenet L. 1692. *Phytographia pars 3*: tab. CXCIII, fig. 6.

Spencer MA, Irvine LM & Jarvis CE. 2009. *Taxon* 58: 237-260.

Vaillant S. 1719. *Memoires de l'Academie des Sciences de Paris* 1719: 9-48.

Wood RD. 2015. *Transactions of the American Microscopical Society* 79: 219-226.

The "*Chara hispida* species complex" kept in the Herbarium RO of the Sapienza University of Rome

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The Herbarium (RO) of Sapienza University of Rome hosts 124 specimens belonging to the *Chara hispida* species complex (*Characeae*, Charophyta). This complex is under revision for the preparation of a European monograph on *Characeae*. Herbarium specimens were identified over time with different binomials. A taxonomical revision of the Italian specimens was carried out by A. Pelosi around 1887, and by L. Formiggini and A. Béguinot in 1908. This work reports 1) the most important information transcribed or recognized on the herbarium sheets stored in RO, 2) a distribution map of the collection sites in Europe, 3) selected images of the most significant specimens, and 4) a nomenclatural update of the binomials made according to the most recent monograph on *Characeae* (Arbeitsgruppe Characeen Deutschlands, 2016).
Chara papillosa Kützing. The Herbarium RO preserves 25 specimens collected in fresh and salt water from Germany, Sweden, and Greece by the most important specialists of *Characeae* of the nineteenth century. They were identified as *C. intermedia* A. Braun (varieties and forms). All these specimens were revised by Formiggini who attributed them to *C. papillosa* Ktzg. Herbarium RO retains type collections of *C. intermedia* A. Braun (n. 45, 46, 47 *Charac. Exs.* by Braun, Rabenh., Stizenb.), currently considered as a heterotypical synonym of *C. papillosa* Ktzg. Four specimens of the species were collected in Italy, in fresh water.
Chara horrida Wallman. RO preserves seven specimens collected in brackish water in Sweden, Denmark and Germany and only one specimen collected in Italy (Spezia). The latter, initially identified as *C. hispida*, was afterwards revised as *C. horrida*.
Chara baltica (Hartman) Bruzelius. 14 specimens are present in RO, collected in brackish waters in Poland, Denmark, Norway and Sweden, all identified as *C. baltica* Fries.
Chara aculeolata Kützing. RO preserves 16 specimens collected in fresh and salt waters of Denmark and Germany, identified as *C. polyacantha* A. Braun with the exception of two specimens named *C. aculeolata* Kützing. One of these is part of the Kützing's type material "Im Bruchteiche bei Tennstädt in Thüringen" (Reichenbach H.G.L *Flora germanica exsiccata* n. 426). Three specimens were collected in Italy and identified as *C. polycantha* A. Braun.
Chara subspinosa Ruprecht. The Herbarium RO hosts 10 specimens collected in Germany and Poland, identified as *C. hispida* var. *rudis* A. Braun (or

forms of this), including the Stizenberger's type material "In einem Teich bei Constanz" (Braun, Rabenh., Stizenb. *Charac. exs.* n.4). Only one specimen was collected in Italy and determined as *C. rudis* A. Br.

Finally, 43 specimens identified as *C. hispida* L., *C. hispida* Wallr., *C. hispida* Auct., *C. hispida* L. varietas (31 collected in Europe, and 12 in Italy) are hosted at RO. In absence of a revision based on the recent type of *C. hispida* (Gregor *et al.*, 2014), these specimens are currently considered as *Chara hispida* L. sensu auct. nonnull. (Bazzichelli & Abdelahad, 2009).

Arbeitsgruppe Characeen Deutschlands (Ed.). 2016. *Armleuchteralgen - Die Characeen Deutschlands.* Springer-Verlag, Berlin Heidelberg.

Bazzichelli G & Abdelahad N. 2009. *Alghe d'acqua dolce d'Italia. Flora analitica delle Caroficee.* Sapienza Università di Roma - Ministero dell'Ambiente e della Tutela del Territorio e del Mare.

Gregor T, Blindow I, Raabe U, Schubert H, Stewart N. 2014. *Taxon* 63 (4): 933–934.

Occurrence of *Characeae* in the *Herbarium Universitatis Taurinensis* (TO)

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The Herbarium of the University of Turin (TO) hosts a Cryptogamic section (TO-*Cryptogamia*), which stores about 10000 algal specimens. The collection was created in 1891, after that algal specimens from many different herbaria were combined together. Few other algal specimens are also present in some closed collections, kept separated due to their high historical or scientific value. The *Characeae* specimens hosted in TO collections were indexed and their origin analysed.

Characeae samples were found both in TO-*Cryptogamia* (475 specimens), and in three closed collections (12 specimens). The specimens belonging to the first group came from some important collections such as Braun, Rabenhorst, & Stizenberger, *Characeae exsiccatae*, Jack, Leiner und Stizenberger *Kriptogamen Badens*, Migula, Sydow et Wahlstedt *Characeae exsiccatae* and *Erbario Crittogamico Italiano I* and *II serie*. There are also *exsiccata* from G.B. Balbis, P. Gennari, A. Malinverni and G. Gibelli herbaria. The three closed collections keep some samples of Characee: 7 specimens from G.G. Moris *Flora Sardoa*, 2 collected by F. Bruno included in M. Zumaglini herbarium and 3 from E. Ferrari *Piante acquatiche e palustri del Piemonte*. The specimens have been collected mainly in Europe, particularly in Germany and in Italy, from the second half of the 19th century to the first half of the 20th century. One hundred and fifteen *exsiccata* in TO-*Cryptogamia*, including the typus of *Chara pelosiana* Avetta, have been revised by Formiggini in 1908-1910 (the revisions are written on labels marked *Characeae Italicae*).

The indexing of *Characeae* is part of a project aimed at the scientific enhancement of Cryptogamic collections hosted in TO. In particular, the data collected may be shared in the context of recent initiatives, promoted by the Italian Botanical Society (SBI) and the Federation of European Phycological Society (FEPS), designed for the set up of databases that will be populated with the census of algal collections and for the study of the Italian and European distribution of Charophyta.

The role of herbaria for taxonomic and distributional studies in *Characeae*: examples from the Herbarium Mediterraneum Panormitanum (PAL) and the Florence Tropical Herbarium (FT)

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Characeae is a taxonomically critical family. Taxonomical uncertainties inevitably affect its distributional data. The role of herbarium specimens, particularly types and original material, is crucial for unravelling taxonomical 'knots'. Moreover, wet areas have undergone dramatic reduction and modification in the last century and historical herbarium specimens may represent basic documents for the reconstruction of former distributions. Some preliminary data from two different Italian Herbaria are here presented.

The Herbarium Mediterraneum Panormitanum (PAL, the standard acronym according to the Index herbariorum, http://sweetgum.nybg.org/ih) houses four folders of *Characeae* exsiccata. Two of them contain Italian material, the other two extra-Italian, mostly European material. Italian material totals 88 specimens, many of them collected in Sicily in 19th Century and often reviewed by Formiggini (1908). Many of these Sicilian collection localities are today deeply modified, but as later collections are quite rare, current knowledge on many taxa still relies on those very specimens, which should be carefully reviewed. As an example, one of the few known bisexual populations of *Chara canescens* Loisel., reported in Sicily at Pergusa Lake (one specimen is in PAL), could not be confirmed by recent exploration of the site.

The Tropical Herbarium of Florence (FT) hosts 30 specimens of *Characeae* (data are available online: http://herbarium.univie.ac.at/database/search.php), most of them unidentified, but important because collected between the end of 19th and the first decades of 20th century in the Horn of Africa (the east African peninsula including Ethiopia, Somalia, and Eritrea, geographical core of FT collections). Present knowledge of the charophyte flora of this area is poor, and (as stated by Langangen 2015) "a more systematic survey will undoubtly produce interesting results".

Formiggini L. 1908. *Bullettino della Società Botanica Italiana* 1908: 81-86.
Langangen A. 2015. *Acta Musei Nationalis Pragae, series B - Historia Naturalis* 71(3-4): 239–248.

Peculiarities of *Chara filiformis* distribution in Lithuania

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Chara filiformis A. Braun in Hertzsch morphologically strongly differs from other *Chara* species by "threadlike" appearance and has limited distribution in Europe. It has been recorded in Belarus, Denmark, Estonia, France, Germany, Latvia, Lithuania, Poland, Russia, Sweden, Switzerland and in most of these countries the species is rare, threatened or even extinct (Becker, 2016, 2016). The most recent location has been recorded in NE Germany, NE Poland, Lithuania and Latvia. Analysis of distribution and ecological requirements of *C. filiformis* in Lithuania was based on the Herbarium and literature data, the results of State monitoring of water bodies and personal investigations.

Since the 19th century *C. filiformis* in Lithuania has been recorded in more than 70 lakes. In the beginning of the 19th century, only scattered locations were recorded in Vilnius city environs (Wolfgang, 1822), while major inventory of the 20th century has revealed species distribution in the Lakelands throughout the country (Trainauskaite, 1970). During the last two decades, *C. filiformis* has been recorded in 60 lakes (21% of the investigated lakes). Preferable depth range is 1-4 m; however, it occurs also in the deepest and shallowest locations. Communities with dominant *C. filiformis* (as *Charetum filiformis*) are quite common in clear water lakes. Data on water chemistry of the monitored lakes hosting *C. filiformis* were obtained from the Agency of Environment Protection (aaa, 2005-2017). Water chemistry parameters minimum–maximum (average) ranges estimated for 56 lakes: pH – 8.1-9.3(8.5); Secchi depth m – 1-7.48(4.31), Conductivity μS/cm – 129-508(316), calcium concentration (Ca^{2+} mg/l) – 24.8-79.8(45.5) and nutrients: total phosphorus (TP mg/l) – 0.006-0.067(0.020), total nitrogen (TN mg/l) – 0.245-1.725(0.663). Most of these lakes are attributed to habitat "3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp."

Becker R. 2016. *Gefährdung und Schutz von Characeen. In: AG Characeen Deutschlands (Hrsg.) Armleuchteralgen Die Characeen Deutschlands.* Springer Verlag, Berlin, Heidelberg, 149-185.

aaa, 2005-2017. *Ežerų ir tvenkinių monitoringo rezultatai.*(http://vanduo.gamta.lt)

Trainauskaitė I. 1970. *Kharovyje vodorosli v vodojomakh Litovskoj SSR (Avtoreferat disertacii).* Vilnius (In Russian).

Wolfgang JF. 1822. *Wiadomości o świezo odkrytych lub rzadszych roślinach przybyłych do flory Litewkiey w r. 1821. Pamiętnik Farmaceutyczny Wileński*, 2: 649-653.

From invasive species to charophytes meadows: impact of the rehabilitation of a French canal

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The invasion of many wetlands and rivers by invasive alien plant species has led to many study programs in France, some of them related to *Egeria densa* and *Ludwigia* sp. Their impact on the human activities in the Canal of Marans, situated near the Atlantic coast of France, has initiated studies targeting on efficient measures to control the spread of these species. The aim of the work presented here is A) to give an overview about the control approaches tested and B) to describe the kinetics of the Charophytes meadows in this system.

Built between 1806-1888, for merchandises transport by boats (it was a failure), the canal has a length of 22 km, is around 15 m wide and connects the Natural Regional Park of the Poitevin marshes to the old part of La Rochelle harbour. Since May 1970, a third of this canal is protected as a classified natural site with paths and preserved landscapes. Identified in 2001, *Egeria densa* quickly spread over 16 km as mono-specific stands along the canal bed, negatively impacting different activities as, e.g. fishing, canoe rides. In order to restore the canal's potential for recreation purposes, different techniques were tested, including dredging in the years 2012-2014. The results of the restoration activities with respect to vegetation composition and structure since 2014 will be presented and discussed with a focus on spatial heterogeneity and temporal effects. In this context, the possible explanations for the development of charophytes meadows in parts of the canal will be discussed.

Carbon sequestration by charophytes and submerged vascular plants: a research project conducted in lakes of climatically different western and north-eastern regions of Poland

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The purpose of the presentation is to characterize the main assumptions of the research project that aims to compare the amount of carbon fixed and then deposited in the sediments of lakes by the communities of charophytes and of submerged vascular plants. Charophytes are able to store C not only by biomass production but also in the form of $CaCO_3$ encrustations, by far more abundant compared to vascular plants. We therefore hypothesize that charophytes are capable of permanently bind and accumulate in sediments significant amounts of carbon, and their effectiveness in this respect is higher compared to submerged vascular plants.

The project has been carried out since autumn 2017. We plan to study 12 lakes located in western and north-eastern Poland that allows for accounting the effect of climatic differences related to different proportions between oceanic and continental influences in both regions. The seasonal dynamics of macrophyte biomass is studied in lakes dominated either by charophytes or submerged vascular plants. The content of organic and carbonate carbon is analysed in plants and in profiles of littoral sediments, ca. 0.5 m long, in which macrofossil analyses are carried out to determine whether charophytes or vascular macrophytes dominated the study sites in the past. In order to evaluate the effect of habitat conditions on C accumulation, pH, conductivity, alkalinity, the concentrations of calcium, dissolved phosphorus and nitrogen, and chlorophyll-*a* are analyzed in lake waters. The analyses of phytoplankton and settling seston will allow evaluating the contribution of phytoplankton to the C fixation and deposition.

As a result of the study presented we expect to determine the rate of sedimentation and deposition of both C forms in the sediments and to assess the proportion of recycled carbon to that permanently stored in sediments by charophyte meadows and communities of submerged vascular macrophytes.

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Differences in charophyte overwintering between mid-western and north-eastern Poland

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Charophytes can form dense underwater meadows in lakes and several species are wintergreen. Mild climate promotes overwintering of great amounts of charophyte biomass and can intensify their impact on different levels of a lake ecosystem structure. We aimed to investigate overwintering ability of characean species (*Chara tomentosa* L., *Chara filiformis* Hertsch, *Nitellospis obtusa* (Desv.) J.Groves) based on their biomass production in two Polish regions differing in climate conditions.

The study was performed in Lake Jasne (52°12′57″ N 16°05′31″ E) in mid-western Poland (Lubuskie Lakeland) of milder climate and in Lake Majcz Mały (53°46′5.83″ N 21°26′16.54″ E) in more severe north-eastern region (Masurian Lakeland). On average the vegetation season lasts 20 days longer in the Lubuskie Lakeland because of the earlier onset of spring and the later onset of autumn. In 2017, the mean annual air temperature was by over 1°C higher in mid-western Poland than in the north-eastern region.

Both the studied lakes are mesotrophic and hardwater. Lake Jasne had lower chlorophyll *a*, Ca^{2+} and nutrient concentrations ($N\text{-}NO_3^-$, TN, SRP, TP), and higher alkalinity than Lake Majcz Mały. Charophytes were sampled in July, November 2017 and April 2018 with Bernatowicz's grab (0.16 m^2) from three sites in each lake. Samples from Lake Jasne contained mainly *C. tomentosa* but *C. filiformis* was also present at one site. Samples from Lake Majcz Mały were always a mix of two species: *C. tomentosa* and *N. obtusa*. Mean charophyte summer biomass in Lake Jasne was 2144.2 g DW m^{-2} and 350.1 g DW m^{-2} in Lake Majcz Mały and above 60% and 21% of summer biomass overwintered in respective lakes. The differences in characean summer biomass can be explained by phytoplankton abundance but spring biomass proves the climate impact on charophyte overwintering in Poland.

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Application of geoinformation systems in the study of charophytes

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In recent years geoinformation systems have been used to solve practical problems in ecology. We have started working on the use of GIS-technologies to study macrophytes, and in particular the charophytes, of Kazakhstan.

Using the decoded satellite imagery of the medium-expansion LANDSAT-8 device in the ERDAS-9 (Earth Resources Data Analysis System) software, a modern state of the wetlands was revealed and water objects of the territory of Kazakhstan were mapped. The investigated components - the climatic regime, the amount of precipitation, the physical and chemical characteristics of the water objects according to gauging stations, the species composition of the charophytes and the accompanying macrophytes –were all entered in the geographic database created in the ArcGIS10.1 software.

It is expected to obtain a map of the species diversity of macrophytes, including charophytes, allowing to analyze the relationship between plant propagation and geoecological conditions.

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