

Under the Auspices of H.E.
the President of the Hellenic Republic
Mr. Prokopios Pavlopoulos

ABSTRACTS



XVI OPTIMA Meeting



Organized by:

OPTIMA (Organization
for the Phyto-Taxonomic
Investigation of the
Mediterranean Area)

Agricultural University
of Athens

2-5 October 2019
Agricultural University of Athens, Greece

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Abstracts

Oral Presentations, E-posters

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Scientific Programme

Tuesday, 1 October 2019

10.30 Meetings of the OPTIMA Commissions (restricted).

Wednesday, 2 October 2019

9.30 Meetings of Executive Council & International Board of OPTIMA

9.30 **Registration of the participants.** The Registration desk will remain open as per official programme timings throughout the entire meeting.

11.30 **Opening Ceremony and Plenary Lecture**

Dimitrios Phitos

The evolutionary course of Botanical science in Greece from Theophrastus to the present day.

13.00 **Welcome lunch**

Symposium 1 - Hall 1

Geoparks and Protected areas of Greece

Organizers: Georgia Kamari & Nikolaos Zouros

14.30 **Zouros N.** (Keynote presentation): The Global Geoparks Network.
Fassoulas Ch., Pattakos D. & Perakis E.: The Cretan Geoparks, synergies and actions for local sustainable development.
Liapi E. & Iliopoulos G.: The paleoflora of Chelmos-Vouraikos Unesco Global Geopark: A geological and palaeobotanical heritage.

Coffee break

Kontaxi Ch., Dalaka A. & Alvanopoulos G.: Protection and management of natural environment in Greece.

Kamari G., Mitsainas G. & Xanthakis M.: A successful example in the management of protected areas in Greece: The National Park of Mt. Aenos.

Phitos D., Kamari G. & Bareka P.: Red Data Books as valuable tools for the conservation of plant biodiversity in Protected Areas.

Symposium 2 – Hall 2

Fungal diversity in the Mediterranean area: recent advances and future prospects

Organizers: Giuseppe Venturella & George Zervakis

- 14.30 **Mello A.** (invited lecture): Advances in the identification of ectomycorrhizal fungi - insights on their biological and ecological aspect.
Zambonelli A., Iotti M. & Hall I. (invited lecture): Diversity of the genus *Tuber* in the wider Mediterranean Area and prospects for the commercial exploitation of selected truffle species.
Venturella G., Ferraro V. & Gargano M. L.: Biodiversity, conservation and exploitation of medicinal mushrooms in Italy.
- Coffee break**
- Lewinsohn D.:** The unique mycobiota of the Negev desert in Israel.
Leonardi M., Comandini O. & Rinaldi A. C.: *Halimium* and associated mycobionts: a new look at Mediterranean ectomycorrhizal communities.
Polemis E., Daskalopoulos V., Fryssouli V. & Zervakis G. I.: Inventory of macrofungi associated with *Alnus glutinosa* (priority habitat 91E0) from Andros island, Greece.
- Discussion**
DIRFIS MUSHROOMS: Let's taste the mushroom diversity.

Symposium 13 – Hall 3

Advances in lichen diversity in the Mediterranean region

Organizer: Ana Rosa Burgaz

- 14.30 **Guttová A., Slovák M., Kučera J., Senko D., Vďačný P., Zozomová-Lihová J., Melichárková A. & Fačkovcová Z.:** Revealing evolution, biogeography and ecology of Mediterranean centred genus *Solenopsora*: An integrative approach.
Burgaz A. R., Gutiérrez-Larruga B., Rodríguez-Arribas C. & Pino-Bodas R.: The genus *Cladonia* in Greece.
Llop E.: Lichen diversity from the Sicoric territory, continental Western Mediterranean region.
- Coffee break**
- Sohrabi M.:** Iranian Lichenology: Progress and Problems.
Pino-Bodas R., Gargiulo R., Cano E. & Burgaz A. R.: Assessing the genome wide RAD sequencing method to address the species delimitation in the genus *Cladonia* (*Cladoniaceae*, *Ascomycota*).

- 18.00 **Welcome Cocktail**

Thursday, 3 October 2019

Symposium 3 – Hall 1

History of early botanical exploration in the Mediterranean

Organizers: Werner Greuter & Vernon H. Heywood

- 9.30 **Bueno A. G. & Heywood V. H.:** Early botanical exploration of Spain.
Valdés Castrillón B.: Early botanical exploration of the Maghreb countries.
Raimondo F. M., Camarda I. & Lucchese F.: Early botanical exploration of Italy.
- Coffee break*
- Lack W. H.:** Early botanical exploration of the southern Balkans, Anatolia, and Caucasia.
Al-Zein M.: Early botanical exploration of the Levant and Egypt.
Leschner H.: The Big Bang - botanical investigation of the Middle East during 1900-1960.

Symposium 6 – Hall 2

Mediterranean algal diversity: Past, Present and Future

Organizers: Anna Maria Mannino & Sotiris Orfanidis

- 9:30 **Boudouresque C.-F., Blanfuné A., Perret-Boudouresque M., Ruitton S. & Thibaut Th.:** Extinction of Mediterranean macrophyte taxa: local extinctions and functional extinctions matter.
Rodríguez-Prieto C.: Past, present and future of Gigartinales and Cryptonemiales *sensu lato*.
Rindi F.: Diversity of Mediterranean coralline algae: recent advancements in the knowledge of a highly threatened group of seaweeds.
- Coffee break*
- Panayotidis P. & Tsiamis K.:** Diversity and ecology of macroalgae in Eastern Mediterranean.
Kooistra W. H. C. F., Gaonkar C. C., Montresor M., Piredda R., Sarno D. & Zingone A.: Species diversity and seasonality in the marine planktonic diatom *Chaetoceros* assessed by means of metabarcoding.

- 12.30 **Light lunch**

Symposium 5 – Hall 1

Plant diversity and evolution in polyploid, dysploid, and hybrid complexes of the Mediterranean flora

Organizers: Lorenzo Peruzzi & Sonja Siljak-Yakovlev

14.00

Introduction

Nemati Z., Harpke D. & Blattner F. R.: Greece, Home of Saffron – Progenitor, areas and consequences of triploidy.

Astuti G., Liu L., Coppi A. & Peruzzi L.: Different chromosome numbers, but slight morphological differentiation and genetic admixture among populations of *Pulmonaria hirta* complex.

Coffee break

Farhat P., Bou Dagher - Kharrat M., Adams R., Thierry R. & Siljak-Yakovlev S.: Polyploidy and hybridization as the main evolutionary driving forces of *Juniperus sabina* in its Mediterranean range.

Peterson A. & Harpke D.: The Mediterranean basin as secondary speciation centre of *Gagea*.

Nardi F. D., Alonso-Marcos H., Hülber K., Tribsch A. & Dobeš C.: How ploidy level and mating system influence the ecogeography of amphipomicitic *Potentilla puberula* (*Rosaceae*).

Symposium 4 – Hall 2

Origin and diversification of Mediterranean crops

Organizer: Benito Valdés Castrillón

14.00

Valdés Castrillón B.: Introduction

Weiss E.: Daniel Zohary

Plitman U. & Melamed Y.: The plausible roles of women in the domestication of lentils.

Coffee break

Weiss E.: The domestication of wheat and barley - new evidences.

Dimitrova D. & Ivanova T.: From crop fields to home gardens - transitions and identities.

Cermeño P.: New Mediterranean crops - aromatic plants.

Friday, 4 October 2019

Symposium 7 – Hall 1

New methods in Plant Systematics

Sponsored by: Plant Systematics & Evolution – Springer Link

Organizers: Karol Marhold & Christoph Oberprieler

9.30

Frajman B., Závěská E. & Schönswetter P.: Integrating next generation sequencing, ecological niche modelling and classical phylogenetic and morphometric methods disentangles relationships within Eurasian *Euphorbia seguieriana* alliance (*Euphorbiaceae*).

Tomasello S., Karbstein K., Hodač L., Pätzold C. & Hörandl E.: Resolving phylogenetic relationships in *Ranunculus auricomus* using target enrichment.

Liveri E., Crawl A. A., Mavrodiev E., Yildirim H., Kamari G., Phitos D. & Cellinese N.: Another piece of the puzzle, another brick in the wall: the inevitable fate of *Campanula* L. section *Quinqueloculares* Phitos.

Coffee break

Aydin Z. U., Dönmez A. A. & Koch M. A.: Efficiency of plant DNA barcoding for taxonomy: A case study in *Dianthus* L. (*Caryophyllaceae*).

Wagner F., Ott T., Schall M., Lautenschlager U., Vogt R. & Oberprieler C.: Taming the Red Bastards: Hybridisation and species delimitation in the *Rhodanthemum arundanum*-group (*Compositae, Anthemideae*).

D'Antraccoli M., Roma-Marzio F., Carta A. & Peruzzi L.: Patterns of floristic richness in the Euro-Mediterranean area.

Karbstein K., Tomasello S., Hodac L., Daubert M. & Hörandl E.: New approaches in TaxonOmics: RADseq supported by geometric morphometrics uncovers relationships of sexual species within the *Ranunculus auricomus* complex.

Symposium 8 – Hall 2

Useful Plants of the Mediterranean

Organizers: Kemal Hüsnü Can Baser & Stella Kokkini

9.30

Assimopoulou A.: Alkannins and Shikonins: From Ancient Codes to Modern Medicine.

Çalis I.: Recent Advances on the chemistry of *Astragalus* species of Turkey.

Pirintsos S.: Linking Biodiversity with Drug development in the framework of Ethnopharmacology: The experience of Cretan IAMA research group.

Coffee break

Polissiou M.: Essential oils from Mediterranean MAPs as potential biopesticides.

Tsimidou M.: The bioactive apocarotenoids of *Crocus sativus* L. and its wild Mediterranean allies.

12.30

Light lunch**E-Poster Session – Hall 3**

Organizers: Pepy Bareka & Giannantonio Domina

14.00

The posters will be at display throughout the entire Meeting.

19:30

Congress Dinner**Saturday, 5 October 2019****Symposium 9 – Hall 1****Islands and insular systems**

Organizers: Frédéric Médail & Panagiotis Trigas

9.30

Médail F. & Trigas P.: Introduction: Importance of Mediterranean islands for biogeography and conservation of plants.

Panitsa M., Kougioumoutzis K., Kagiampaki A., Triantis K. A. & Trigas P.: Plant diversity patterns in the Aegean Islands: history, climate or isolation?

Nikolić T.: The eastern Adriatic islands – state and perspectives.

Coffee break

Pasta S., La Rosa A., Pavon D., Lo Cascio P. & Médail F.: Tentamen Florae Aeolicae: A critical checklist of the vascular plants of the Aeolian Islands (Sicily, Italy).

Cambria S., Brullo S., Bogdanovic S. & Giusso del Galdo G.: Taxonomy and vicariance within the endemic species of *Solenopsis* (*Campanulaceae*) in the Mediterranean islands.

Kougioumoutzis K., Kokkoris G., Panitsa M., Strid A., Trigas P. & Dimopoulos P.: Climate change in a Mediterranean island biodiversity hotspot and its impact on the endemic Cretan flora.

Symposium 10 – Hall 2

Web Botany

Organizers: Ernst Vitek & Dimitris Koureas

- 9.30 **Koureas D.:** The Distributed System of Scientific Collections (DiSSCo) research infrastructure; Integrating European natural history collections to enable data-driven innovation and frontier biodiversity research.
- Raab-Straube E. von:** Euro+Med PlantBase and the Common Data Model (CDM) – integrating, further updating and expanding floristic and taxonomic information on Euro-Mediterranean plant diversity.
- Hofbauer M., Berger A., Gilli C., Lachmayer M., Prehler D., Reich D., Sander R., Sonnleitner M. & Gutermann W.:** Flora Ionica online – an integrative resource for plant biodiversity.
- Coffee break*
- Groom Q.:** Progress towards better management of and access to herbarium data.
- Dimopoulos P.:** The Flora of Greece website – FoG web.

12.30 **Light lunch**

Symposium 11 – Hall 1

Plant Conservation

Organizers: Magda Bou Dagher-Kharrat & Theophanis Constantinidis

- 13.30 **Véla E., Allen D., Barrios V., Lansdown R. & Numa C.:** Assessing the conservation status of Monocots in the Mediterranean region: reflections from a recent IUCN Red List evaluation.
- Dimopoulos P., Constantinidis Th., Raus Th. & Strid A.:** Taxonomic plant diversity and conservation needs in Greece.
- Lansdown R., Grillas P., Galewski Th. & Bazos I.:** Conservation of Mediterranean Wetland Plants.
- Peruzzi L., Astuti G., Carta A., D'Antraccoli M., Roma-Marzio F. & Bedini G.:** Interdisciplinary studies in plant conservation: lessons from some Italian case studies.
- Bou Dagher Kharrat M., Roukoz A., Depalle F., Samad N. A., Jardak R., Kahale R., Saliba C. & Sakr R.:** Conservation of endemic *Oncocyclus*, Iris of the eastern Mediterranean Region.

Coffee break

- Xu X., Ma K., Luo M., Liu B., Wang H., Xue J., Lin Q., Li W., Xu Z. & Ganeshaiyah K. N.: Mapping Asia Plants: Initiative and Progress.
- de Montmollin B., Gotsiou P., Bacchetta G., Christodoulou Ch. S., Cogoni D., Fournaraki Ch., Giusso del Galdo G. P., Kokkinaki A., Kyratzis A., Piazza C., Vicens M. & Fenu G.: Ex-situ and in-situ joint conservation actions for threatened Mediterranean island flora: lessons learnt from the CARE-MEDIFLORA project.
- Özhatay F. N., Demirci Kayıran S. & Kaya E.: Conservation of endemic *Colchicum* species distributed in the Mediterranean Region of Turkey.
- Lazaridi E., Thanopoulos R. & Bebeli P. J.: On-farm conservation impact on cowpea diversity in Greece.

Symposium 12 – Hall 2

Invasive plants: botanical gardens, orchards, crops and aquatic habitats as hotspots of spreading the alien species in the Mediterranean

Organizers: Stephen L. Jury & Olja Vasić

- 13.30 **Tanner R.:** Mitigating the impacts of invasive alien plants through international cooperation.
- Mannino A. M.:** Alien macrophytes in the Mediterranean sea: an overview.
- Papini A. & Santosuosso U.:** Modelling the center of origin and the spreading pattern of *Caulerpa* invasion in the Mediterranean.
- Farelo P., Gómez-Bellver C., Montserrat J. M., Pyke S., López-Pujol J., Nualart N. & Ibáñez N.:** Montjuïc Mountain (Barcelona): A hotspot for plant invasions in a Mediterranean city.

Coffee break

- Del Guacchio E.:** The role of the botanical gardens of Campania (Italy) in introducing invasive plants.
- Jury S. L.:** *Nicotiana glauca*: a neglected invasive?
- Herrando-Moraira S., Viales D., Nualart N., Gómez-Bellver C., Ibáñez N., Massó S., Cachón-Ferrero P., González-Gutiérrez P. A., Herrera I., Shaw D., Stinca A., Wang Z. & López-Pujol J.:** From greenhouse to the wildlife: global invasion patterns of *Kalanchoe ×houghtonii* (Crassulaceae).

- 17:00 **Closing Ceremony and General Meeting of OPTIMA**

Sunday, 6 October 2019

Field Excursion

Oral Presentations

SYMPOSIUM 1

Geoparks and Protected areas of Greece

Organisers: *Georgia Kamari & Nikolaos Zouros*

Programme

- 1) **Zouros N.** (*Keynote presentation*): The Global Geoparks Network.
- 2) **Fassoulas Ch., Pattakos D. & Perakis E.**: The Cretan Geoparks, synergies and actions for local sustainable development.
- 3) **Liapi E. & Iliopoulos G.**: The paleoflora of Chelmos-Vouraikos Unesco Global Geopark: A geological and palaeobotanical heritage.
- 4) **Kontaxi Ch., Dalaka A. & Alvanopoulos G.**: Protection and management of natural environment in Greece.
- 5) **Kamari G., Mitsainas G. & Xanthakis M.**: A successful example in the management of protected areas in Greece: The National Park of Mt. Aenos.
- 6) **Phitos D., Kamari G. & Bareka P.**: Red Data Books as valuable tools for the conservation of plant biodiversity in Protected Areas.

The Global Geoparks Network

Nickolaos Zouros

*GGN President, University of the Aegean, Department of Geography, 81100 Mytilenee, Greece.
E-mail: nzour@aegean.gr*

The Global Geoparks Network (GGN) established in 2004, under the umbrella of UNESCO, as an international network, which provides a platform of cooperation among Geoparks. The GGN consists a unique worldwide partnership including 147 Geoparks working to protect geological heritage and promote local sustainable development.

The GGN mission is to influence, encourage and assist local societies all over the world to conserve the integrity and diversity of abiotic and biotic nature, to ensure that any use of natural resources is equitable and sustainable and to support economic and cultural development of local communities through the valorization of their unique heritage and identity.

In 2014 after one decade of successful operation as a volunteer network the GGN gained legal personality. Global Geopark activities have been part of the UNESCO work plan since 2001 and, since 2004, UNESCO has offered ad-hoc support to Global Geoparks upon requests from individual Member States. In 2015 the 38th UNESCO General Conference ratified the statutes of the new International Geoscience and Geoparks Programme and the UNESCO Global Geoparks Operational Guidelines, introducing the brand UNESCO Global Geopark as a label of excellence for areas that meet the criteria set by the above-mentioned guidelines. In doing so, the GGN became officially the partner of UNESCO for the operation of the UNESCO Global Geoparks programme.

The GGN organizes co-operation and mutual assistance between the UNESCO Global Geoparks and the Global Geopark professionals to develop and promote the Geopark concept world-wide.

The GGN initiates and co-ordinates Regional Geoparks Networks which enhance international co-operation in Geoparks building and management, supporting local communities and fostering local development.

The GGN is operating a variety of communication tools to disseminate information among its members and to promote the Geopark concept and activities to the broad public.

The GGN organizes campaigns for the celebration of international days such as Earth's day, Mountains day, Natural Disaster reduction day, Museum's day, World Environmental day etc.

The GGN organizes capacity building activities to disseminate knowledge on Geoparks building and management focusing on geographical areas with less representation in the Network. Capacity building activities are implemented in collaboration with UNESCO, national authorities and universities as well as regional and national Geopark networks.

GGN celebrates in 2019 15 years of successful operation and development and faces new challenges for the years to come. These include the development of Geoparks

in all continents, strengthening of Geoparks visibility through marketing and communication, the implementation of best practices in geodiversity management, geo-conservation, geo-tourism, geo-education and sustainable local development as well as the high quality activities and services for visitors in the UNESCO Global Geoparks.

Keywords: Global, Geoparks, Network, UNESCO.

The Cretan Geoparks, synergies and actions for local sustainable development

Charalampos Fassoulas¹, Dimitrios Pattakos² & Evaggelos Perakis³

¹ *Natural History Museum of Crete, Uni. Crete, Coordinator of HGF, Vice Coordinator of EGN, Scientific Coordinator of Psiloritis UGGp, Heraklion, Crete, Greece. E-mail: fassoulas@nhmc.uoc.gr*

² *Director of AKOM Psiloritis SA and Psiloritis UGGP, Anogia, Rethimnon, Crete, Greece.*

³ *Coordinator of Sitia UGGp, Municipality of Sitia, Sitia, Crete, Greece.*

Crete hosts two UNESCO Global Geoparks, the Psiloritis and Sitia, together with the Samaria Man and Biosphere Reserve. The Geoparks are areas with significant geological heritage that aim at local sustainable development through the conservation of Natural and Cultural environment, the continuous training and education of local people and visitors and the support of local products and activities.

Located at Crete, both geoparks expose outstanding areas of natural and cultural beauty, influenced and governed by the geological bedrock. From the coastal zone to the high mountains the prevailing carbonate rocks form gorges, plateaus, caves, springs and various other habitats where wild life and humans evolved through time at a continuous reforming and active landscape. The geoparks share also similar history, traditions and cuisine, with local peculiarities that add special flavor and characteristics at each place.

Geotourism is the main tool of geoparks to achieve local sustainable development and under this target both geoparks, Psiloritis and Sitia, have developed individual and common actions to enhance and promote their natural and cultural wealth, develop special infrastructures for the visitors, produce and implement educational activities focused on the peculiarities of each place and undertake actions to support and promote local production and goods. In past both areas participated in GEOTOPIA, an INTERREG Greece-Cyprus project that contributed significantly in the development of necessary infrastructure and promotional material for Sitia and Troodos areas in Cyprus and helped them to successfully apply for nomination as UNESCO Global geoparks. Collaboration continued under a new INTERREG Greece- Cyprus program titled GEO-IN, under which the Hellenic and Cypriot coastal UNESCO Global Geoparks develop and implement actions to strengthen geotourism at their territories and promote the geoparks in global level. New interactive and web-based applications have been produced and new educational products have been designed together with studies, temporary exhibitions and participation at international fairs.

Last but not least, Psiloritis and Sitia geoparks in collaboration with the Samaria MAB and the Region of Crete designed and already implement a Spatial Integrated Investment under the regional funding period, titled "The UNESCO Sites of Crete", aiming to develop a new alternative tourism product for the island.

The Paleoflora of Chelmos-Vouraikos Unesco Global Geopark: A geological and palaeobotanical heritage

Eleni Liapi & George Iliopoulos

Department of Geology, University of Patras, University Campus, GR-25504, Rio, Greece.

Chemos-Vouraikos UNESCO Global Geopark of Greece hosts several geosites that represent important geological features such as caves, lakes, gorges or palaeontological remains. A great number of the geotopes, which are being related with surface and underground water, present the scientific value of the Geopark.

Nevertheless, in the lignite beds of the Kalavryta basin, Late Miocene to Early Pliocene fossiliferous lacustrine deposits containing numerous fossils leaves or leafy twigs have been recently discovered. These plant macro-remains are characterized by high preservation quality and have been preserved mainly as compressions or leaf impressions. A significant number of specimens (more than 1000 plant fossils) were collected from the lignite beds of two different localities of the Kalavrita basin (Drosato and Palaiochori). In the framework of this study the description and systematic classification of these plant macro-remains was carried out. The preliminary results show that the following taxa have been identified: *Quercus roburoides*, *Quercus pseudocastanea*, *Quercus kubinyii*, *Zelkova zelkovifolia*, *Acer integerrimum*, *Acer integrilobum*, *Platanus academiae*, *Populus* sp., *Salix* sp., *Paliurus* sp. and *Carya* species. In addition, conifer macro-remains and mainly *Glyptostrobus europaeus* are being identified in the palaeofloras of the wider study area. Based on the fossil record, a mixed mesophytic forest with different species of *Quercus* and other floristic elements seems to prevail in the lowland areas, whereas in the swampy areas the conifer *Glyptostrobus europaeus* and branches of monocotyledons dominated respectively.

The study focuses in the reconstruction of the vegetation in the Late Miocene-Early Pliocene, as well as the representation of the palaeoenvironment of the Geopark. Moreover, comparisons of the modern Mediterranean flora along with the extinct species of *Glyptostrobus* and *Zelkova* will be carried out showing simultaneously the evolution of the vegetation structure. Such well-preserved plant macro-remains are certainly an important part of the local geoheritage and could become in the future one of the most significant assets for the Chemos-Vouraikos UNESCO Global Geopark.

Keywords: Late Miocene- Early Pliocene, Kalavryta, plant macrofossils, lignite deposits.

Protection and management of natural environment in Greece

Christina Kontaxi, Anastasia Dalaka & George Alvanopoulos

Management of Natural Environment and Biodiversity - Ministry of Environment and Energy, Greece.

The protected areas system in Greece consists mainly of Natura 2000 sites. This network comprises a total of 446 sites, of which 215 are SAC, 181 are SPA, 24 are SAC/SPA and 26 are SCI. The marine area of the Natura sites is equal to 19.90% of the national marine area and the land area is equal to 27.55% of the land.

According to national legislation, the definition of land uses and the permitted or non-permitted activities within Natura requires the preparation of a Special Environmental Study and the issuance of a Presidential Decree and a Management Plan. The Management Plan specifies the provisions of the PD and is supported by the monitoring following the implementation of the management measures. The Ministry of Environment and Energy is currently implementing a project for the adoption of the PDs for all Natura sites, funded by the NSRF.

In order to implement the relevant National and European legislation on the management of the protected areas, 36 Management Bodies have been constituted, with responsibilities including the implementation of management plans and public information on protected species (habitat types and types).

A successful example in the management of protected areas in Greece: the National Park of mt. Aenos

Georgia Kamari¹, George Mitsainas¹ & Michael Xanthakis²

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The Management Authority of the National Park of Mt. Aenos was established in 2002, in order to manage, protect and promote awareness on the National Park, an important protected area of the NATURA 2000 network of Greece (GR2220002), located on Cephalonia, (Ionian islands). The iconic feature of the National Park, that also led to its foundation in 1962, is the *Abies cephalonica* forest (*locus classicus*), an endemic fir species of Greece. Just last year, the Management Authority's area of jurisdiction increased remarkably in size from just 2,862 ha to a total area of 57,981.30 ha and it is now responsible for all six NATURA sites of Cephalonia and Ithaca (GR2220001, GR2220002, GR2220004, GR2220005, GR2220006 & GR2220007) that include both aquatic and terrestrial areas. Over the past years, the Managing Authority undertook the coordination and implementation of scientific monitoring actions for the Flora, Macromycetes, Fauna, Avifauna, as well as the habitat types, of the National Park of Mt. Aenos, but also the wider area of Cephalonia - Ithaca. These monitoring efforts produced very important data on the local biodiversity and its protection. For example, in the latest edition of the Red Data Book of Threatened Plants of Greece, ten plant taxa of Cephalonia - Ithaca (five exclusive of Mt. Aenos) have been included. The Management Authority was also responsible for patrolling/Guarding the National Park and undertook extensive and diverse environmental awareness/education initiatives, targeting both students and the general public and ranging from interactive activities outside the Park to excursions inside. A variety of publicity material has been created over time (leaflets, posters, cards, calendars, poster-size plates that inform visitors in the National Park etc.) culminating in the publication of a book in Greek and English on the National Park of Mt. Aenos, that presented the significant knowledge that has been gathered over the years of operation of the Management Authority and before. Acting further as a scientific entity, the Management Authority has organized a series of seminars and conferences and hosted students through the Erasmus exchange initiative. It has also undertaken innovative actions, such as the creation of a seed bank and regeneration lab for plant species, the radio-dating of the Fir forest, the design of a virtual tour and museum platform for the National Park etc. During the past two years, the Management Authority has undertaken the ambitious task to organize the Geopark of Cephalonia - Ithaca with the support of the Region of Ionian Islands, since the area meets all the geological qualifications. Currently, the candidacy is under preparation to apply for membership at the UNESCO Global Geoparks. All these actions, were implemented in the best possible way, through the productive cooperation of the Board and the staff of the Management Authority, achieving in the end to inspire,

inform and change the attitude of students, citizens and very difficult stakeholders, such as the shepherds of the region from initial skepticism, suspicion and fear to understanding the value of the National Park and becoming allies towards its protection.

Keywords: Cephalonia, Patrolling/Guarding, Environmental Awareness, Biodiversity Monitoring, Innovative Actions.

SYMPOSIUM 2

**Fungal diversity in the Mediterranean area: recent advances
and future prospects**

Organiser: *Giuseppe Venturella & Georgios Zervakis*

Programme

- 1) **Mello A.** (*invited lecture*): Advances in the identification of ectomycorrhizal fungi – insights on their biological and ecological aspects.
- 2) **Zambonelli A.** (*invited lecture*): Diversity of the genus *Tuber* in the wider Mediterranean Area and prospects for the commercial exploitation of selected truffle species.
- 3) **Venturella G., Ferraro V. & Gargano M. L.:** Biodiversity, conservation and exploitation of medicinal mushrooms in Italy.
- 4) **Lewinsohn D.:** The unique mycobiota of the Negev desert in Israel.
- 5) **Leonardi M., Comandini O. & Rinaldi A. C.:** *Halimium* and associated mycobionts: a new look at Mediterranean ectomycorrhizal communities.
- 6) **Polemis E., Daskalopoulos V., Fryssouli V. & Zervakis G. I.:** Inventory of macrofungi associated with *Alnus glutinosa* (priority habitat 91E0) from Andros island, Greece.

Advances in the identification of ectomycorrhizal fungi – insights on their biological and ecological aspects

Antonietta Mello

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Ectomycorrhizal (ECM) symbiosis is established by fungi almost exclusively belonging to Basidiomycetes and Ascomycetes, and host plants including most angiosperm and gymnosperm trees, as well as shrubs. The development of an ECM symbiosis requires morphological changes in the two partners, needed to the formation of the symbiotic structures. The ectomycorrhiza is formed by two fungal pseudotissues: the mantle, which develops outside the root, and the Hartig net, which colonizes the apoplastic space between root cells. Starting with the manual dissection of the mantle from the Hartig net of *Amanita muscaria* ectomycorrhizae, it has been proved that the two compartments are functionally different and, later on, that the mantle is the responsible for the mineral elements (i.e. nitrogen) and water uptake from soil, whereas the Hartig net shows an enhancement of the expression of several transporters.

The identification of ECM fungi has generally been focused on the macro- and microscopic examination of fruiting bodies. Only since the early 1990s these fungi have also been characterized by DNA-based methods mainly involving direct sequence analysis of the ITS region and its deposit in GeneBank or EMBL. Once the molecular tools as sequencing and specific primers have been available, they have allowed typing the ECM tips, usually after sorting these in morphotypes and therefore to study the EM community of trees in different habitats. As each ECM species is specialized in exploiting specific resources of the soil ecosystem, investigations have been thereafter focused on the spatial distribution of the extraradical mycelium. *Hebeloma cylindrosporum* was the first ECM fungus to be detected in soil, within 50 cm from the fruiting bodies. Studies as this have been focused on the individual recognition of ectomycorrhizal fungi, clarifying many aspects of their population biology. The introduction of high-throughput sequencing techniques and the suitability of studying (micro)organisms directly *in situ* (metagenomics or environmental genomics) have provided new information on ECM fungal communities by 'barcodes' of ITS regions in several biomes/ecosystems. At the same time genomic and transcriptomic sequencing projects starting in 2008 with the first mycorrhizal genome sequencing (i.e. that of *L. bicolor*) have allowed the identification of the common core of ECM symbiosis-related genes, as determinants of the symbiotic lifestyle.

In this presentation I will trace some advances in the identification, biology and ecology of the ECM fungi achieved in the last 30 years mainly focusing on the advent of new techniques and of an interdisciplinary research approach.

Diversity of the genus *Tuber* in the wider Mediterranean Area and prospects for the commercial exploitation of selected truffle species

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True truffles are ascomycetous fungi of the genus *Tuber* characterized by hypogeous ascomata and an ectomycorrhizal lifestyle. Although, the genus *Tuber* includes around 200 species, only a few Mediterranean species are considered gourmet foods commanding high prices. The most precious species are *Tuber magnatum* (the Italian white truffle) *Tuber melanosporum* (the Périgord truffle), *Tuber aestivum* (the summer truffle) and *Tuber borchii* (the bianchetto truffle).

Traditionally wild truffles are harvested and commercialized in Italy, France and more recently in Spain. However, in the last years several other Mediterranean countries, like Greece or Morocco began to exploit their natural truffle resources. Of particular note is *T. magnatum*, a species that has long been considered an almost exclusive Italian species, has been found to be widespread in Greece.

Intensive harvesting of truffles has been shown to cause falls in truffle production as a consequence of physical damage to *Tuber* ectomycorrhizas, the soil mycelium and, probably suppressing fertilization. In order to protect this important resource, it is essential to enforce strict rules during the harvest to protect their unique environment and to stop harvesting in same areas allowing spore diffusion. Recent studies have been shown their important role in truffle fertilization and fructification.

Truffle cultivation has also become an important agricultural alternative in rural Mediterranean regions, which at the same time promotes reforestation, economic restoration of rural lands and land-use stability. The new mycelial techniques for the production of truffle infected plants could assist to improve truffle cultivation given the possibility select the best fungal strains for each hostplant and environmental condition. However, more research will be needed to perfect techniques for the cultivation of *Tuber magnatum*, which still gives uncertainty results.

Over the past quarter Century truffle cultivation has been successfully introduced in several European countries and others such as Canada, the USA and China. Extensive plantings have also been successful in the Southern Hemisphere in areas with suitable climates in countries like New Zealand, Australia, Chile and South Africa. The result has meant that quality truffles are now available the year round in both the Northern and Southern Hemispheres.

Biodiversity, conservation and exploitation of medicinal mushrooms in Italy

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The Italian territory, characterized by countless types of vegetation, expresses a remarkable diversity of fungal species capable of performing multiple and fundamental roles for the balance and survival of ecosystems. The diversity of mushrooms in Italy is expressed by a high number of taxa which, according to recent estimates, amounts to more than 6,000. *In situ* conservation strategies are mostly activated in natural areas and in regional and national parks thanks to special regulations. In other areas there are regulations that protect natural habitats and consequently also fungal communities. The examples of *ex situ* conservation are rather limited and addressed to some species with point distribution. A contribution to *ex situ* conservation is provided by the Mycoteques whose presence in Italy is currently limited to a few universities and the National Research Council. In recent times, researchers have begun to look at fungal diversity in terms of income support, alternative foods to traditional ones, and prevention and treatment of various diseases of man and of domestic and farmed animals. The cultivation of the fungi has therefore assumed a double value. To the traditional cultivation of mushrooms for commercial purposes has been added the one for the production of mushrooms to be dried and to be destined, in the form of dry extract, to the nutraceutical industry. In this abstract are reported the recent actions taken at national level in the field of Science-to-business (S2B) marketing and related to the activation of a production chain that enhances the fungal biodiversity in Italy for the production of mushrooms to be used in the fresh market and the production of certified extracts to be used in nutraceutical companies.

Keywords: science-to-business, mushrooms cultivation, mushroom extracts, mycotherapy, Italy.

The unique mycobiota of the Negev desert in Israel

Dalia Lewinsohn

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Desert truffles are mycorrhizal, hypogeous fungi considered a delicacy. On the basis of morphological characters we identified three desert truffle species that grow in the same habitat in the Negev desert. These include *Picoa lefebvrei* (Pat.,) *Tirmania nivea* (Desf.) Trappe, and *Terfezia boudieri* (Chatain), all associated with *Helianthemum sessiliflorum*. Their taxonomy was confirmed by PCR-RFLP. The main volatiles of fruit bodies of *T. boudieri* and *T. nivea* were 1-octen-3-ol and hexanal.

However, volatiles of the latter species further included branched-chain amino acid derivatives such as 2-methylbutanal and 3-methylbutanal, phenylalanine derivatives such as benzaldehyde and benzenacetaldehyde, and methionine derivatives such as methional and dimethyl disulfide. The least aromatic truffle, *P. lefebvrei*, contained low levels of 1-octen-3-ol as the main volatile.

Axenic mycelia cultures of *T. boudieri* displayed a simpler volatile profile compared to its fruit bodies. This work highlights differences in the volatile profiles of desert truffles and could hence be of interest for selecting and cultivating genotypes with the most likable aroma.

Keywords: *Helianthemum sessiliflorum*, *Picoa lefebvrei*, *Tirmania nivea*, *Terfezia boudieri*, desert truffles, volatiles.

Halimium and associated mycobionts: a new look at Mediterranean ectomycorrhizal communities

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Cistaceae are an important reservoir of ectomycorrhizal fungi in Mediterranean ecosystems, with significant ecological consequences. While this has been widely recognized for *Cistus*, the allied genus *Halimium* has been generally neglected from this point of view. The genus comprises 13 accepted species, all of them being evergreen or semi-deciduous small to large shrubs, with yellow or white flowers with three locules in each ovary. The centre of diversity is in the western part of the Mediterranean basin. As *Cistus*, *Halimium* species are mainly found in open vegetation types, like matorral shrublands and garrigues, but also occur at the verges of woods, in degraded forest areas, abandoned fields, pasturelands, and also on coastal sandy soils. So far, *Halimium* mycorrhizal biology has received little attention. To fill this gap, we recently described the morpho-anatomical and molecular features of the ectomycorrhizae formed by *Halimium halimifolium* with *Scleroderma meridionale* as collected from coastal dunes in Sardinia (Leonardi et al, Symbiosis 76: 199-208, 2018). Further field work on pure *Halimium* stands in Sardinia, coupled with a thorough analysis of literature records, has permitted to ascertain that over 50 species of ectomycorrhizal fungi are associated with *Halimium*. These belong to genera such as *Amanita*, *Cortinarius*, *Hebeloma*, *Inocybe*, *Russula*, *Lactarius*, *Leccinellum*, *Thelephora* and others, and include some rare and possibly new species. An analysis of the composition of the *Halimium*-bound fungal guild reveals that *Halimium* is apparently able to establish mycorrhizal symbiosis with fungal species considered to be *Cistus*-specific mycobionts, and that the ectomycorrhizal contingent of *Halimium* is shared with other host plants, including *Quercus* and *Pinus*.

Inventory of macrofungi associated with *Alnus glutinosa* (priority habitat 91E0) from Andros island, Greece

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Alluvial forests/woods dominated by trees of the genus *Alnus* (priority habitat 91E0, Annex I Directive 92/43/EEC) are widely distributed throughout Europe and occur along river banks and watercourses. Diversity of macrofungi associated with this habitat was only scarcely studied in Greece despite the fact that it represents a species-rich niche for such organisms. Several *Alnus glutinosa* (alder) stands exist in streams and rivulets of permanent flow in Andros island (Central Aegean) representing their southernmost distribution limit in the Balkan Peninsula as well as the most important forest-relicts of this type in the Aegean Archipelago. These stands and the adjacent littoral alluvial valleys have been inventoried for more than 20 years in respect to macrofungi; sampling was intensified during the past two years in the frame of an ongoing project (LIFE16 NAT/GR/000606). The material collected was subjected to detailed morphological and phylogenetic study. The outcome of the pertinent inventory comprises a total number of 96 species (Basidiomycota). The majority are saprotrophs, i.e. 48 wood decomposers (saproxylic) and 11 litter decomposers within the alder stands, while 24 were detected in the adjacent littoral zone at the estuaries of streams and rivulets. In addition, 13 ectomycorrhizal (ECM) species were also recorded, most of them being alder-specific symbionts. Among the species of this inventory, six constitute new national records, namely the ECMs *Inocybe calospora* and *Naucoria luteolofibrillosa*, the saprotrophs *Hyphodermella corrugata* and *Peniophora rufomarginata* as well as the sabulicolous *Gymnopilus arenophilus* and *Psathyrella almerensis*. Many more constitute the only confirmed records of their presence to date in Greece, including three taxa new to science (i.e. *Entoloma alnicola*, *Gymnopus amygdalisporus* and *G. dysosmus*). Furthermore, the majority of saproxylic and ECM species, which were found growing in association with alder trees in Andros, were not recorded to occur elsewhere in Greece.

Acknowledgments: This study was funded by the project titled “Conservation of priority species and habitats of Andros Island protected area integrating socioeconomic considerations, LIFE Andros Park” (European Commission – LIFE Nature, LIFE16 NAT/GR/000606).

SYMPOSIUM 3**History of early botanical exploration in the Mediterranean**

Organisers: *Werner Greuter & Vernon H. Heywood*

Programme

- 1) ***Bueno A. G. & Heywood V. H.***: Early botanical exploration of Spain.
- 2) ***Valdés Castrillón B.***: Early botanical exploration of the Maghreb countries.
- 3) ***Raimondo F. M., Camarda I. & Lucchese F.***: Early botanical exploration of Italy.
- 4) ***Lack H. W.***: Early botanical exploration of the southern Balkans, Anatolia, and Caucasia.
- 5) ***Al-Zein M.***: Early botanical exploration of the Levant and Egypt.
- 6) ***Leschner H.***: The big Bang - botanical investigation of the Middle East during 1900-1960.

Early botanical exploration of the Maghreb countries

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The Maghreb is considered as the N African territories covered by Mauritania, Morocco, Algeria, Tunisia and Libya, an area which almost coincides with what it was named "The Barbary" by Europeans from the XVI to the XIX centuries. The period included in this presentation covers from the first botanical visit to Algiers by John Tradescant the Elder at the beginning of the XVII century, to the end of the XVIII. It includes notices on Tradescant, Balaam, Spotswood, Shaw, Vahl, Desfontaines, Broussonet, Durand, Jackson and Schousboe.

History of early botanical exploration in Spain

Antonio Gonzalez Bueno (Madrid) & Vernon H. Heywood (Reading)

The early botanical exploration of Spain was undertaken by both Spanish botanists and foreign European botanists and plant collectors. It can be roughly divided into three phases: (1) the peri-Linnaean period dominated by Joseph Quer, author of the prelinnean *Flora Española*, completed, with Linnaean nomenclature, by Casimiro Gómez Ortega, at a time when botanical knowledge of the Iberian Peninsula was still little known, and together with the works of Ignacio Jordán de Asso and European botanists such as Carolus Clusius, Jacques Barrelier and Joseph Pitton de Tournefort formed the main base of knowledge of the flora (2) the short-lived renaissance of Spanish botany at the beginning of the 19th century when Antonio José Cavanilles became director of the Jardín Botánico de Madrid, and his disciples, Mariano La Gasca and José Demetrio Rodríguez worked on the Spanish flora, then followed by a period of decline. (3) The second half of the 19th century saw attempts by Mariano de la Paz Graells, Miguel Colmeiro and others to revitalize Spanish floristics, and the preparation of regional Floras by, for example, Francisco Loscos, Juan Joaquín Rodríguez-Femenías, José María Pérez-Lara, Antoni Cebrià Costa, as well as extensive floristic exploration by foreign botanists, notably Edmond Boissier, George Bentham, Heinrich Moritz Willkomm and Johan Lange and plant collectors such as Eugène Bourgeau, followed around the end of the century by a number of plant collectors including Rupert Huter, Pietro Porta, Giorgio Rigo, Elisée Reverchon, Gabriel Marie Joseph Hervier-Basson and Michel Gandoger. The location of the herbarium collections is highly diverse, largely due to the political unrest and economic difficulties in Spain and the involvement of so many plant collectors who made large numbers of sets of exsiccatae which were sold to individuals or Herbaria in Europe and elsewhere.

Early botanical exploration of Italy

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Throughout its geopolitical history, Italy's territory and in particular its flora have been carefully studied, starting especially in the early centuries of the second millennium CE. However, even before then, the medieval *horti conclusi* played a fundamental role in the birth of botanical gardens, which were the first centres that specialised in the study of flora using a scientific method. As is widely known, they were born in Italy, first in Tuscany and then in the Veneto. Padua was home to the first institution where botany was practiced, especially with regard to medicinal plants and plants of economic interest. But it was in Pisa where two years later the Italian and world history of academic gardens and their herbariums would begin, with Luca Ghini and Andrea Cesalpino. The study and scientific exploration of the territory would later intensify with the invention—it too attributed to Luca Ghini—of the *herbarium* as a collection of *exsiccata*. From then on, *herbaria* made it possible to document collections so that they could be preserved and then studied.

All over Italy, principalities and small kingdoms, throughout the Renaissance and until the birth of the Kingdom of Italy (1861), favoured the creation of a series of botanical institutions that would become centres for the promotion and pursuit of botanical exploration at a local level. At times this effort was very thorough, especially from the end of the eighteenth century and in the early nineteenth century. Suffice it to mention Allioni in Piedmont, Piazza and Moris in Sardinia, Targioni-Tozzetti and Parlatore in Tuscany, Bertoloni in Emilia-Romagna and the most popular botanists in southern Italy, especially in Sicily. These regions were at the forefront, together with Lazio and the lands that once belonged to the Papal States, which included Lazio, as well as Umbria, the Marches, part of Central Italy and the southernmost tip of the peninsula with the exception of the Kingdom of Naples. The history of this exploration is masterfully covered by Pignatti in the introduction to his *Flora d'Italia* (Pignatti, 1982) and proposed again—with an even deeper level of detail, region by region—by various authors (Pedrotti, 1988). At the beginning of the current century, it was covered once again in the volume edited by Scoppola & Blasi (2005): *Stato delle conoscenze floristiche sulla flora Vascolare d'Italia*, it too comprising the contributions of several authors. These are the key documents of our presentation which examines not only the contributions to the early explorations of Italian botanists but also the contributions of botanists from different European countries. Among these is important the journey made by the Englishman John Ray (1627-1705), the father of English Botany, in some European countries and in Italy, which is visited from 3 October 1663 to 16 March 1665, arriving in Sicily and also Malta.

SYMPOSIUM 4**Origin and diversification of Mediterranean crops****To the memory of Daniel Zohary**

Organiser: *Benito Valdés Castrillón*

Programme

- 1) **Valdés B.:** Introduction
- 2) **Weiss E.:** Daniel Zohary
- 3) **Plitman U. & Melamed Y.:** The plausible roles of women in the domestication of lentils.
- 4) **Weiss E.:** The domestication of wheat and barley - new evidences.
- 5) **Dimitrova D. & Ivanova T.:** From crop fields to home gardens - transitions and identities.
- 6) **Cermeño P.:** New Mediterranean crops - aromatic plants.

Introduction

Benito Valdés Castrillón

At the beginning of the Neolithic several annual plants were introduced into cultivation in E Mediterranean, a process investigated by many experts amongst which Daniel Zohary was a leading figure. From there, Mediterranean agriculture spread along Europe and the Mediterranean at a speed of c. 1 km per year. Early crops diversified to produce regional and local land-races, many of which have, unfortunately, been lost in modern times. Of course, new crops were introduced into cultivation later, including fruit trees, which cultivation widely generalized from SE Europe and W Asia elsewhere. But the search for new crops is also a contemporary process and affects plants such as borage, golden thistle, bladder campion, wild green asparagus, etc.

The content of this Symposium will in a way summarize all this process, with a lecture by *U. Plitmann* and *Yoel Melamed* on “The plausible roles of women in the domestication of lentils”, another by *E. Weiss* on “The domestication of wheat and barley – new evidence”, another by *D. Dimitrova* and *T. Ivanova* on “From crop fields to home gardens – transitions and identities” and a fine lecture by *P. Cermeño* “New Mediterranean crops: aromatic plants”.

The plausible roles of women in the domestication of lentils

Uzi Plitmann & Yoel Melamed

Following the hypothesis that women had been the principal gatherers in the Neolithic and likewise experimented in growing plants in small plots, we shall demonstrate that (1) such women gatherers could collect sufficient fruits of *Lens orientalis* (the ancestor of *L. culinaris*) sufficing for both processing of food and preserving seeds for further use; (2) owing to the extremely thin seed coat in these lentils, their germination rate is rather high, and likewise, food-processing is easier compared with other beans; and (3) lentils, like several annual legumes, do not need mutants, neither for indehiscence or for their threshing. Altogether, we shall discuss that this combination of characters and/or pre-adaptations, plus the merit of preferable tasty food, had been selected (or adopted) by the first female gatherers and female farmers, and is still retaining lentils as one of the most favorable beans. Altogether, those Neolithic women might be considered as the first plant-breeders.

The domestication of wheat and barley – new evidence

Ehud Weiss

The domestication of wheat and barley, together with the rest of the “Founder Crops” are considered a constitutive event in the emergence of agriculture in the Fertile Crescent. In the case of these two cereals, this process involved the transformation from a wild form – *Triticum dicoccoides* and *Hordeum spontaneum* – to a non-shattering form of domesticated type – *T. dicoccum* and *H. distichum*. Due to its impact of human history and potential contribution for future breeding much research was devoted to the understanding of the process of their domestication evolution.

In this paper I’d like to refer mainly to two research avenues which contributed much to our knowledge in recent years: archaeobotany and ancient DNA.

Archaeobotanical assemblages are prime source for data regarding plant species used by early human societies – hunter-gatherers and farmers. We can trace their use of wild plants, as well as their transition from collecting and managing wild plants to first appearance of domestic forms in human dwellings. The emerging field of archaeogenetic, which progressed immensely in the last decade, give critical insights into the “when” and “where” of plant domestication.

From crop fields to home gardens - transitions and identities

Dessislava Dimitrova & Teodora Ivanova

Department of Plant and Fungal Diversity and Resources, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria.

High depopulation rate frames the processes currently developing in Bulgarian rural areas. The migration and the population ageing result in a decline and/or abandonment of traditional agricultural practices and local plant genetic resources. We have explored and documented Bulgarian rural home gardens and have analyzed how particular plant species and varieties affect social relations and cultural patterns and, on the other hand, how cultural orientations, local knowledge and experience, social relations, cultural practices, and trans- and interactions do affect plant diversity, how they lead to preservation, modification or loss of genetic resources. We also have analyzed possible opportunities and obstacles of small-scale farmers and food producers that depend on these gardens to sustain their production and farming practices amidst global climatic and socio-cultural transformations. The ethnobotanical and ethnographical interdisciplinary field work was focused on village and small urban settlements situated in four provinces in South and North-West Bulgaria. Semi-structured interviews were performed in 32 settlements together with plant composition surveys of home gardens and historical/archive surveys. Current data provide evidence that collection of wild plants, and cultivation of specific local crops and landraces are still maintained together with the related knowledge (traditional and modern) by interested individuals but are not clearly recognized as a community value. Changes in climatic, biological, economic and socio-political circumstances were recurring themes in the interviews, showing complex fluctuations that shaped present personal agro/horticultural choices. Preservation of local drought-adapted crops (*Vigna unguiculata* (L.) Walp., *Lathyrus sativus* L., *Vicia faba* L., *Cicer arietinum* L., etc.), knowledge on collection of wild greens as hunger foods and general willingness to participate in nature protection were found as positive keystones for grassroots activities that are urgently needed, especially among younger people and agriculture and food processing entrepreneurs. The latter were seen as unaddressed target group for development of sustainable (re)innovative products and practices based on preserved local bio(cultural) resources. Development of local identities around plant-related cultural events is discussed as a potential tool for preservation of valuable genetic resources on the ground.

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New Mediterranean crops - aromatic plants

Pedro Cermeño Sacristán

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The European consumer is increasingly demanding natural products obtained from plants. Sometimes, one part from one or more plants is demanded, especially specific chemical compounds or extracts. Current extraction methods allow us to obtain individual chemical compounds or extracts which are valuable due to their properties. In this sense, the grower may work individually or in association with other growers in order to manage these modern extraction systems.

Andalusia, located in the south of Spain, has a Mediterranean climate characterised by a long summer period with a severe water deficit in which the evapotranspiration is higher than the pluviometry. This fact involves a differential growing rate among botanical species: some of them show a growth inhibition and consequently a biomass reduction. Apart from the above mentioned, it is necessary to highlight the wide variety of microclimates in Andalusia mainly due to the presence of a huge range of coastline (875 kilometres) and its varying orography with mountains which can reach 3,500 metres of altitude. Considering the pluviometry, the variance between areas can be mentioned, for instance, the arid conditions of the desert of Tabernas in Almería or areas with a high pluviometry of 2,000 mm per year, such as the Grazalema mountain range. As far as temperature is concerned, it is possible to differentiate between areas with subtropical climate, such as the coast of Granada, and areas with high mountain temperatures which reach an average annual temperature of 4 °C being sometimes completely snowy.

Regarding the soil typology and morphogenesis in these regions, wide differences among soils can be found, considering different factors such as the number of layers in the soil, soil pH value, textures, structures as well as the different soil evolution degrees.

These edaphoclimatic variations have given rise to different biogeographic regions with a high level of flora diversity ranging around 4,000 botanical species, from which many of the them belong to the aromatic and medicinal plants (PAM) sector. The *Lamiaceae* family has a huge number of these PAM species and consequently play an essential role in this sector. Some of these species show a certain degree of water stress tolerance allowing their better adaptation to the environment.

Since there is an increasing demand for these plant species, we consider it is necessary to implement the growth of these species in order to supply the consumer with the chemical compounds or extracts obtained from them already mentioned but without decimating natural populations. Moreover, it is necessary to consider that the high diversity of environmental conditions leads to variations in plants chemical composition, which can be solved through an accurate homogenization of the final product. The implementation of these growing systems requires an in-depth analysis

based on the growing trend of each species under different culture techniques as well as their acclimation to different environmental conditions.

In order to optimize this process, it is necessary to determine the interrelationships among the three main factors assessed: botanical species (autochthonous aromatic and medicinal plants), growing systems (culture techniques) and environmental conditions (edaphoclimatic conditions of the production area). After the determination of the best interrelationship among the factors studied, it will be submitted to an economic analysis, variable in time according to market prices. In addition, progress in the biodiversity and sustainability objectives of agricultural productions is required.

At present the current lines of our work are being developed in order to implement the growing production system of the species of the *genera Rosmarinus, Salvia, Thymus, Santolina, Lavandula, Origanum, Melissa* and *Matricaria*.

Plant material selection from wild populations.

Obtaining plant material and the methodology required for its multiplication on an industrial scale.

Physiological changes studies in each phenological stage in order to be modified using different culture techniques in the corresponding phase of the growing system.

The implementation of the mechanization on the production system.

Determination of the most adequate chemical extraction process according to the different species assessed as well as the chemical compounds and the yield to be obtained.

Studies of cultivation costs and extraction of products and chemical compounds.

Results transference to the producers.

SYMPOSIUM 5

Plant diversity and evolution in polyploid, dysploid, and hybrid complexes of the Mediterranean flora

Organisers: Lorenzo Peruzzi & Sonja Siljak-Yakovlev

Programme

- 1) Introduction
- 2) ***Nemati Z., Harpke D. & Blattner F. R.***: Greece, Home of Saffron – Progenitor, Areas, and Consequences of Triploidy.
- 3) ***Astuti G., Liu L., Coppi A. & Peruzzi L.***: Different chromosome numbers, but slight morphological differentiation and genetic admixture among populations of *Pulmonaria hirta* complex.
- 4) ***Farhat P., Bou Dagher Kharrat M., Adams R., Thierry R. & Siljak-Yakovlev S.***: Polyploidy and hybridization as the main evolutionary driving forces of *Juniperus sabina* in its Mediterranean range.
- 5) ***Peterson A. & Harpke D.***: The Mediterranean basin as secondary speciation centre of *Gagea*.
- 6) ***Nardi F. D., Alonso-Marcos H., Hülber K., Tribsch A. & Dobeš Ch.***: How ploidy level and mating system influence the ecogeography of amphi-apomictic *Potentilla puberula* (*Rosaceae*).

Greece, Home of Saffron – Progenitor, areas and consequences of triploidy

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Crocus sativus, the saffron crocus, is the source of the world's most expensive spice, which is made from the dried stigmas of the plant. The species is a male-sterile triploid lineage that ever since its origin has been propagated vegetatively. Its mode of evolution and area of origin are matters of long-lasting debates.

To identify saffron's wild progenitor and the area where it originated, we inferred first the phylogeny of all *Crocus* series *Crocus* species and, thus, identified the Greek endemic *Crocus cartwrightianus* as closest relative of the crop. By analyzing polymorphisms in the chloroplast (obtained through genome skimming) and nuclear genomes (obtained through genotyping-by-sequencing; GBS) in *C. cartwrightianus* and *C. sativus* we were able to identify the wild *C. cartwrightianus* populations in the vicinity of Athens as most similar to saffron. We could place 99.3% of saffron GBS alleles in *C. cartwrightianus*, indicating that *C. sativus* is an autotriploid. Heterozygosity rates are similar in both species, which points towards an origin of the triploid through fertilization of an unreduced (2n) egg cell by a haploid (1n) pollen cell. RNA-seq was used to analyze differences between the crop and its wild progenitor in transcription activity of the genes involved in the apocarotenoid biosynthesis pathway of the styles. We found differential transcription levels in these genes between both species but could also identify *C. cartwrightianus* individuals exhibiting for some of the genes expression patterns, which are quite close to what we see in *C. sativus*.

In the populations of diploid *C. cartwrightianus* occur all the distinctive traits of *C. sativus* like bunchy growing habit, long and red stigmas, and also the typical aroma of saffron. However, we never found these characters combined within single plants in the same way as in saffron. Due to the high genetic diversity in *C. cartwrightianus* and the species being an obligate outbreeder, its allelic composition is constantly jumbled by genetic recombination. This makes it very unlikely to find in today's individuals regularly allele combinations characteristic for triploid *C. sativus*. In contrast, triploid sterility and the vegetative propagation mode of the saffron crocus prevented segregation of the favorable traits of saffron after its origin in Attica, resulting in worldwide cultivation of a unique clonal lineage.

Different chromosome numbers, but slight morphological differentiation and genetic admixture among populations of *Pulmonaria hirta* complex

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In the genus *Pulmonaria*, puzzling systematic relationships are evident within closely related and morphologically similar taxa that may naturally hybridize. This is the case of *P. hirta* L. complex, which includes also *P. vallarsae* A.Kern. subsp. *vallarsae* and *P. vallarsae* subsp. *apennina* (Cristof. & Puppi) L.Cecchi & Selvi; the latter taxon was treated in other classifications either as a subspecies of *P. hirta* or as a distinct species. In Italy, *P. hirta* is confined to the northern-central Apennines, overlapping with *P. vallarsae* subsp. *apennina*, which spreads all along Apennines. *P. vallarsae* subsp. *vallarsae* is instead limited to some areas of northeastern Italy, being geographically isolated from the other two taxa. Shape, maculation and hairs of summer basal leaves are considered as diagnostic characters for these taxa. We provided here quantitative data to assess the diagnostic value of these characters in both spring and summer, and we reconstructed the relationships among taxa using molecular phylogenetics, population genetics, and karyology. Hence, we collected and cultivated around 200 plants from 11 populations. We measured corolla and calyx, and categorized plants as longistylous or brevistylous. Leaf shape was calculated using elliptic Fourier descriptors subjected to PCA, and both a Discriminant Analysis and a MANOVA were carried out on the effective components. On leaves, we also measured spotted and total areas, as well as length and width, and we counted hairs assigning them to normal, glandular, and microglandular categories. For karyological analysis, we applied Feulgen protocol to root-tips of all plants. Phylogenetic analysis was performed on five individuals for each population using cpDNA and nrDNA markers, whereas AFLP analysis was performed on all plants. Generally, *P. vallarsae* s.l. showed spring leaves less slender, with base and petiole more distinct than in *P. hirta*, which had instead a more lanceolate shape with a winged base running into the petiole; no difference was found between the two subspecies of *P. vallarsae*. Conversely, the other features evaluated were poorly able - or unable - to discriminate the three taxa. This morphological overlapping reflects the massive genotype admixture found in cpDNA, nrDNA and AFLP analyses. Chromosome numbers were instead seemingly constant within populations, and the typical number previously reported for each taxon was confirmed, with the exception of one population attributed to *P. vallarsae* subsp. *apennina* that showed $2n = 26$, a value intermediate between those of *P. vallarsae* s.l. ($2n = 22$) and *P. hirta* ($2n = 28$).

Polyploidy and hybridization as the main evolutionary driving forces of *Juniperus sabina* in its Mediterranean range

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Polyploidy and hybridization are considered to be as major forces for plant evolution. While polyploidy is estimated to be very rare in conifer, recent investigations have revealed an exceptional rate of polyploidy in *Juniperus* genus (*Cupressaceae*). Interestingly, cases of intraspecific variation in ploidy level were detected in this genus notably in *Juniperus sabina* where earlier just one population has been found to be tetraploid in the Dinaric Alps. Two varieties have been described for this taxon: *J. sabina* var. *sabina* and *J. sabina* var. *balkanensis*. The latter has been postulated to have arisen from an ancient hybridization between *J. thurifera* and *J. sabina* var. *sabina*. In the French Alps, where *J. sabina* var. *sabina* and *J. thurifera* occur in sympatry, individuals with intermediate morphologies and suspected to be potential hybrids between these two taxa were observed. The aim of this study was to prospect polyploidy and hybridization in *J. sabina* throughout its large geographical distribution with special focus on the Mediterranean region. Genome size and the ploidy level of 29 populations of *Juniperus sabina* covering almost its entire geographical distribution were estimated by flow cytometry. Our results showed that *J. sabina* var. *sabina* sampled populations were shown to be diploid, whereas *J. sabina* var. *balkanensis* populations were all tetraploid. Moreover, the individuals with atypical morphologies were found to be triploids and more probably a first-generation hybrids between the diploid *J. sabina* var. *sabina* and the tetraploid *J. thurifera*. This study highlights the importance of hybridization and polyploidy in the evolution of *Juniperus sabina*. In this sense, *Juniperus* represents an interesting model for investigating the importance of gene flow between species in sympatry and their consequences for diversification, evolution and adaptation in this coniferous genus.

The Mediterranean basin as secondary speciation centre of *Gagea*

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The Mediterranean region presumably represents a second centre of diversity after southwestern Asia for the monocot genus *Gagea* (*Liliaceae*). Nine out of 14 sections of this species-rich (ca. 300 species) genus occur in the Mediterranean. With about 88 % of its species one most of the species-rich sections of the genus, *G. sect. Didymobulbos* (> 43 species), has its highest diversity there. Molecular and karyological studies showed that this section is characterized by complex hybridization pattern and a high number of polyploids. Although hybridization and polyploidization are also important drivers for speciation in other sections of the genus, they do not possess such a high diversity in the Mediterranean. Thus, the high diversity of *G. sect. Didymobulbos* in the Mediterranean can probably not be explained by hybridization and polyploidization alone. Therefore, we estimated the ancestral distribution ranges and divergence times of the major lineages (sections) of the genus and reconstructed colonization events. Our analyses were based on three molecular markers (ITS region: ITS1 + 5.8S + ITS2, chloroplast marker: *trnL-trnF* IGS and *psbA-trnH* IGS) and included 517 accessions representing about 40 % of the species and all sections of the genus of nearly its entire distribution area. The Mediterranean region was represented by 182 accessions corresponding to 46 species and eight sections of which most accessions (139, representing 32 species) belonged to *G. sect. Didymobulbos*. The diversification of *Gagea* most likely started during the Early Miocene/Middle Miocene in southwestern Asia, part of the Irano-Turanian (IT) floristic region. Radiation and migration out of southwestern Asia were mainly driven by Miocene climate changes creating drier and open habitats. Thus, our study supports the importance of the IT floristic region as a source of taxa for neighbouring areas including the Mediterranean. The Mediterranean region was presumably repeatedly colonized in the Miocene and later during the Messinian Salinity Crisis by *G. sect. Didymobulbos*. Starting from Euro-Siberia the Mediterranean was colonized by representatives of *G. sect. Gagea* during the Pliocene. Except for Miocene colonization of the Mediterranean by *G. sect. Didymobulbos*, most other lineages arrived there more recently starting from the Pliocene. According to our data, most of the currently existing species of all sections originated during the last 3 Ma which is connected with the onset of the Mediterranean climate. The arrival in the Mediterranean was followed by extensive in situ speciation, which was presumably driven by hybridization and polyploidization in *G. sections Didymobulbos* and *Gagea*. The high species diversity of *G. sect. Didymobulbos* probably resulted from its much earlier colonization of the Mediterranean in comparison to the colonization by other sections.

How ploidy level and mating system influence the ecogeography of amphiapomictic *Potentilla puberula* Krašan (*Rosaceae*)

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Polyploidy is often associated with a shift to asexuality, which – in plants – is usually represented by apomixis (i.e., asexual reproduction via seeds). Both polyploidy and apomixis can directly or indirectly determine changes in the ecological and geographical distribution of a species. However, separating the effects of these two factors can be challenging, as they usually co-occur. In order to understand the role of polyploidy and apomixis on the ecogeography of taxa, we chose *Potentilla puberula* Krašan (*Rosaceae*) as a model, a species with reproductive differentiation between sexual tetraploids and apomictic penta- to octoploids. We sampled 238 populations in a transect of the Eastern Alps, where the five cytotypes are sympatric, and we conducted genetic, ecologic, morphologic and reproductive studies to identify the main factor – ploidy level or reproductive mode – differentiating the cytotypes. Sexuals and apomicts resulted slightly differentiated both genetically and ecologically – with apomicts preferring more humid human-made habitats than sexuals, but these differences were not mirrored among apomictic cytotypes, showing that the mating system has a stronger effect than ploidy level on the biology of this species. Competition and reproductive interference can result in a mutual exclusion of sexuals and apomicts which could eventually diverge.

Symposium 6

Mediterranean Algal Diversity: Past, Present and Future

Organizers: Anna Maria Mannino & Sotiris Orfanidis

Programme

- 1) ***Boudouresque C.-F., Blanfuné A., Perret-Boudouresque M., Ruitton S. & Thibaut Th.***: Extinction of Mediterranean macrophyte taxa: local extinctions and functional extinctions matter.
- 2) ***Rodríguez-Prieto C.***: Past, present and future of Gigartinales and Cryptonemiales *sensu lato*.
- 3) ***Rindi F.***: Diversity of Mediterranean coralline algae: recent advancements in the knowledge of a highly threatened group of seaweeds.
- 4) ***Panayotidis P. & Tsiamis K.***: Diversity and ecology of macroalgae in Eastern Mediterranean.
- 5) ***Kooistra W. H. C. F., Gaonkar C. C., Montresor M., Piredda R., Sarno D. & Zingone A.***: Species diversity and seasonality in the planktonic diatom *Chaetoceros* assessed by means of metabarcoding.

Extinction of Mediterranean macrophyte taxa: local extinctions and functional extinctions matter

Charles-François Boudouresque, Aurélie Blanfuné, Michèle Perret-Boudouresque, Sandrine Ruitton & Thierry Thibaut

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A very few species of macrophytes are regarded as extinct worldwide, the best known being *Vanvoorstia bennetiana*, a red alga endemic to Australia. Before 1994, the IUCN category of 'extinct species' included species that have not been definitely sighted in the wild during the past 50 years. The definition has been subsequently revised: 'A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range, have failed to record an individual'. As concerns the Mediterranean *Phaeophyceae*, which include ~300 taxa, 20 taxa have never been reported for at least 50 years, some of them for 100 years. Have they become extinct? Possible biases will be discussed, e.g. the small size of these taxa. In addition to putative complete extinctions, local extinctions are to be considered. They often concern large canopy-forming taxa. Along the French Catalonia coast, only 5 out of 16 taxa of Fucales (*Cystoseira* and *Sargassum*), reported at the end of the 19th century, still occur. Local extinctions also concern the Venice Lagoon, the Gargano promontory (Italy), Provence and French Riviera, the Bulgarian coast (Black Sea), etc. However, from an ecological point of view, functional extinctions are more worrying. A species may become functionally extinct when only a small number of individuals survive, which are unable to reproduce due to poor health, age, sparse distribution over an extensive range, and/or which can no longer play their former role within the ecosystem. The functional extinction of canopy-forming species, such as *Cystoseira* and *Sargassum* taxa, results in a disruption of the functioning of the ecosystem, of which they constituted key species or ecosystem engineers, with the loss of ecosystem services: habitat for epibiontic primary producers, spawning area and nursery for fish and crustaceans, export of biomass towards adjacent ecosystems, etc. Possible causes of functional extinctions will be discussed: overfishing of predatory fish resulting in overgrazing, uprooting by nets, damage by trawling, invasive species and coastal development. The role of global warming, although for the moment largely surpassed by other human pressures, will also be discussed.

Past, present and future of Gigartinales and Cryptonemiales *sensu lato*

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The foundations of the current ordinal classification of Rhodobionta were primarily based on the morphology of female reproductive structures and post-fertilization stages. They were established in the posthumous treatise of Kylin (1956) which incorporated most relevant information at the time, and especially, a revision of the preceding noteworthy works of Schmitz (1889, 1896) and Schmitz and Hauptfleisch (1896, 1897). In Kylin (1956), 6 orders of *Florideophyceae* were recognized, among which the Gigartinales (1892) and Cryptonemiales (1892). Since the mid-twentieth century until the 1990's, the morphological, structural, biochemical and ultrastructural advances allowed to split those initial 6 orders into 13, and, in particular, the Gigartinales and Cryptonemiales resulted in 4 orders. Thus, some Gigartinales were transferred to the Ahnfeltiales (1989), and the Cryptonemiales disappeared as such, so that some of them became part of the Hildenbrandiales (1982) and the Corallinales (1986), and the rest were transferred to the Gigartinales. In the 1990's, molecular tools began to be used to study the *Florideophyceae*. As a consequence, the Ahnfeltiales were divided into Ahnfeltiales and Pihelliales (2013), and the Corallinales into Corallinales, Rhodogorgonales (1995), Sporolithales (2009) and Hapalidiales (2015). Finally, only some Gigartinales remained as such, while the rest were transferred into 8 orders, some resurrected, as the Nemastomatales (1925), and the rest as new orders: Gracilariales (1989), Plocamiales (1994), Halymeniales (1996), Acrosymphytales (2007), Sebdeniales (2007), Peyssonneliales (2009) and Catenellopsidales (2016). The genera that have remained within the Gigartinales belong to families that are still non well known and there is a pretty good chance that some of these (e.g. *Calosiphonaceae*, *Caulacanthaceae*, *Dumontiaceae*, and *Sphaerococcaceae*) will be raised to the order level in a near future. Molecular techniques have strongly and firmly contributed to the changes in the ordinal level within the Gigartinales (including Cryptonemiales), but in fact, to build up an increasingly robust phylogeny the best is to merge molecular and reproductive data. In this communication, taxonomic and evolutionary contributions to taxonomy of red algae are discussed, stressing on the reproductive features as key elements to explain the taxonomic system.

Diversity of Mediterranean coralline algae: recent advancements in the knowledge of a highly threatened group of seaweeds

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Coralline algae are globally distributed ecosystem engineers that in the Mediterranean Sea act as key builders of habitats (such as coralligenous concretions, rims of *Lithophyllum byssoides*, rims of articulated corallines and rhodolith beds) extending on large stretches of coastal rocky bottoms. Due to the semi-enclosed nature and oceanographic features of the basin, Mediterranean corallines are considered particularly vulnerable to future climatic changes. For this reason they have attracted much interest in the last decades, with many investigations focusing primarily on responses to ocean acidification and responses of coralline-dominated communities to anthropogenic stressors. Several aspects of their diversity, however, have also received great attention. Taxonomy and systematics of Mediterranean corallines have been studied for more than two centuries but, until recently, the classification of these seaweeds was based entirely on traditional morphoanatomical grounds. The introduction of molecular data has substantially reshaped our view of their taxonomic diversity. The first DNA sequence data for Mediterranean corallines were published in 2009 and unraveled the presence of *Corallina caespitosa*, an articulated species now known to be widespread and formerly confused with *Ellisolandia elongata*. Overall, *Lithophyllum* is the genus that has been most studied by an integrative approach combining morphological and molecular data. Such studies revealed in the Mediterranean a striking case of cryptic diversity, a phenomenon that is now known to be pervasive in coralline algae: the *Lithophyllum stictiforme* complex. Two recent studies showed that this alga, previously known as a single species, represents a complex of at least 11 different cryptic species (of which not less than 8 present on the French coasts). *Lithophyllum incrustans*, the type species of *Lithophyllum*, has been shown to be primarily an infralittoral species, despite of frequent reports in mesolittoral habitats. Mediterranean populations of *Lithophyllum byssoides*, known as builders biogenic rims, are likely to represent a separate species from Atlantic populations. Molecular data also allowed the phylogenetic assessment of *Pneophyllum cetinanensis*, the first coralline alga discovered in freshwater. Additional molecular data led to new records for the Mediterranean and to an improved biogeographic circumscription for several species, especially of the genus *Mesophyllum* and *Phymatolithon*. The current number of 59 coralline species recorded for the Mediterranean should not be considered a definitive estimate and new species can be expected to be discovered in the near future (particularly in the genera *Lithophyllum* and *Neogoniolithon*).

Diversity and ecology of macroalgae in Eastern Mediterranean

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The diversity of the marine macroalgal flora of the Eastern Mediterranean Sea seems to host fewer species comparing with the Western basin. However, this difference should reflect the limited studies that have been hitherto conducted in the Eastern basin, with several coastal regions still remaining poorly surveyed, particularly in the sublittoral and circalittoral zones. In addition, many past species records in the Eastern basin have not been updated in a modern context or are pending confirmation due to their lack of documentation, since many records have been given in the form of species names without deposition of material in public herbaria. Many other species are treated as *excludenda* or *inquirenda*, which underlies the taxonomic difficulties, particularly concerning certain genera (e.g. *Polysiphonia*, *Cladophora*, *Lithophyllum*). Recent research projects, such as the “Brown algal biodiversity and ecology in the Eastern Mediterranean Sea” revealed new macroalgal findings for the Eastern Mediterranean Sea, such as *Chondria boryana*, *Sebdenia dichotoma* and *Padina di-tristromatica*. Moreover, new alien introductions have further increased the known diversity of macroalgae in the Eastern basin, such as *Dictyota cyanoloma*, *Neosiphonia harveyi* and *Caulerpa taxifolia* var. *distichophylla*. In addition, updated and annotated treatments of the past macroalgal findings in the Eastern Mediterranean countries, such as Greece and Cyprus, contributed to the reduction of the taxonomic confusion of the recorded macroalgal diversity. When it comes to the marine vegetation of the Eastern basin, massive seasonal blooms of nitrophilous green algae have been substantially reduced in many coastal areas, indicating a lower organic pollution level in bays once heavily eutrophicated. However, at the same time, there is a severe decline of the large brown algae canopy forests (*Cystoseira* and *Sargassum* communities), once thriving in the Eastern basin. The reason for this seems to be sea-urchin overpopulations that have created “barrens” in previously rich in macroalgae areas. In addition, alien herbivorous fish, such as *Siganus luridus*, are now thriving in the Eastern basin and decimate the macroalgal marine vegetation. We argue that this degradation is a rapidly progressing phenomenon, strongly related to overfishing and the consequent destruction of coastal food web structures, coupled with climate change pressures. In conclusion, there are still major gaps in the documentation of the marine macroalgal diversity of the Eastern Mediterranean Sea, while its marine vegetation faces degradation threats under varying pressing factors.

Species diversity and seasonality in the marine planktonic diatom *Chaetoceros* assessed by means of metabarcoding

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Environmental DNA metabarcoding is proving to be a powerful approach to assess planktonic diatom diversity next to -or instead of- cell counting by means of light microscopy (LM). In the present study we examine the performance of 18S rDNA V4-metabarcoding in revealing the diversity in the diatom family *Chaetocerotaceae* at the LTER-MC station in the Gulf of Naples. To this aim, we analysed a metabarcode dataset collected on 48 sampling dates over 3 years, and assigned them to distinct species based on a phylogenetic analysis including named reference sequences from a database of taxonomically validated strains. The LTER-MC was chosen because its plankton diversity has been monitored regularly since 1984. So, contextual information is available. Chaetocerotaceans resolved into a series of solitary haplotypes, each containing a modest number of metabarcodes, as well as a series of terminal polytomies composed of multiple haplotypes, each with usually one haplotype containing the vast majority of the metabarcodes. Both the solitary haplotypes as well as the dominant haplotypes with their retinues of peripheral haplotypes were considered molecular operational taxonomic units (MOTUs). A total of 53 out of the 73 MOTUs included a reference, usually matching its solitary or dominant haplotype, and could thus be identified. Distribution of the metabarcodes over the sampling dates revealed clear seasonal patterning. The various species in cryptic species complexes generally were found in different or offset periods. Comparison of the phylogenetic results with those on commonly applied clustering revealed the following: the number of MOTUs depends on the similarity cut-off threshold. Too close to 100% and numerous fringe haplotypes within phylogenetically delineated MOTUs drop over the threshold into their own MOTUs, generating "Lots of Rare Biodiversity." Set it lower and phylogenetically closely related MOTUs collapse into single MOTUs. Unfortunately, there is no magic cut-off for clustering haplotypes into MOTUs at which results are anywhere near OK. A comparison with contextual LM data showed that the species commonly recognized in the LM data were also present in the contemporary metabarcode data.

SYMPOSIUM 7

New Methods in Plant Systematics

Organisers: Christoph Oberprieler & Karol Marhold

Sponsored by Plant Systematics and Evolution – Springer Link

Programme

- 1) **Frajman B., Závěská E. & Schönswetter P.**: Integrating next generation sequencing, ecological niche modelling and classical phylogenetic and morphometric methods disentangles relationships within Eurasian *Euphorbia seguieriana* alliance (*Euphorbiaceae*).
- 2) **Tomasello S., Karbstein K., Hodač L., Pätzold C. & Hörandl E.**: Resolving phylogenetic relationships in *Ranunculus auricomus* using target enrichment.
- 3) **Liveri E., Crowl A. A., Mavrodiev E., Yildirim H., Kamari G., Phitos D. & Cellinese N.**: Another piece of the puzzle, another brick in the wall: the inevitable fate of *Campanula* L. section *Quinqueloculares* Phitos.
- 4) **Aydin Z. U., Dönmez A. A. & Koch M. A.**: Efficiency of plant DNA barcoding for taxonomy: A case study in *Dianthus* L. (*Caryophyllaceae*).
- 5) **Wagner F., Ott T., Schall M., Lautenschlager U., Vogt R. & Oberprieler C.**: Taming the Red Bastards: Hybridisation and species delimitation in the *Rhodanthemum arundanum*-group (*Compositae, Anthemideae*).
- 6) **D'Antraccoli M., Roma-Marzio F., Carta A. & Peruzzi L.**: Patterns of floristic richness in the Euro-Mediterranean area.
- 7) **Karbstein K., Tomasello S., Hodac L., Daubert M. & Hörandl E.**: New approaches in TaxonOmics: RADseq supported by geometric morphometrics uncovers relationships of sexual species within the *Ranunculus auricomus* complex.

Integrating next generation sequencing, ecological niche modelling and classical phylogenetic and morphometric methods disentangles relationships within Eurasian *Euphorbia seguieriana* alliance (*Euphorbiaceae*)

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Next generation sequencing has revolutionised biology. Restriction-associated DNA sequencing (RADseq) has primarily been used to study infraspecific relationships but has also been applied in multi-species phylogenomic analyses. In this study, we used a combination of phylogenomic (with RADseq data) and phylogenetic (with sequences of the nuclear internal transcribed spacer, ITS) methods to explore relationships within the taxonomically intricate *Euphorbia seguieriana* s. l., one of the most widespread *Euphorbia* taxa inhabiting zonal and extrazonal steppes from Iberia to Central Asia. In the inferred phylogenies the southeastern Balkan and Anatolian populations were clearly separated, supporting the distinction of *E. niciciana* from *E. seguieriana* at the species level. Within *E. seguieriana*, the populations from the Caucasus, Iran, and easternmost Anatolia were sister to all other populations based on RADseq, making necessary the description of a new, morphologically divergent subspecies, *E. seguieriana* subsp. *armeniaca*. Niche analyses indicated that differences in the climatic niche between *E. niciciana* and *E. seguieriana* are relatively small compared with the climatic differences between the regions over which they are distributed. Contrary to previous beliefs, *E. niciciana* and *E. seguieriana* are allopatric and have likely diverged during the Pleistocene in two different glacial refugia as suggested by distribution modelling. *Euphorbia niciciana* nowadays has a Submediterranean distribution, occupying habitats that are slightly warmer, moister, and less seasonal in temperature but more seasonal in precipitation than *E. seguieriana*, a characteristic species of continental steppes. Using flow cytometry, we demonstrate that the relative genome sizes of *E. niciciana* and *E. seguieriana* differ significantly. Additionally, multivariate morphometric analyses of 56 morphological characters indicated clear morphological divergence of the two species. Importantly, we also provide a revised taxonomic treatment including formal nomenclatural changes, an identification key and species descriptions. Our study demonstrates that an integrative approach, combining modern phylogenomic methods with traditional phylogenetic, cytogenetic, environmental and morphological analyses can result in satisfactorily resolved relationships in intricate groups of closely related species. Finally, phylogenetic inference using ITS sequences is still a useful tool for resolving relationships among the taxa at the species level, but the phylogenomic approach based on RADseq data certainly provides better resolution both among and within species.

Resolving phylogenetic relationships in the *Ranunculus auricomus* polyploid complex using Target Enrichment

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Resolving relationships of young polyploid complexes is still a challenge for molecular systematics, and genomic markers are usually needed to understand reticulate evolution and genome duplications. Target Enrichment refers to the sequencing of a subset of genomic regions using high-throughput sequencing methods. It permits the use of a large number of loci out of the nuclear genome (hundreds or thousands) at a relatively low cost. Target genomic regions can be selected beforehand by the researcher, according to the required characteristics (e.g., variability, copy number, etc...). When applied to systematic biology, Target Enrichment has demonstrated its potential for resolving phylogenies in intricate groups, in which traditional markers usually fail. The advantage of working with known and supposedly single-copy regions makes it very suitable for reconstructing reticulate evolutionary histories in polyploid complexes. It has demonstrated to be relatively insensitive to quality of DNA template, being already applied successfully on relatively old herbarium material.

The *Ranunculus auricomus* complex comprises a handful of diploid to tetraploid sexual species and numerous polyploid agamospecies (833 names in Euro+Med database). It is, therefore, a suitable group to investigate diversification processes (both in space and time) and species delimitation in facultative apomictic polyploid complexes. Traditional markers have failed in properly reconstructing phylogenetic relationships in the *R. auricomus* complex. Therefore, we applied Target Enrichment to produce sequence information for roughly 700 hundred single-copy nuclear genes selected from an RNA sequencing dataset. Using coalescent-based species tree/network reconstruction methods, we aimed at: i) resolving the gross phylogenetic relationships among sexual representatives of the *Ranunculus auricomus* complex; ii) reconstruct biogeographical patterns of sexual species and clarify their classification; iii) investigating patterns of evolution among apomictic polyploids (i.e., monophyly vs. polyphyly of “morphogroups”, hybrid origin and parentage of derivative agamic lineages).

Another piece of the puzzle, another brick in the wall: the inevitable fate of *Campanula* L. section *Quinqueloculares* (Boiss.) Phitos

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The *Campanulaceae* includes ca. 2400 species in five major lineages (Campanuloideae, Cyphioideae, Cyphocarpoideae, Lobelioideae and Nemacladoideae). *Campanula* represents the most speciose (ca. 420 species) and controversial taxon in the Campanuloideae. Up to now, all phylogenetic studies based on molecular data and modern analytical methods revealed the polyphyly of this group and highlighted the need for an in-depth understanding of the evolution of *Campanula* species and the Campanuloideae. Seventeen well-supported clades have been recognized, although the relationships among and within clades are not fully resolved or well-supported, especially for taxa occurring in Mediterranean hotspots, such as the Middle East, Greece, and the Balkan Peninsula. *Campanula* is completely scattered across the 17 clades, often nested with other traditional genera. The largest and most diverse clade includes the traditionally defined section *Quinqueloculares* (Boiss.) Phitos, with ca. 39 *Campanula* species, mostly distributed in Greece and western Anatolia.

The significant morphological polymorphism among and within members of this section makes it one of the least understood and yet, most interesting taxa. Most of these species are stenoendemics or have peculiar disjunct distributions in a few Aegean islands and/or the continental landmass. We present a comprehensive phylogenetic study of all species traditionally included in sect. *Quinqueloculares* in order to understand, finally, the historical nature of this complex group and highlight evolutionary patterns in the Mediterranean Basin.

Our results highlight the multiple independent origin of sect. *Quinqueloculares* and a biogeographic pattern that very much reflects the intricate paleogeographic history of the eastern Mediterranean Basin. Our findings represent an important piece of a complex puzzle that *Campanula* represents, adding even more evidence on the feeble taxonomic nature of this entity.

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Efficiency of Plant DNA Barcoding for Taxonomy: A case study in *Dianthus* L. (*Caryophyllaceae*)

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Generally, the aim of DNA barcoding is species-specific identification using short and standardized DNA sequences. During last decades, several DNA barcode markers have been tested and proposed to address applications e.g. in conservation biology and ecology. It is also often claimed to resolve taxonomic difficulties when morphology based taxonomy is insufficient. At the present, there is no standard DNA barcode region among flowering plants. In the present study, three regions from the plastid genome, *rbcL*, *trnH-psbA* and *matK*, were evaluated for its discriminating value to serve as DNA barcoding standard. One of the desirable feature for any potential barcode region is high discrimination power to be applied at any taxonomic rank – a theoretical goal, which most likely cannot be achieved. Beside this, PCR and amplification success, sequence quality and variation of DNA barcodes were tested for our case study – the genus *Dianthus*- for each locus and selecting 80 individuals belonging to 40 *Dianthus* taxa. All taxa were represented by multiple accessions to cover maximum intraspecific sequence variation. Tree-based methods and distance methods were used to evaluate its respective performance in resolving taxonomic entities. Genetic divergences were calculated and Neighborjoining trees were constructed with pairwise deletion and the K2P model using MEGA6. For distance methods, barcoding gap was calculated using TaxonDNA under the K2P distance model. According to the results, *rbcL* and *trnH-psbA* are the most effective regions in terms of PCR amplification. However, one of our selected core barcodes, *matK*, is performing not optimal in the experiments, but provide significantly more discriminative power for species discrimination than the other two marker regions.

Keywords: *Dianthus*, DNA barcoding, *matK*, *rbcL*, taxonomy, *trnH-psbA*, Turkey.

Taming the Red Bastards: Hybridisation and species delimitation in the *Rhodanthemum arundanum*-group (Compositae, Anthemideae)

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Delineating species boundaries in a group of recently diverged lineages is challenging due to minor morphological differences, low genetic differentiation and the occurrence of gene flow among taxa. Here, we employ traditional Sanger sequencing and restriction-site associated DNA (RAD) sequencing, to investigate species delimitation in the close-knit Moroccan daisy group around *Rhodanthemum arundanum* B.H. Wilcox & al. that diverged recently during the Quaternary. After evaluation of genotyping errors and parameter optimisation in the course of de-novo assembly of RADseq reads in IPYRAD, we assess hybridisation patterns in the study group based on different data assemblies and methods (NEIGHBOR-NET networks, FASTSTRUCTURE and ABBA-BABA tests). RADseq data and Sanger sequences are subsequently used for delimitation of species, using both, multi-species coalescent methods (STACEY and SNAPP) and a novel approach based on consensus *k*-means clustering. In addition to the unveiling of two novel subspecies in the *R. arundanum*-group, our study provides insights into the performance of different species delimitation methods in the presence of hybridisation and varying quantities of data.

How many species should be there? A novel modeling approach applied to Euro+Med area to predict floristic species richness

Marco D'Antraccoli, Francesco Roma-Marzio & Lorenzo Peruzzi

Understanding global patterns of species richness is crucial to identify diversity hotspots. In this context, floristic inventories can provide an invaluable source of precious data. The aim of this work is to unravel patterns of floristic richness in the Euro+Med area (hereafter E+M), using a new modeling approach based on the Species-Area Relationship (hereafter, SAR), namely the increase in the species number with the increase of the area. Residuals in a SAR model, i.e. divergences among observed and predicted values, reflect the actual floristic richness after the removal of the area effect. However, residual values are not able to elucidate, *per se*, the contribution of environmental variables in causing their divergence from predicted values. To overcome this limitation, we applied to E+M a spatially explicit modeling technique (i) to quantify how each environmental variable affects SAR residuals and (ii) to improve species richness predictions, by adjusting the SAR model according to local environmental features.

Firstly, we collated over 900 vascular floras across E+M, ranging from 0.0005 to 6,702,669 km². For each flora, we extracted the area extent and the number of total, alien and native taxa inventoried. Then, we sampled several environmental variables falling within a circular buffer centred on the flora's centroids and with area equal to flora's total surface. These variables were used as predictors in a Generalised Linear Model having the SAR residual as dependent variable and the spatial autocorrelation removed.

Results show that the area alone explains 42% of the variance of total species richness (46% for native and 28% for alien species, respectively); the species richness expected for 1 km² is 163.3 taxa, 10% of which are estimated to be aliens. The model for all the species adjusted by environmental predictors allows to explain more than 80% of variance. The main predictors of species richness are 'annual mean temperature', 'annual mean precipitation', 'altitude' and 'temperature annual range'.

Our approach pushes forward the floristic research on both theoretical and practical grounds. Firstly, it allows an innovative use of floristic data to quantitatively assess patterns of species richness. Secondly, it represents an operative tool to make adjusted *a priori* species number predictions for a given study area. Consequently, our approach will be available to anyone interested in elaborating a 'starting hypothesis' of expected species number, before starting a floristic inventory in a territory falling in E+M.

New approaches in TaxonOmics: RADseq supported by geometric morphometrics uncovers relationships of sexual species within the *Ranunculus auricomus* complex

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Recognizing and delimiting species is methodically challenging in fast evolving, evolutionary young species complexes characterized by hybrid origin, steady gene flow, introgression and incomplete lineage sorting (ILS). We established a new workflow – a combination of next generation sequencing (RADseq) and geometric morphometrics. As a model group, we study the large apomictic polyploid *Ranunculus auricomus* complex comprising more than 800 described but taxonomically unresolved species.

As a starting point for the treatment of the whole apomictic complex, we first analyzed the sexual *R. auricomus* species. Concatenated RAxML/ExaML trees based on RADseq data revealed two well-resolved clades, i.e. a basal clade with non-dissected leaf species ('*cassubicus*') and a derived clade with non-dissected ('*cassubicus*') and dissected ('*auricomus*') leaf species, rejecting the old Linnaean classification of morphotypes as two species ('*auricomus*', '*cassubicus*'). Thus, non-dissected leaf lineages probably have been the progenitor of all, morphologically diverse, dissected leaf lineages. We also examined RAxML/ExaML tree by the quartet sampling method. This approach revealed a high amount of nodes with concordant patterns and informativeness but also signs of reticulate evolution among subclades. STRUCTURE analysis confirmed major clades as genetic partitions.

We will further analyze the morphology of *R. auricomus* with a quantitative approach called geometric morphometrics. The sampling of taxonomically informative features will comprise more than 1000 basal and stem leaves and carpellophores from plants equally grown in garden culture. The shape analysis will include landmark and outline morphometrics. Shape variables from different plant organs will be concatenated in a multivariate analysis.

Finally, the sexual species of the *R. auricomus* complex will be newly delimited based on a multidisciplinary approach – a combination of phylogenies, STRUCTURE analysis, sequence-based species delimitation methods (e.g., SNAPP) and geometric morphometrics.

SYMPOSIUM 8

Useful Plants of the Mediterranean

Organisers: Kemal Hüsni Can Baser & Stella Kokkini

Programme

- 1) **Assimopoulou A.:** Alkannins and Shikonins: From Ancient Codes to Modern Medicine.
- 2) **Çalis I.:** Recent Advances on the chemistry of *Astragalus* species of Turkey.
- 3) **Pirintzos S.:** Linking Biodiversity with Drug development in the framework of Ethnopharmacology: The experience of Cretan IAMA research group.
- 4) **Polissiou M.:** Essential oils from Mediterranean MAPs as potential biopesticides.
- 5) **Tsimidou M.:** The bioactive apocarotenoids of *Crocus sativus* L. and its wild Mediterranean allies.

Alkannins and Shikonins: From Ancient Codes to Modern Medicine

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There are few natural products with histories as rich as those of the enantiomeric naphthoquinones Alkannin and Shikonin (A/S). Their story can be traced back many centuries, where extracts from the roots of *Alkanna tinctoria* (*A.t.*) in Europe and *Lithospermum erythrorhizon* (*L.e.*) in the Orient have been used independently as natural red dyes and crude drugs with the magic property of accelerating wound healing. The first recorded use of *A.t.* roots is found in the works of Hippocrates and Dioscorides for the treatment of ulcers. Since then, the medicinal properties of the plant either have drifted into folklore, or been forgotten.

In 1976, Prof. V.P. Papageorgiou inspired by these textbooks revived the study of these plants and discovered the science behind ancient codes. The results of his experiments confirmed the wound healing, antimicrobial and anti-inflammatory properties of *A.t.* root extracts and he was the first to identify alkannin derivatives as the active components. He developed several pharmaceutical preparations, the clinical trials of which proved their outstanding efficacy in patients with indolent ulcers, burns and wounds. These were approved by the National Organization for Medicines (Greece) (Histoplastin Red®, Epouloderm®, HELIXDERM®). Since then, our research focuses on three pillars: chemistry, biology and technology of A/S and related compounds. The discovery of oligomeric A/S brought new insights into chemistry of naphthoquinones. The significant antioxidant and cytotoxic activity and anti-*Leishmanial* action of A/S were confirmed. New clinical trials conducted with HELIXDERM® on diabetic and indolent ulcers, but also on other therapeutic indications, present impressive results. Drug delivery systems for A/S (microcapsules, liposomes, hyperbranched polymers, chimeric systems, nanofibers) have also been formulated. Simultaneously, new formulations (liquid strip/spray, lipogel, impregnated gauzes and plasters) have been developed.

The discovery and establishment of Alkannins and Shikonins in the contemporary pharmacopoeia, inspired by ancient codes, as potent wound healing and regenerative agents, is a paradigm how natural products can be exploited for the discovery and development of modern medicines.

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Recent Advances on the Chemistry of *Astragalus* species of Turkey

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Astragalus L., the largest genus in the family *Fabaceae* (*Leguminosae*), comprises about 2200 species distributed mainly in the northern temperate regions and, in particular, it is represented by more than 428 species in the flora of Turkey. In traditional medicine, the roots of various *Astragalus* species represent very old and well-known drugs for the treatment of nephritis, diabetes, leukemia, uterine cancer and as antiperspirant, diuretic, and tonic.

Astragalus species are known to be rich in two major classes of biologically active compounds, polysaccharides and triterpenic glycosidic compounds which are mainly cycloartane- and oleanene-type structures, and they were found to exert interesting biological activities. Cycloartane-type triterpenoids were first reported from *Astragalus* species in 1981 by N.K. Abubakirov et al. in Uzbekistan. At the beginning of the 1990s, the observation of the uses of *Astragalus* roots against leukaemia in Anatolia triggered the intensive studies on the chemistry of this genus. As a part of our ongoing research of new bioactive compounds from the plants growing in the flora of Turkey, several *Astragalus* species have been investigated resulting in the isolation of many new and novel cycloartane-type glycosides, in addition to flavonol, simple phenol, oleanan and lignan glycosides. A wide range biological activity studies performed on the cycloartane-type glycosides showed interesting pharmacological and biological properties, including immunostimulating, anti-inflammatory, haemolytic, anti-protozoal, antiviral, gastroprotective activities and adjuvant properties. Recently, we demonstrated that Astragaloside IV showed neuroprotective effects against hyperglycemia mediated neurotoxicity via inhibiting neuronal loss, strengthen membran integrity and impairing oxidative damage.

This presentation will briefly focus on the results of the studies performed on the taxonomy, isolation, structure elucidation, biological and pharmacological activities.

Linking Biodiversity with drug development in the framework of Ethnopharmacology: The experience of Cretan IAMA research group

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Undoubtedly, Ethnopharmacology by understanding the biological and pharmacological properties of plants and the benefits and risks of their uses in traditional medicine is linking plant biodiversity with drug development. It is an essential scientific field, especially for areas of high plant biodiversity such as the Mediterranean Area. Nevertheless, despite the high number of papers published each year in the field, the increasing knowledge of plant-biodiversity and the increasing analytical power of the involved labs, the number of new released in the market plant-based drugs is gradually declining worldwide. In Greece, rather recently, an antiviral product based on phytochemicals of *Thymbra capitata*, *Salvia fruticosa*, and *Origanum dictamnus* has been developed at the University of Crete from faculty members of the School of Medicine and the Department of Biology. The product is protected by an international patent (PCT) and released in the market in 2015 by the pharmaceutical companies Galenica sa and Olvos Science sa under the brand name Cretan IAMA. Here a presentation of the collected experience will be attempted and several conclusions will be discussed within the international scene of plant-based drug development.

Essential oils from Mediterranean MAPs as potential Biopesticides

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Certain Essential Oils (EOs) from Medicinal and Aromatic Plants (MAPs) can be used as environmentally compatible pest-control alternatives to synthetic pesticides. This is because they have strong biocidal properties, are biodegradable, the risk for subsequent pest resistance is very limited and may not cause harm on non-target organisms.

The effects of MAP usage as plant protection products have been proven in studies of the fungicidal activity of the essential oils of oregano, thyme, dittany and marjoram, which at relatively low concentration levels completely inhibit the growth of *Botrytis cinerea*, *Fusarium sp.*, *Clavibacter michiganensis* subsp. *michiganensis* και *Penicillium digitatum*. The main substances of the above essential oils are carvacrol and thymol.

As for their insecticidal effects, the usage of essential oils of pennyroyal and mint had a significant impact against *Culex pipiens* mosquito larvae. Essential oils of basil, satureja (savory), lavender and peppermint were proven to work against stage 3 larvae and adults of *Planococcus ficus*, without causing any toxicity in vine plants. Moreover, emulsions containing vegetable and essential oils of marjoram, lemon balm and pennyroyal produced remarkable results, reducing by up to 87% the longevity and by up to 100% the fecundity of *Myzus persicae* Sulzer aphids. Hydrosols, a by-product of the marjoram, lemon balm and pennyroyal essential oil distillation, were a strong deterrent for *Myzus persicae* Sulzer aphids on aubergine leaves. In addition, mortality of said aphids increased by 15% after 24 hours from applying marjoram hydrosols on aubergine plants. In a very recent study, essential oils of mint as well as their main ingredients not only displayed insecticidal effects against *Leptinotarsa decemlineata*, *Spodoptera littoralis* και *Myzus persicae*, but also nematocidal properties against *Meloydogine javanica*, as well as pesticidal properties against *Lactuca sativa*, *Lolium perenne*, *Solanum lycopersicum*.

However, despite their advantages, the volatile nature of EOs as well as their sensitivity in the exposure to light and heat reduces their efficacy in pest control and causes shortcomings in their formulation and storage. Aiming to address these constraints, recent research has focused on developing formulation by encapsulation in order to prevent rapid degradation and to increase their period of bioactivity.

The development and usage of new pesticide products from Mediterranean MAPs can bring significant benefits to the protection of both consumer health and the environment.

The bioactive apocarotenoids of *Crocus sativus* L. and its wild Mediterranean allies

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Crocus sativus L. (family Iridaceae; subfamily Crocoideae, genus *Crocus*) is a perennial plant cultivated in a number of countries around the Mediterranean basin, it is sterile and propagated by corms. Genetic variability is rather limited with the exception of random mutations. Moreover, Mediterranean basin hosts different species of the genus grown in the wild but only the stigmas of *Crocus sativus* L comprise saffron. Use of the stigmas of a wild progenitor is evidenced on the frescoes found at Akrotiri (Santorini) and Knossos (Crete) whereas saffron plant cultivation in Mediterranean countries goes on over the centuries despite difficulties related to limited genetic resources and manual labor requirements. Currently, Greece is the greatest producer of saffron in this area; Spain is the leading country in its trade, whereas Morocco seems to be an emerging player in the global terrain that is dominated by the Iranian production since many decades. Iran accounts for more than the 90% of the global production of this culinary spice, which steadily recuperates its fame among scientists for the wide range of bioactive properties reported in an uprising number of studies. Saffron major bioactive components are volatile and non volatile apocarotenoids, responsible for its unique culinary persona, i.e. aroma, taste and colouring strength. The presentation focuses on the major bioactive components of saffron, i.e. crocetin in its free or bound forms with sugars (crocins). Accumulation in the plant, changes upon processing and storage, extraction means and bioactive properties are critically discussed. Future prospects and challenges for the survival of this 'useful plant' are also pointed out regarding the effect of climatic crisis and outdated characteristics of the cultivation.

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SYMPOSIUM 9

Islands and insular systems

Organisers: Frédéric Médail & Panagiotis Trigas

Programme

- 1) **Médail F. & Trigas P.:** Introduction: Importance of Mediterranean islands for biogeography and conservation of plants.
- 2) **Panitsa M., Kougioumoutzis K., Kagiampaki A., Triantis K. A. & Trigas P.:** Plant diversity patterns in the Aegean Islands: history, climate or isolation?
- 3) **Nikolić T.:** The eastern Adriatic islands – state and perspectives.
- 4) **Pasta S., La Rosa A., Pavon D., Lo Cascio P. & Médail F.:** Tentamen Florae Aeolicae: A critical checklist of the vascular plants of the Aeolian Islands (Sicily, Italy).
- 5) **Cambria S., Brullo S., Bogdanovic S. & Giusso del Galdo G.:** Taxonomy and vicariance within the endemic species of *Solenopsis* (*Campanulaceae*) in the Mediterranean islands.
- 6) **Kougioumoutzis K., Kokkoris G., Panitsa M., Strid A., Trigas P. & Dimopoulos P.:** Climate change in a Mediterranean island biodiversity hotspot and its impact on the endemic Cretan flora.

Plant diversity patterns in the Aegean Islands: history, climate or isolation?

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Ecological and evolutionary theory has mainly focused on oceanic archipelagos, in spite them being a small fraction of island systems worldwide. Hence, continental archipelagos, such as the Aegean, provide unique opportunities for advancing island biogeography theory towards more complex island systems. The Aegean Archipelago, lying at the crossroads of three biogeographical regions, Europe, Asia and Africa constitutes a considerable biogeographic barrier between the Balkan and Anatolian Peninsulas. Many studies concerning the flora, endemism and phytogeography in the Aegean region have been published documenting the presence of numerous endemic species that have been evolved comparatively recently, as well as some relict species with no close relatives in the current flora. Previous studies have demonstrated the strong influence of topographic and geological heterogeneity in shaping island species richness in the Aegean, while in small Aegean islands plant diversity is mainly shaped by heterogeneity among local communities. However, several factors affecting the diversity and structure of Aegean island plant assemblages have yet to be addressed, such as the phylogenetic aspect of alpha and beta diversity, the potential impact of historical factors on their community composition, as well as whether their assembly is due to spatial, historical or environmental factors. Palaeogeographical barriers and geographical distance have largely shaped the plant diversity patterns in the Aegean, demonstrating that geographical and historical isolation have left their mark in the distribution of plant taxa in the study region. This finding is consistent with the region's palaeogeographical evolution since the middle Miocene. Strong dispersal barriers exist even in short geographical distances within the Aegean and dispersal limitation is the predominant force driving endemic plant taxa beta diversity. Finally, the phylogenetic structure of endemic Aegean plants was better explained by regional differences in the species pool, rather than any other abiotic variable,

highlighting thus the role of palaeogeographical affinity in shaping Aegean plant assemblages.

Keywords: Beta diversity, phylogenetic diversity, palaeogeography, endemism, continental archipelago.

The eastern Adriatic islands – state and perspectives

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Of the 52 Mediterranean refugia of vascular plants, four are located along the eastern Adriatic coast. Additionally, the Balkan Peninsula in broader sense is one of the 240 world centers of vascular plant diversity. The high taxonomic diversity of the Balkan Peninsula was presented recently and was placed in a global context.

The Croatian portion of the of the eastern Adriatic shoreline, including the coast and the islands, has a total length of 6 116 km containing 1 151 islands, islets and reefs, and, depending on the tides, 80 additional reefs periodically appear above sea level. The islands' altitudes are vary widely by archipelago and range from several meters above sea level to 778 m a.s.l.

On the basis of half a million findings and their spatial distributions, it is concluded that within one grid cell (35km²) 542 species could be expected. The Power (Arrhenius) function is used for modelling (by non-linear regression) the Species Area Relationships. The results showed the expected dependence on the size of the islands and the number of species.

Sixty-three endemics are recorded on 126 islands, islets and reefs. One hundred thirteen range restricted species are recorded on 186 islands, islets and reefs. Therefore, a total of 249 taxa thrive on the east Adriatic islands, composing 66% of all Croatian endemics and range restricted species. Although these data are strongly dependent on how well these areas have been studied, it is clear that the eastern Adriatic islands are generally important centers of endemism in the Mediterranean, even without the inclusion of the data from the eastern Adriatic coastal area.

The spatial distribution of α -diversity indicates that the national hot spots were more consistent with the important plant areas network than with the network of officially protected areas.

Tentamen Florae Aeolicae: A critical checklist of the vascular plants of the Aeolian Islands (Sicily, Italy)

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More than 140 years after the first and only monograph published by Lojacono-Pojero on the flora of Aeolian Islands, we present here an updated and comprehensive checklist of the vascular plants currently thriving in the archipelago. This list builds on the synthesis of the data scattered within the available literature carried out by Pasta (1997), and was updated thanks to the plant specimens and the data collected in the 1980s by S. Brullo and collaborators and during last 25 years by the authors. These surveys allowed to discover 87 taxa which result to be new to the whole archipelago and occur at least on one island. Contrariwise, 65 previously reported species probably became extinct as a consequence of the fading or even the destruction of their preferential habitats (e.g. temporary ponds, arable fields and fallows, coastal plant communities). Additionally, 57 more records probably issued from misidentifications, and their current occurrence on the archipelago needs to be confirmed. If we discard all these extinct or doubtful plants, the Aeolian Islands currently host 899 infrageneric taxa. Occurrence data concern not only the 7 main islands of Alicudi, Filicudi, Vulcano, Lipari, Salina, Panarea and Stromboli, but also the islet of Basiluzzo and 23 small satellite islets and stacks. 16.6% of the whole Aeolian flora is not native (96 naturalized and 54 casual), confirming the vulnerability of Mediterranean volcanic islands to the colonization of alien plants. 35.6% of the whole flora belongs to three families only, i.e. *Poaceae* (114 taxa), *Asteraceae* (110) and *Fabaceae* (97). Other species-rich families are *Brassicaceae* (39 taxa), *Caryophyllaceae* (33), *Apiaceae* (28), *Plantaginaceae* and *Amaranthaceae* (26), *Lamiaceae* (22) and *Orchidaceae* (20). The most common chorotype is represented by pan-Mediterranean plants (16.5%). Also, the western element plays an important role, as testified by the occurrence of 53 CW Mediterranean, 33 Mediterranean-Atlantic and 28 Mediterranean-Macaronesian taxa. As for endemic/stenochorous taxa, 7 are endemic to Aeolian Islands, 8 to Sicily, 8 to S Italy and 4 to both S Italy and circum-Tyrrhenian lands. Life-form spectrum points out the absolute dominance (82.6%) of annual (471 therophytes) and perennial herbs (177 hemicryptophytes and 96 geophytes). The vascular flora of the archipelago includes 74 phanerophytes, 59 chamaephytes, 22 nanophanerophytes and 1 hydrophyte, too. We are convinced that this first inventory represents a very useful tool, giving the opportunity to biologists not only to improve the list but also to use the data for biogeographical analyses.

Taxonomy and vicariance within the endemic species of *Solenopsis* (*Campanulaceae*) in the Mediterranean islands

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Solenopsis C. Presl is a small genus of *Campanulaceae* occurring in the Mediterranean and Macaronesian areas. It is currently represented by 9 taxa usually linked to wet habitats. The genus groups annual and perennial species, caulescent or acaulescent, having a small size, floral pedicels axillary, much longer than leaves, corolla 5-lobed, bi-labiate, with divaricate to patent lips, white to bluish, often whitish in the throat, with unicellular papillae on the lower lip, capsula bilocular, loculicide, with several small seeds. Within this genus can be distinguished two main groups: the first one is characterized by annual species with habit erect and scapose, leaves usually cauline, flowers very smaller with corolla slightly divaricated at the top; the second one groups perennial and annual species with habit acaulescent, leaves in basal rosettes and flowers larger with markedly patent lips. The first group is represented by *Solenopsis laurentia* C.Presl (widespread in Mediterranean area and Canary islands) and *S. mothiana* C.Brullo, Brullo & Giusso (Sicily), while the second group includes much more species, such as *S. bicolor* (Batt.) Greuter & Burdet (Tunisia and Algeria), *S. bivonae* (Tineo) M.B. Crespo et al. (Cyprus, Sicily, southern Italy and Sardinia), *S. minuta* C.Presl subsp. *minuta* and subsp. *annua* Greuter et al. (Crete), *S. balearica* (E.Wimm.) Aldasoro et al. (Mallorca), *S. corsica* (Meikle) M.B.Crespo et al. (Corse and Sardinia) and *S. antiphonitis* Hadjik. & Hand (Cyprus). Besides, the two groups differs also from the phytogeographic viewpoint, since the second one is mainly represented by species localized in insular stands, while the first one includes mainly *S. laurentia*, which occurs in many continental territories of Mediterranean. On the basis of literature data and personal investigations, it is clear that many of the currently known taxa of this genus are represented by small endemic populations exclusive to Mediterranean islands, where the speciation processes appeared to be particularly active (Crespo et al. 1998). In order to deepen the taxonomical relationships among the perennial populations previously attributed to *S. bivonae*, the most critical ones within the second group, it was possible to verify that there are significant morphological differences among those geographically more isolated. In particular, *S. bivonae* should be considered a Sicilian endemic and is well differentiated from the Sardinian and Cyprian populations, as well as from those Calabria ones. Therefore, *S. bivonae* seems to represents a species complex, within which can be recognized different taxa probably at subspecific rank, which expression of their marked geographical isolation for insularity.

Climate change in a Mediterranean island biodiversity hotspot and its impact on the endemic Cretan flora

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Centres of endemism, i.e., geographic regions with an exceptionally high endemism rate, mainly due to mild past climatic fluctuations and other factors (e.g., insularity, topographical heterogeneity), have long attracted the biogeographers' and conservationists' attention. Nowadays, challenged with the certainty of massive climate change, these regions face an imminent threat of losing their unique biodiversity and represent crucial focal points for the prevention of climate-induced extinctions. Even though a quarter of the global biodiversity hotspots is composed exclusively of islands, it is the large continental biodiversity hotspots that have the lion's share regarding the intensity of climate change research. Island biotas are expected to be severely impacted, as the opportunities for island species to shift their ranges in climate-relevant latitudinal extents and to maintain population size and genetic variability remain extremely limited.

The Mediterranean Basin, one of the world's major centres of plant diversity, hosts ca. 30.000 vascular plant taxa, many of them being island endemics. The Mediterranean is among the regions expected to experience the largest changes in climate, with these impacts being more prominent on islands and mountain summits.

Crete, the fifth largest Mediterranean island, with its' rugged topography and past climatic stability, constitutes the most important endemic hotspot in the region, since it hosts two endemic monotypic genera and more than 180 single island endemics (SIE), 40% of which are restricted to high elevation belts. These narrowly ranged, cold-adapted species could have an especially limited chance to survive during a rapid climate change due to the 'escalator to extinction' phenomenon. Here, we used a subset of the Cretan SIE in order to assess the impacts of climate change via a species distribution modelling approach, using an ensemble modelling framework under three different climate models and two climate scenarios. We also identified the species that should be of conservation priority based on the EDGE (Evolutionary Distinct and Globally Endangered) framework. All Cretan SIE will experience severe range contraction and several are projected to become extinct under any climate model/scenario. The eastern, central and high altitude parts of Crete are more likely to lose the vast majority of the SIE occurring there. Four species (*Asplenium creticum*, *Cyclamen confusum*, *Horstrissea dolinicola*, *Euphorbia rechingeri*) emerge as the most important species based on their EDGE scores, while the NATURA 2000 sites do not

seem to adequately protect the most vulnerable of the Cretan SIE in terms of species and phylogenetic diversity.

Keywords: distribution modelling, endemic hotspot, extinction risk, global warming, Greece.

SYMPOSIUM 10

Web-Botany

Organizers: Ernst Vitek & Dimitris Koureas

Programme

- 1) ***Koureas D.***: The Distributed System of Scientific Collections (DiSSCo) research infrastructure; Integrating European natural history collections to enable data-driven innovation and frontier biodiversity research.
- 2) ***Raab-Straube E. von.*** Euro+Med PlantBase and the Common Data Model (CDM) – integrating, further updating and expanding floristic and taxonomic information on Euro-Mediterranean plant diversity.
- 3) ***Hofbauer M., Berger A., Gilli C., Lachmayer M., Prehler D., Reich D., Sander R., Sonnleitner M. & Gutermann W.***: Flora Ionica online – an integrative resource for plant biodiversity.
- 4) ***Groom Q.***: Progress towards better management of and access to herbarium data.
- 5) ***Dimopoulos P.***: The Flora of Greece website – FoG.

The Distributed System of Scientific Collections (DiSSCo) research infrastructure; Integrating European natural history collections to enable data-driven innovation and frontier biodiversity research

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Distributed System of Scientific Collections, Leiden, The Netherlands

European Natural Science Collections (NSC) are part of the global natural and cultural capital. Data derived from these collections underpin thousands of scholarly publications and official reports (used to support legislative and regulatory processes relating to health, food security, sustainability and environmental change) and let to inventions and products that today play an important role in our bio-economy.

In the last decades, the research practice in natural sciences changed dramatically. Advances in digital, genomic and information technologies enable natural science collections to provide new insights but also ask for changes in the current operational and business models of individual collections held at local natural history museums and universities. A new business model that provides unified access to collection objects and all scientific data derived from them. Although aggregating infrastructures like the Global Biodiversity Information Facility, genomic information repositories and Catalogue of Life now successfully aggregate data on specific data classes, the landscape remains fragmented with limited capacity to bring together this information in a systematic and robust manner and with scattered access to the curated physical objects (specimens).

The Distributed System of Scientific Collections (DiSSCo) represents a pan-European initiative, and the largest ever agreement of NSCs, to jointly address the fragmentation of European collections. DiSSCo is unifying European natural science collections into a coherent new research infrastructure, able to provide bio- and geo-diversity data at the scale, form and precision required by a multi-disciplinary user base in science. DiSSCo is harmonising digitisation, curation and publication processes and workflows across the scientific collections in Europe and enables linking of occurrence, genomic, chemical and morphological data classes as well as publications and experts to the specimens.

In this paper we discuss the organisational aspirations (vision, mission and organisational values) of DiSSCo in relation to the developing scientific and societal needs for data-driven innovation and excellence. Furthermore, we briefly analyse the technical approach to the challenge and describe the political landscape and funding instruments that DiSSCo makes use of, in order to deliver its service portfolio by 2025. Finally, we look on the step change DiSSCo operation introduces to the phytotaxonomic community of practice in Europe.

Euro+Med PlantBase and the Common Data Model (CDM) – integrating, further updating and expanding floristic and taxonomic information on Euro-Mediterranean plant diversity.

Eckhard von Raab-Straube

The well-known Euro+Med PlantBase, the most comprehensive information source for Euro-Mediterranean plant diversity, is entering a new phase. Intense data cleaning and migration from an older system to the Common Data Model (CDM), the core data repository of the EDIT Platform for Cybertaxonomy, has been successfully completed. Most important components of the new system are the EDIT Taxonomic Editor and the new Euro+Med PlantBase Data Portal. The Editor, already in daily use for a number of international projects, allows for direct editing of taxonomic, nomenclatural and distribution data of the Euro+Med Plantbase. Unlike its predecessor, the new Editor is directly linked with the online version of the database. Therefore, all updates will become visible immediately upon editing, not only after a long period of delay. This is also true for the distribution maps, which are now generated on-the-fly on the new Euro+Med PlantBase Data Portal. A flexible rights and roles system allows for different access levels for different users, according to their roles as editors for certain taxonomic groups. In the new portal, the users have simple and improved advanced search options, as well as the possibility to find taxa by browsing a taxonomic tree. Taxon pages within the portal include accepted names and synonyms arranged in homotypic blocks with complete authorship and nomenclatural references, misapplied names with bibliographic references, a distribution map with status levels, a condensed distribution string together with full distribution indications and the according references, vernacular names with their bibliographic references, and a bibliographic part. The EDIT Platform for Cybertaxonomy also enables effective and direct production of a variety of publishable outputs from the database, e.g. taxonomic or regional checklists for selected groups.

Flora Ionica online – an integrative resource for plant biodiversity

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Rapid ongoing loss of biodiversity mediated by anthropogenic factors calls for efficient, fast and up-to-date methods for documenting species diversity and distribution. Cross-linked mapping data available to scientists and key stakeholders allows for making informed decisions and implementing effective conservation measures. Due to its geographic position in the Adriatic Sea W of the Greek mainland linking the W and E Mediterranean flora, its orography and climate, the Ionian Islands exhibit an exceptionally high plant biodiversity. The islands were long since of interest to botanists with first observations dating back to the 16th century. Continuous and intensive field work mapping the vascular flora on a 1 × 1 km basis as well as assessment of historic data (literature, herbarium vouchers) started in the 80ies of the 20th century. All records were initially stored in a dbase database and just recently transferred to a MariaDB database to allow for further development and online accessibility. Currently more than 110,000 own distribution data sets documented by more than 12,000 own herbarium vouchers and more than 52,000 data sets retrieved from literature are available. Herbarium research in W and WU yielded more than 5,000 vouchers from the Ionian Islands, which were made available via the international Virtual Herbaria JACQ online database. At this point the distribution data for each taxon is displayed in 10 × 10 km resolution. Georeferenced in situ photographs of plants and habitats are continuously added with a total of more than 7,000 pictures of more than 1,200 taxa (approx. 60% of the entire flora) already available online. Corresponding herbarium vouchers stored in W and WU are continuously photographed and databased in JACQ and linked to the Flora Ionica website. Ongoing field work is performed with mapping apps using aligned taxa lists to increase the geographic resolution and to gain data which can directly be imported in the Flora Ionica database. Based on this data herbarium labels and import lists for herbarium databases can be generated on the fly. Due to its manifold features Flora Ionica database allows for fast and efficient mapping and Flora Ionica website offers valuable information for both scholars, naturalists as well as policy makers.

Progress towards better management of and access to herbarium data

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Imagine if the world's herbarium specimens were accessible with a few clicks of a mouse; that they could be searched in many different ways and that you could easily reuse the data. The efficiency of traditional botanical research would improve and new forms of research would be enabled. Such access would also open these collections to new communities and improve the verifiability and repeatability of botany. This talk will present some of the initiatives in this direction and what is on the horizon.

Some of the elements required to achieve this are production workflows for imaging, label transcription and data curation. Portals and interfaces are required to disseminate these images and their data, and standards are needed to ensure interoperability. All of this facilitates the aggregation of data to make it findable and useable.

Key parts of an integrated infrastructure are persistent identifiers for unique entities, so called PIDs. We can use these PIDs to link data together unambiguously and persistently.

These PIDs are the glue that holds the system together. We are all familiar with Digital Object Identifiers (DOI) on scientific papers, but publications are only one of the unique entities we need to identify. Others are specimens, people, scientific names, molecular sequence and geographic entities.

To make this function at an institutional level the collection management system is an indispensable infrastructure. Yet, many organizations find the available solutions insufficient. A common theme is the struggle with software maintenance and lifespan. Spreadsheets are unsuitable for maintaining and publishing herbarium data and yet they are still widely used. Furthermore, a dedicated, trained, IT literate staff are required to maintain collection management systems.

At a global level the Global Biodiversity Information Facility (GBIF), the International Association for Plant Taxonomy (IAPT) and Biodiversity Information Standards (TDWG) are critical. These organizations work with the botanical community to develop standards, methods and tools to improve the quality of specimen data. They also train biodiversity informatics to curators and scientists internationally.

To build systems suitable to realise the dream of a globally integrated herbarium access system does not just require technical development, but also a shared desire among the botanical community and long-term structural planning, independent of short-term research goals. Yet the potential to revolutionize botanical research in the 21st century should inspire us to work towards this goal.

The Flora of Greece website – FoG web

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The database and the online portal of the Flora of Greece are using the EDIT (European Distributed Institute of Taxonomy) Platform for Cybertaxonomy to capture, process, maintain and publish the data according to the current published information. Aiming to make electronically available to the public the printed version of the *Vascular Plants Checklist of Greece* (Dimopoulos et al. 2013) and its *Supplement* (Dimopoulos et al. 2016), the "Flora of Greece" website, <http://portal.cybertaxonomy.org/flora-greece> was launched in June 2017. The website on the Flora of Greece (FoG_web) is continuously updated in order to: a) bring together data from authoritative sources and b) incorporate information on all species and subspecies of vascular plants occurring in Greece. The 1st version of the FoG_web, under the EDIT platform, was considering taxonomic and floristic novelties published till October 2013. All the new published information from November 2013 to December 2017 were considered and uploaded gradually. The 2nd version of the FoG_web included all published information up to May 2018, while the 3rd version was uploaded in mid-July 2019. In the end of July 2019, the vascular flora of Greece comprises 5873 species and 1990 subspecies (native and naturalized), representing 6738 taxa, belonging to 1085 genera and 185 families. The full dataset includes a total of 7863 records, comprising species and subspecies, plus ten sections and two aggregates. The FoG_web at its current version (July 2019) contains: 7875 valid taxa names, 6510 synonyms, 1055 "excluded taxa", i.e. taxa disregarded as being reported in error, non-established aliens, non-stabilized hybrids, taxonomically enigmatic, or vanished from Greece, 1370 comments on taxa disregarded as being reported in error, non-established aliens, non-stabilized hybrids, taxonomically enigmatic or vanished, distribution maps showing occurrence of each taxon in the 13 floristic (phytogeographical) regions of Greece, chorological category/type for each taxon, life-form category for each taxon, status for each taxon (native, alien, range-restricted), habitat category that a taxon occupies (falling mostly into one habitat category but may comprise two or more categories), 5200 images representing about 2500 species and subspecies, as well as relevant [bibliography](#). Special effort has been made for this web site to be equally accessible and usable via mobile devices (smartphones and tablets), so that it can be accessed from everywhere (as long as internet access is available).

Keywords: EDIT platform, taxonomy, vascular plants, flora, Greece.

SYMPOSIUM 11

Plant conservation

Organisers: Magda Bou Dagher-Kharrat & Theophanis Constantinidis

Programme

- 1) ***Véla E., Allen D., Barrios V., Lansdown R. & Numa C.***: Assessing the conservation status of Monocots in the Mediterranean region: reflections from a recent IUCN Red List evaluation.
- 2) ***Dimopoulos P., Constantinidis Th., Raus Th. & Strid A.***: Taxonomic plant diversity and conservation needs in Greece.
- 3) ***Lansdown R., Grillas P., Galewski Th. & Bazos I.***: Conservation of Mediterranean Wetland Plants.
- 4) ***Peruzzi L., Astuti G., Carta A., D'Antraccoli M., Roma-Marzio F. & Bedini G.***: Interdisciplinary studies in plant conservation: lessons from some Italian case studies.
- 5) ***Bou Dagher Kharrat M., Roukoz A., Depalle F., Samad N. A., Jardak R., Kahale R., Saliba C. & Sakr R.***: Conservation of endemic *Oncocyclus* Iris of the eastern Mediterranean Region.
- 6) ***Xu X., Ma K., Luo M., Liu B., Wang H., Xue J., Lin Q., Li W., Xu Z. & Ganessaiah K. N.***: Mapping Asia Plants: Initiative and Progress.
- 7) ***de Montmollin B., Gotsiou P., Bacchetta G., Christodoulou Ch. S., Cogoni D., Fournaraki Ch., Giusso del Galdo G. P., Kokkinaki A., Kyratzis A., Piazza C., Vicens M. & Fenu G.***: Ex-situ and in-situ joint conservation actions for threatened Mediterranean island flora: lessons learnt from the CARE-MEDIFLORA project.
- 8) ***Özhatay F. N., Demirci Kayıran S. & Kaya E.***: Conservation of endemic *Colchicum* species distributed in the Mediterranean Region of Turkey.
- 9) ***Lazaridi E., Thanopoulos R. & Bebeli P. J.***: On-farm conservation impact on cowpea diversity in Greece.

Taxonomic plant diversity and conservation needs in Greece

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The flora of Greece consists of 5871 species and 1997 subspecies (native and naturalized), which represent 6741 taxa and belong to 1085 genera and 185 families. The endemics and range-restricted plants of Greece include respectively 1508 and 2036 taxa (22.4% and 30.2% of the total nr of taxa in Greece), distributed in 1114 endemic and 1510 range-restricted species (19% and 25.7% of the total nr of Greek species) and 463 endemic and 633 range-restricted subspecies (23.1% and 31.7% of the total nr of subspecies) (analysis of the *Vascular Plants Checklist database* - version III, July 2019). Taking total species and endemic species richness in relation to area size as a measure of its plant diversity, Greece ranges among the highest in European and Mediterranean or Mediterranean-type climate areas. At the same time, Greece is known for its islands and its mountains, coastal plants and plants of the high mountains which cumulatively account for ca. 18 % of the Greek flora; however, our assessment on plant taxa habitat preferences reveals that Greece is in fact a country of cultural landscapes, i.e. anthropozoogenic, landscapes. Most common are plants of agricultural and ruderal habitats (18.1 %), followed by plants of grasslands and dwarf shrublands, with 17.7 % representing sub-mediterranean/temperate lowland to montane pastures and meadows, and 15.4 % Mediterranean annual-rich grasslands and phrygana. The conservation needs for the high total and endemics/range-restricted plant diversity in Greece have been spatially outlined taking into consideration that: a) species do not have the same conservation importance and thus different weighting schemes have been tested for conservation purposes, b) Greece has, both national and international obligations to conserve its diversity, c) the analysis and interpretation of the endemic/range-restricted species distribution patterns are fundamental to biogeography and biodiversity conservation and its planning, d) delineating plant diversity- and endemism- hotspots across the different floristic regions of Greece is the basic tool for shaping European, national and regional conservation policies. By comparing the plant diversity (total, endemic, range-restricted, unique) occurring within the Natura 2000 network of Greece (covers 28% of the country's territory) with the plant diversity outside the Natura 2000 network, we evaluate and complement the current conservation measures for plant species within the Natura 2000 network (Annexes II, IV, V of the Dir. 92/43/EEC list only 64 taxa of community importance for conservation) with respect to its performance in representing endemic plants. The results are discussed, interpreted and suggestions are made to determine national

conservation responsibilities and to improve the effectiveness in endemics/range-restricted plant species conservation at national, regional and local scale.

Keywords: plant diversity, endemism, range-restricted flora, conservation priorities, Greece.

Interdisciplinary studies in plant conservation: lessons from some Italian case studies

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The Mediterranean basin is a well-known biodiversity hotspot where, unfortunately, native plant diversity is highly threatened by environmental changes, notably human-induced changes. Within this territory, Italy hosts about one-third of the animal and half of the European plant taxa. Among these taxa, the endemics and the so-called PIPPs (Peripheral and Isolated Plant Populations) are of particular conservation interest. To pursue proper conservation of these species, an adequate knowledge of their distribution, systematic relationships, autoecology, genetic structure and basic reproductive strategies is crucial in planning conservation activities.

Our research group has carried out for the last few years an interdisciplinary, integrated approach to the conservation of threatened plants of the Italian flora, among which the Italian endemics *Bellevalia webbiana* Parl. (*Asparagaceae*) and *Crocus etruscus* Parl. (*Iridaceae*), and the Italian PIPPs of *Hypericum elodes* L. (*Hypericaceae*) and *Cistus laurifolius* L. (*Cistaceae*). Our interdisciplinary protocol included: a) basic systematic and taxonomic characterization (if needed), b) herbarium and field investigations to check the species' current distribution, c) ecological characterization, d) investigation on reproductive strategies, e) investigation on genetic structure.

According to our results, we can conclude that – in all the investigated case studies – each field of investigation provided data useful in a conservation perspective. Of particular interest, concerning *B. webbiana*, is the discovery of a population distinct from others (both in genetic structure, autoecology, and reproductive outcome), which should be subjected to special conservation. Concerning *Crocus etruscus*, the populations from Elba Island were described as a distinct, narrow endemic species (*C. ilvensis* Peruzzi & Carta), which is even more threatened. For *Crocus etruscus*, a species included in the Annex II of the EU Habitat Directive, we also developed a monitoring protocol aimed at acquiring demographic data minimizing the fieldwork effort; reliable estimates of the reproductive individuals were obtained when at least 25% of the populations were covered. In *Hypericum elodes*, we discovered a peculiar competitive breeding strategy, which results in the production of two kinds of seeds, one less dormant (from self-pollination) and one more dormant (from cross-pollination). The knowledge about this species was beneficial in designing and carrying out a translocation project, maximising the chances of success. Finally, concerning *Cistus*

laurifolius, we demonstrated that the only Italian population shows low genetic variability and suffered habitat fragmentation; its vegetative plasticity allows its persistence under closed canopies, but the reproductive fitness in this sub-optimal ecological context is severely reduced.

Conservation of Mediterranean Wetland Plants

Richard Lansdown, Patrick Grillas, Thomas Galewski & Ioannis Bazos

In recent years there has been an increase in the focus of conservation work on wetland plants in the Mediterranean region, both at a local level and through regional projects, including many carried out or at least stimulated by the IUCN. The IUCN SSC Freshwater Plant Specialist Group (FPSG) operates at a global level and works to support wetland plant conservation initiatives. It has been involved in a number of conservation initiatives in the region since its establishment in 2012, many involving Red List assessments employing the IUCN criteria. One of the most important projects involving the FPSG in recent years has been the development of a baseline for a Red List Index (RLI) of Mediterranean Wetland plants for use by the Mediterranean Wetland Observatory (MWO) and other conservation organisations. The RLI is a tool used by the IUCN to identify trends in the extinction risk of groups of animals or plants by updating Red List assessments at regular intervals and comparing the threat status assigned. Preparation of a baseline for the RLI initially involved development of a list of species to be assessed, by selecting the species most likely to change their threat status. The priority was to assess or re-assess taxa which are endemic to the Mediterranean region, which have been assessed as threatened (CR, EN or VU), NT or DD in the Mediterranean region or which have been assessed as globally threatened and which occur in the Mediterranean region. Taxa for which assessments had been completed in the five years before start of the project (i.e. 2013-2016) were not re-assessed but the existing assessments incorporated into the baseline. A total of 500 assessments have been used to serve as the baseline for the Red List Index. It is hoped that the ongoing management of the RLI will complement and make more robust our assessments of the conservation status of biodiversity in Mediterranean wetlands. Other ongoing and novel work on the conservation of Mediterranean wetland plants include the LIFE Charcos project in Portugal, the Pauli Project in Sardinia, updating the Red List of Italian plants, KBA validation projects in Morocco, Portugal and Tunisia and species-specific conservation work such as surveys of *Callitriche pulchra* in Greece, *C. mathezii* in Morocco and work to clarify the taxonomy of *Lythrum* species to support their conservation.

<https://www.foropenforests.org/en/habitat/3170>

Ex situ and in situ joint conservation actions for threatened Mediterranean island flora: lessons learnt from the CARE-MEDIFLORA project

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Mediterranean islands represent a centre of plant diversity featured by an endemic richness rate higher than mainland areas. However, such plant richness is threatened by several physical and biological factors and many plants are facing the risk of severe impoverishment and require urgent protection measures. The CARE-MEDIFLORA project, an initiative implemented by institutions of six Mediterranean islands and the IUCN/SSC Mediterranean Plant Specialist Group, with a long lasting experience in plant conservation, promoted the use of *ex situ* collections to experiment with *in situ* active actions for several threatened plants. The involved institutions worked to address both short-term and long-term needs for these threatened plants by implementing specific conservation programmes.

Based on common criteria, a priority list of target plant species, mainly selected according to the regional responsibility criterion and/or assessed as threatened in the global and/or regional IUCN Red List, was elaborated. For selected species, germplasm conservation, curation and storage in seed banks was carried out, considering the national and international regulations and standards. As a precautionary measure, accessions were duplicated in the seed banks of the partners or other institutions. Germination experiments were carried out on a selected group of threatened species chosen for further *in situ* actions and plant production.

A total of 50 translocations were implemented in all six islands, focused on plants with different biological cycles and ecological requirements. Different methodological protocols, which included different origin of the genetic material, type of propagative material and/or planting methods, were tested. Additionally, several management actions (e.g. fence erection, eradication of invasive or introduced plants) were implemented, often correlated to translocation actions, experimenting with different methodological protocols depending on the local ecological conditions and on the target plant. For each conservation programme a specific mid- and long-term

monitoring protocol was planned and implemented in order to ensure its sustainability. The programmes were implemented in collaboration with the local and regional authorities, and local stakeholders are actively involved in the monitoring activities.

All project results are disseminated through the website (www.care-mediflora.eu) and social networks. The project experiences and lessons learnt are shared in order to co-develop technical aspects, to refine methodologies and to plan further successful *in situ* conservation programmes.

The CARE-MEDIFLORA project represents the first attempt to develop common strategies and a great opportunity to join and harmonize methods and methodologies focused on threatened plant conservation in unique natural laboratories such as the Mediterranean islands.

Conservation of endemic *Colchicum* species distributed Mediterranean Region of Turkey

Neriman Özhatay, Serpil Demirci Kayıran & Erdal Kaya

Turkey is a major centre of diversity and speciation with the high endemism rate because of its geographical location, climate, topographic features and situated at the cross section of three phytogeographic regions - Mediterranean, Irano-Turanian and Euro-Siberian. The genus *Colchicum* is represented by 52 taxa of which 31 are endemic to Turkey. Because of the high morphological uniformity and low number of diagnostic characteristics among species, the taxonomy of the genus has always been a matter of question to identify *Colchicum* species. The genus *Colchicum* is represented in Turkey by a number of species several of which belong to a polyploidy complex of great taxonomic difficulty. Due to species diversity, and endemism rate Turkey seems to be gene centre of *Colchicum*. The following species are endemic to Turkey and autumn and winter flowering species (21) marked by bold. The species marked by + have very local distribution.

- | | |
|---|---|
| + <i>C. antepense</i> K. Perss. | + <i>C. manissadjanii</i> (Azn.) K. Perss. |
| <i>C. balansae</i> Planchon | + <i>C. maraschicum</i> E. Kaya&N. Ozhatay |
| <i>C. baytopiorum</i> C.D. Brickell | + <i>C. micaceum</i> K. Perss. |
| <i>C. burttii</i> Meikle | <i>C. micranthum</i> Boiss. |
| + <i>C. chlorobasis</i> K. Perss. | + <i>C. minutum</i> K.Perss. |
| <i>C. dolichantherum</i> K. Perss. | + <i>C. munzurensis</i> K.Perss. |
| + <i>C. erdalii</i> N.Ozhatay | + <i>C. osmaniyense</i> N.Özhatay&E.Kaya |
| + <i>C. figlalii</i> (Ö. Varol) Parolly & Eren | + <i>C. paschei</i> K.Perss. |
| <i>C. heldreichii</i> K. Perss. | <i>C. sanguicolle</i> K.Perss. |
| <i>C. hirsutum</i> K. Perss. | <i>C. serpentinum</i> Woron. ex Misch. |
| + <i>C. ignescens</i> K. Perss. | <i>C. sieheanum</i> Hausskn. ex Setf. |
| + <i>C. imperatoris-friderici</i> Siehe ex K. Perss. | + <i>C. stevenii</i> Kunth |
| + <i>C. inundatum</i> K. Perss. | <i>C. szovitsii</i> Fisch. et Mey. |
| + <i>C. lagotum</i> K. Perss. | ssp. <i>branchyphyllum</i> (Boiss.et |
| <i>C. leptanthum</i> K. Perss. | Hausskn.) K. Perss |
| + <i>C. macrophyllum</i> B.L. Burtt | <i>C. trigynum</i> (Steven ex Adam) Stapf |
| | <i>C. turcicum</i> Janka |

On-farm conservation impact on cowpea diversity in Greece

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Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most important food and forage legumes in the semiarid tropics, while its domestication is presumed to have occurred in Africa. Nowadays, its cultivation extends worldwide. The evolution of cowpea over time and space has resulted in cultivation of numerous local populations throughout the world. These have been spread over short or even long distances and gradually adapted to different climatic and soil conditions. A remarkable number of cowpea landraces are therefore cultivated in many Mediterranean countries like Greece, mainly on a small scale by farmers for their own consumption thus evolved without the implementation of formal breeding processes. The empirical selection by the farmers as well as the local people- consumers' preferences (e.g. consumption as seed or/and fresh pods) led to the divergence of cowpea genetic material and thus enhanced the amount of diversity of the species. Our study showed that a large genetic diversity is still being maintained in Greece and phenotypic and genetic variation has been conserved mainly through on-farm conservation, especially in isolated areas like islands. On-farm conservation is considered therefore a strategy that can be effective on cowpea material safeguarding and evolution. Increasing farmers' awareness regarding the importance of genetic material conservation, financial supporting and promoting the consumption of traditional products could enhance their cultivation and ensure the conservation of these important genetic resources.

SYMPOSIUM 12

Invasive plants: botanical gardens, orchards, crops and aquatic habitats as hotspots of spreading the alien species in Mediterranean

Organisers: Stephen L. Jury and Olja Vasić

Programme

- 1) **Tanner R.:** Mitigating the impacts of invasive alien plants through international cooperation.
- 2) **Mannino A. M.:** Alien macrophytes in the Mediterranean sea: an overview.
- 3) **Papini A. & Santosuosso U.:** Modelling the center of origin and the spreading pattern of *Caulerpa* invasion in the Mediterranean.
- 4) **Farelo P., Gómez-Bellver C., Montserrat J. M., Pyke S., López-Pujol J., Nualart N. & Ibáñez N.:** Montjuïc Mountain (Barcelona): A hotspot for plant invasions in a Mediterranean city.
- 5) **Del Guacchio E.:** The role of the botanical gardens of Campania (Italy) in introducing invasive plants.
- 6) **Jury S. L.:** *Nicotiana glauca*: a neglected invasive?
- 7) **Herrando-Moraira S., Viales D., Nualart N., Gómez-Bellver C., Ibáñez N., Massó S., Cachón-Ferrero P., González-Gutiérrez P. A., Herrera I., Shaw D., Stinca A., Wang Z. & López-Pujol J.:** From greenhouse to the wildlife: global invasion patterns of *Kalanchoe x houghtonii* (Crassulaceae).

Mitigating the impacts of invasive alien plants through international cooperation

Rob Tanner

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The European and Mediterranean Plant Protection Organization (EPPO) is an intergovernmental organisation responsible for cooperation in plant health between 52 member countries. EPPO's responsibility in invasive alien plant (IAP) prevention is to analyse potential risks of specific IAP and recommend preventive measures for newly emerging species that have detrimental economic, ecological and social impacts. When presented with a large pool of invasive, or potentially invasive alien plants, prioritizing species for pest risk analysis (PRA) is an essential prerequisite to focus limited resources. With this in mind, EPPO has developed a tool – the EPPO prioritization process for invasive alien plants which can be used to produce a list of invasive alien plants that are established or could potentially establish in the EPPO region, and to determine which of these have the highest priority for a PRA. For specific IAP species, EPPO facilitates Expert Working Groups to evaluate risks through the compilation of pest risk analysis. In addition, EPPO maintains an alert list of potentially harmful species along with a comprehensive database (EPPO Global Database, <https://gd.eppo.int/>) detailing species specific information. Through consultation, EPPO develops Standards and guidelines for individual species and works with experts in industry and governments to provide Codes of Conducts for best practices. All of the aforementioned tools will be discussed in the context of management of IAP in the EPPO region and we will explore how the dissemination of information, in various formats, can be improved to assist stakeholders in the battle with IAP.

Alien macrophytes in the Mediterranean Sea: an overview

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The Mediterranean Sea, one of the most complex marine ecosystems, is inhabited by a rich and diverse biota which is disproportionate to its dimensions. Such high species richness makes the Mediterranean Sea a true hotspot of biodiversity. However, the Mediterranean Sea is amongst the most impacted regional sea areas, due to increasing levels of threats, mainly driven by human activities such as climate change and the introduction of non-indigenous species (NIS, i.e. organisms introduced outside of their natural, past or present, range and outside of their natural dispersal potential). NIS may in time become invasive (i.e. invasive alien species (IAS)) with severe impacts on biodiversity and ecosystem services. Due to the dramatically accelerating rate of such introductions (nearly 1000 marine NIS so far) the Mediterranean Sea may be considered as a true hotspot of marine biological invasions in terms both of the number of species and rate of introduction. In the marine realm, species richness not always confer an “invasion resistance”. For instance, biological invasions may severely affect Marine Protected Areas, whose major aim is biodiversity conservation, due to their proximity to marinas or tourism activities.

The Mediterranean Sea harbours the largest number of non-indigenous macrophytes (around 120-130 taxa) and their number has steadily increased over time. The main vectors of introduction of non-indigenous macrophytes into the Mediterranean Sea are shellfish aquaculture, shipping and the Suez Canal, while the main donor region is the Indo-Pacific Ocean. Most of Indo-Pacific invaders are still confined to the Eastern Mediterranean Basin whereas some have spread to the Western Basin, and with the forecast increase of temperature the westward spread is expected to continue.

In the Mediterranean Sea, the Rhodophyta *Womersleyella setacea* (Hollenberg) R. E. Norris and the Chlorophyta *Caulerpa cylindracea* Sonder, successfully colonizing valuable habitats (e.g. coralligenous outcrops and vermetid reefs), are among the most harmful IAS.

Due to the significant threats biological invasions pose, NIS are targeted in the more recent legislative instruments, such as the Strategy on Invasive Species, the Marine Strategy Framework Directive and the Biodiversity Strategy. Accurate and reliable data on the distribution, pathways and impacts of NIS, contained in several inventories and databases which share their data over the web, are essential for developing effective policies for prevention and control. However, to stem the tide of IAS introduction, a coordination and cooperation among all the States bordering the Mediterranean Sea is needed.

Modelling the center of origin and the spreading pattern of *Caulerpa* invasion in the mediterranean

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Two species of genus *Caulerpa*, *Caulerpa taxifolia* (M. Vahl) C. Agardh and *C. racemosa* (Forskål) J. Agardh are among the most relevant invasive species in the Mediterranean, possibly also in relation to climate change. Their presence is affecting the presence of native species of benthonic algae and the prairies of *Posidonia oceanica*.

The origin of the invasions was previously investigated and, while the center of origin of the invasion of *C. taxifolia* is known (accidental release from an aquarium), it is still a matter of debate for *C. racemosa*.

One of the method employed for this type of analysis, is the Geographic Profiling, a method that was first used to simplify the localization of serial killers home on the basis of the site of the offenses. In the case of invasive species the employed data are the observations in the field reported on a map. The map presents the area of most probable point of origin of the invasion with a red color and the areas with lower probability with other colours (normally yellow and green). Since the method implies the presence of a buffer zone around the origin, where the spreading would not occur (hence dispersal possible only at a given distance, variable depending on the species), ad hoc assumptions based on the biology of the investigated invasive species should be done case by case.

The method can be further refined by dividing the data set in more homogenous subsets of observations with K-means algorithm; increasing the robustness of the observations with a jackknife technique and comparing the results with other methods of analysis of the invasion pattern, such as DB-scan and Isolation Forest.

The use of these methods allowed for *C. racemosa* to exclude a lessepsian origin of the invasion and rather to point at an unvolunteer transport by ship, with the possible center of the origin of the invasion localized most probably in South Italy.

All these methods, implemented in Python programming language by the authors, are open source and available on the internet. These methods can be useful for analyzing also other pattern of distribution of invasive species or, in general the biologicla data set characterized by a starting point on a map.

Montjuïc hill (Barcelona): A hotspot for plant invasions in a Mediterranean city

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The Mediterranean Basin is one of the areas with the highest concentration of alien species in the world, because of its relatively mild climate, the highly modified landscapes and the rich habitat diversity. We have chosen Barcelona, the large Mediterranean city, as a case study to illustrate how urban areas can become major pathways for the introduction and establishment of alien plants, most of which coming from gardening practices. Specifically, we have selected Montjuïc, an urban hill of ca. 3.6 km², located in the sea front. We hypothesized that Montjuïc hill would be a hotspot for plant invasions, given by a series of considerations: (1) it is a deeply transformed area, with land-use changes; the hill was the main quarry of the region from the Iberian and Roman periods until the middle of the 20th century, (2) the occurrence of several artificial “gates” to alien plants, such as the seaport, the expressway, and others, (3) the Barcelona Botanical Garden (partially built on a rubbish dump) as well as a large part of Barcelona’s urban parks, are situated within Montjuïc hill. We present herein the results of a project aimed to obtain a comprehensive catalogue of the hills’s alien flora. An extensive fieldwork in the study area has been carried out over four years, combined with database/literature search, to identify all alien plant species, both casual and naturalized. A total of ca. 270 alien taxa have been identified for Montjuïc hill, which is almost the half of reported for Catalonia, and almost one third of that for the whole Spain, hereby confirming the role of this area as a local hotspot for alien plants. Although most of the alien flora of the Montjuïc hill is shared with these areas, there are several floristic novelties at both a local and regional level.

The role of the botanical gardens of Campania (Italy) in introducing invasive plants

Emanuele Del Guacchio

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Patrician parks, private collections and botanical gardens have played, especially in the past, a crucial role in the invasion by alien plants. This is true also for the alien flora of Campania (Southern Italy), the most densely inhabited region of Italy and one of the most invaded ones. The royal parks of Caserta, Portici, and Capodimonte (Naples) were inaugurated under the Bourbons between the end of the XVIII and the middle of XIX centuries. The important Hortus Camaldulensis of the Count Ricciardi thrived during the same period. Also, private botanical gardens were present in the region since the XVI century. In addition to these, the present-day botanical garden of Naples was the first public one. Relying on the still existing catalogues of these gardens, we are able to assess that, among the alien plants deliberately introduced into Campania, 24% was first recorded in botanical gardens. Unfortunately, however, before the XVIII century, data on introduced plants are occasional (and often not referable to modern Campania with certainty). An exception is constituted by the ancient documents about the mediaeval *Schola Medica Salernitana*. Among the species first recorded for Southern Italy as cultivated in the botanical gardens, we find numerous of the most harmful invasive plants nowadays present in the region, such as *Ailanthus altissima* (Mill.) Swingle. In various occasions, we have adequate documentation about their first introduction into the region (which in some cases corresponds to the very first cultivation in Europe). Surprisingly, the botanical gardens were also involved in the deliberate introduction of plants such as *Amaranthus deflexus* L. which could be believed to have been accidentally imported, given their apparent lack of horticultural interest. *Salpichroa oranifolia* (Lam.) Thell., however, arrived to the botanical gardens of Naples as a contaminant of pots. In some other cases, it is very likely that the introduction dates back to more ancient times (even if a precise datation is lacking) and that the botanical gardens did not play a relevant role in their diffusion. In addition, the introduction of some species through the botanical gardens did not always correspond to the beginning of their colonization. For example, *Eucalyptus camaldulensis* Dehnh. was present in the Garden of Camaldoli, but only much later its wide employment for forestry allowed its naturalization. Nevertheless, the registration in the catalogues of the time is relevant for reconstructing the chronology of the invasion and detecting secondary centres of expansions.

***Nicotiana glauca* Graham: a neglected invasive?**

Stephen L. Jury

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Nicotiana glauca (Tree Tobacco) appears becoming widely naturalised in the Mediterranean. Unlike *Nicotiana tabacum*, it contains the very poisonous alkaloid anabasine and not nicotine and there are reports of poisoning fatalities when people have tried to use it as a smoking substitute. In its native South America (Argentina and Bolivia), the species is self incompatible, but in Europe and North Africa it appears to be self compatible and adopts a weedy strategy. It has been seen to be pollinated by humming-bird hawk moths in Europe as opposed to humming birds and sun birds. It is also a host of Tobacco Mosaic Virus, an unhelpful problem for Spanish tomato growers in Almería where the species grows abundantly around their plastic greenhouses in the dry ramblas.

From greenhouse to the wildlife: global invasion patterns of *Kalanchoe x houghtonii* (Crassulaceae)

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The invasive alien species are currently considered one of the main threats to global biodiversity, with ornamental horticulture being the major introduction pathway of alien plants. One of the most rapidly expanding invasive plants in recent times is *Kalanchoe x houghtonii* (Crassulaceae), an artificial hybrid created in the 1930s in the United States, by experimental crossings between two species endemic to Madagascar, *K. daigremontiana* and *K. tubiflora*. Soon, thanks to its large colonizing capacity and to its extended ornamental use, this nothospecies escaped from cultivation and quickly spread in many parts of the world. Its actual range is not well known because of the lack of a formal description until recent times (2006), and its strong morphological resemblance with one of its parentals (*K. daigremontiana*). The study delimits for the first time the present distribution area of *K. x houghtonii* at global scale by gathering and validating all the occurrences and to track its colonization history. Although it did not reach a global distribution until the 2000s, *K. x houghtonii* now can be found in all continents except Antarctica. In the Mediterranean Basin, the species was detected at late 1990s, and at present it is behaving as an aggressive invader. In some areas, such as the eastern part of the Iberian Peninsula, it is a very common species in urban and peri-urban habitats. Its potential distribution, estimated with MaxEnt modelling, is mainly centered in Mediterranean-climate and subtropical regions, from 20° to 40° of both northern and southern latitudes. Unexpectedly, niche models suggest a considerable reduction of its range at worldwide scale (of up to one-third compared to the present) concomitant to a poleward migration for the year 2070, which might be related with the Crassulaceae Acid Metabolism (CAM) of *K. x houghtonii*.

SYMPOSIUM 13

Advances in lichen diversity in the Mediterranean region

Organiser: Ana Rosa Burgaz

Programme

- 1) **Guttová A., Slovák M., Kučera J., Senko D., Vďačný P., Zozomová-Lihová J., Melichárková A. & Fačkovcová Z.**: Revealing evolution, biogeography and ecology of Mediterranean centred genus *Solenopsora*: An integrative approach.
- 2) **Burgaz A. R., Gutiérrez-Larruga B., Rodríguez-Arribas C. & Pino-Bodas R.**: The genus *Cladonia* in Greece.
- 3) **Llop E.**: Lichen diversity from the Sicoric territory, continental Western Mediterranean region.
- 4) **Sohrabi M.**: Iranian Lichenology: Progress and Problems.
- 5) **Pino-Bodas R., Gargiulo R., Cano E. & Burgaz A. R.**: Assessing the genome wide RAD sequencing method to address the species delimitation in the genus *Cladonia* (*Cladoniaceae*, *Ascomycota*).

Revealing evolution, biogeography and ecology of Mediterranean centred genus *Solenopsora*: an integrative approach

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Filling the gaps in the knowledge on diversity, species boundaries, evolutionary history, or ecological factors driving distributions of nowadays non-cosmopolitan lichen groups, but centred in the Mediterranean, is exciting field. Members of the genus *Solenopsora* A. Massal. (*Catillariaceae*; current molecular studies outlined the position within a recently described and morphologically diverse family *Leprocaulaceae*), are good example of such organisms. Based on multilocus DNA sequence data we clarified the relationships between the *Solenopsora* taxa in the Mediterranean basin and Europe. We identified two major lineages characterized by thallus organization, presence/absence of rhizines, secondary chemistry, and anatomy of the upper cortex. We determined ecological niches of *Solenopsora* congeners occurring in Europe in the area representing their ecological optima in the biogeographical centre of their distribution and the key ecological factors shaping their environmental niches, looking both at climatic as well as non-climatic covariables. We also focused on the closely related species pair having its distributional limit in more continental climate of the Western Carpathians and Pannonia, where they geographically segregate. The analyses showed that their distribution reflects ecological niche conservatism rather than ecological differentiation. Their potential occurrence was projected to Last Inter-Glacial, Mid-Holocene, Last Glacial Maximum, as well as to future climate change scenarios. The aspects of vicariance of European *Solenopsora* taxa (they colonize different rock types – sedimentary and metamorphic, e. g. ultramafic), as well as their distribution ranges in connection to dispersal strategies and abilities are approached by exploration of photoautotrophic components of lichen symbioses.

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The genus *Cladonia* in Greece

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Greece is a fragmented and tortuous country with a coastline very twisty and a large number of islands. There are two major mountain ranges: part of the Dinaric Alps in the W with mostly chalky karstic relief, extending towards the Peloponnese and those who belong most of the Greek mountain ranges where Mount Olympus is located, with the highest peak in Greece (Mytikas peak, 2919 m), and the Rhodope Mountains in the NE with metamorphic rocks, complete with some southern islands.

The Mediterranean climate is dominant except in some northern regions. Several vegetation belts are recognized in the country. Most of the lower terrains harbour Mediterranean vegetation constituted of maquis and phrygana while the mixed deciduous woodland, pines, beech forest, mixed beech-fir and spruce forest are situated in localities higher than 500 m altitude.

There are no previous studies of the group but the data are scattered in the bibliography and therefore the study of the *Cladoniaceae* family in the country has been carried out being only represented the genus *Cladonia*. As a result of collections in 190 locations during three years (2015, 2017 and 2018), nearly 1000 specimens of *Cladonia* have been studied. Seven new records of *Cladonia* are provided to Greece: *C.corsicana*, *C. digitata*, *C. dimorpha*, *C. macrophyllodes*, *C. polycarpoides*, *C. subturgida* and *C. subulata*.

The distribution of many of the previously mentioned taxa is extended getting up to 42 recognized species to Greece and the chemical variability of the species is discussed. We found several chemotypes in *C. cariosa*, *C. firma*, *C. furcata*, *C. homosekikaica*, *C. humilis*, *C. parasitica*, *C. pyxidata*, *C. rangiformis* and *C. symphycarpa*.

The commonest species are: *C. fimbriata*, *C. foliacea*, *C. furcata*, *C. chlorophaea*, *C. pyxidata* and *C. rangiformis* which have altitudinal ranges higher. More than half of species appear only in the submediterranean belt with temperate climate such as: *C. borealis*, *C. caespiticia*, *C. ciliata*, *C. coccifera*, *C. crispata*, *C. cryptochlorophaea*, *C. diversa*, *C. floerkena*, *C. graeca*, *C. homosekikaica*, *C. macilenta*, *C. parasitica*, *C. phyllophora*, *C. polycarpoides*, *C. polydactyla*, *C. rei*, *C. scabriuscula* and *C. uncialis*.

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Lichen diversity from the Sicoric territory, continental Western Mediterranean region

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The Sicoric territory is a vast and low plane located in the northeast of the Iberian Peninsula, with a Mediterranean xeric bioclimate. Biogeographically, the area is included in the Low Aragonese sector, within the Mediterranean Central Iberian province. Despite climatic features, with low rain and extremely contrasted temperatures between summer and winter; the territory has been highly occupied by agriculture. Herbaceous crops cover most of the area, mixed with orchards. Consequently, natural vegetation has receded to unproductive areas. Most of plant communities are composed by bushes and herbaceous plants; however, small patches of forest scatter in this complex matrix.

Lichen diversity in this area has been almost neglected, except for some occasional quotations in studies focusing on specific taxonomic groups or included in more generic works, ranging a wider geographical scope. Thus, a couple of surveys were organised in some localities in order to cover this lack of knowledge.

Seven localities were examined for lichens, growing in all the available substrata: rocks, trees, bushes, and soil. The surrounding landscape matrix was considered in two sorts. Four localities were standing in areas enclosed on natural vegetation, and three sites were located in a complex matrix of crops and natural plant communities.

The study has yielded a catalogue of 129 taxa. Among them some rare species for the area, such as *Verrucaria geophila* Zahlbr., *Verrucula polycarparia* Nav.-Ros. & Cl. Roux, *Thrombium epigaeum* (Pers.) Wallr., or *Placidium tenellum* (Breuss) Breuss. The estimation in species richness gives a range between 156 and 195 species, quite far for the current number. The great number of singletons, counting for almost half the catalogue, biases that estimation. No significant differences in species richness arise between habitats.

Lichen diversity has been examined in terms of species composition and abundance of functional traits, and compared between both kinds of matrix: natural and mixed. The matrix determines a slightly different composition in species. This variability is higher in localities within natural habitats. Otherwise, abundance of functional traits does not differ between sites, and is independent of landscape matrix. Stress generated by environmental conditions is the main driver. Thus, most of the majority of the species share similar adaptations: moderate to high tolerance to aridity, nitrophilous, and tolerance to medium to high levels of disturbances.

Iranian Lichenology: Progress and Problems

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The lichen flora of the Iran has started to receive new attention by founding of the Museum of Iranian Lichens at the Iranian Research Organization for Science and Technology (IROST) in Tehran in 2017. To be precise, till date, the Iranian lichen checklist includes 940 species, 4 subspecies, 8 varieties and 2 forms. The first checklist of lichens in Iran was published in 2004 (Seaward et al, 2004). The second revised checklist was published in 2008 (Seaward et al, 2008). and the last updated version of the checklist is being available online soon at www.mycolich.ir (Sohrabi et al, 2019). and will be taken into account most recent changes, which have occurred in the lichen flora during 2008-2019 and includes all known new species for Iran. Every year, new species for Iran are recorded, and as a result the numbers of lichens reported in Iran differ in publications of different years. Some geographical regions of Iran *viz.* Caspian Hyrcanian mixed forests, Arasbaran Biosphere Reserve and Zagros Oak forests, dry steppes and deserts of central Iran, and high mountains of Alborz and Zagros are undoubtedly lichen diversity hotspots. In this project some of these hotspots were visited. Over 20000 lichen samples were stored in ICH herbarium. Through this new project we are trying to gather quantitative data at spatial, temporal and taxa levels to develop the Iranian lichen flora as an international project and start our lichen conservation plans in Iran. Any progress in the Iranian lichen flora will be useful for scientists, biologists, bachelor, master and doctoral students, and amateur naturalists with special interest in lichens. Therefore, this study highlights some example of successful progress about the development of the lichen flora of Iran and discuss few problems in this approach.

Assessing the genome wide RAD sequencing method to address the species delimitation in the genus *Cladonia* (*Cladoniaceae*, *Ascomycota*)

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Cladonia is one of the largest and most diverse genus of macrolichens, including 475 species, many of which are significant components of numerous terrestrial ecosystems around the world, such as the boreal forests and Tundra biome. However, numerous species of *Cladonia* are morphologically and chemically variable, being difficult to establish which phenotypical variation corresponds to intraspecific variation and which corresponds to interspecific variation. Species delimitation studies on *Cladonia* carried out using several nuclear markers over the last years have shown low resolution establishing limits among species. Therefore, additional data using genomic techniques are necessary to clarify the species boundaries in many *Cladonia* complexes.

The aim of this study is to explore the utility of the RAD-Seq techniques to solve the species delimitation in the genus *Cladonia*. We address the species delimitation in two complexes of closely related species, *Cladonia dimorpha* complex and *Cladonia ramulosa* complex. *Cladonia dimorpha* is characterized by the presence of some split proliferations at the edge of the scyphi. This species was described for Western North America and then it was found in Europe and in the Macaronesia. However, the species has passed unnoticed because the specimens not developing proliferations can be mistaken for other taxa from *C. humilis* group. *Cladonia ramulosa* is a wide distributed species usually with scyphose podetia and one of the most morphologically variable species of this genus. It is difficult to distinguish from *C. prolifica* and *C. pseudopityrea*.

A total of 49 specimens of *C. dimorpha* complex and 43 specimens of *C. ramulosa* complex, including the entire phenotypical variation of each complex, were analyzed by RAD-Seq. The genome of *Cladonia grayi* was used to filter the reads of the lichen forming fungi and remove the photobiont reads. Different sets of parameters were tested in Bowtie to align the reads with the reference. RAD-Seq results are compared with a multilocus approach to verify whether significantly improvements in species delimitation are achieved using RAD-Seq technique.

E-poster Presentations

Phylogenetics of the genus *Origanum* L. in Greece

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The genus *Origanum* L. (*Lamiaceae*), comprises 12 taxa in Greece, whereas 7 of them are considered to be endemics or/and stenoendemics. The majority of previous research focuses on morphology, chemical composition and essences, distribution, and pharmaceutical/ chemical properties of the species both as herbs and as pills. Very few phylogenetic and phylogeographic research has been done on the basis of evolutionary relationships between species, but also for the biogeography of the genus, which is the final goal for the present PhD project. This poster will present the evolutionary relationships of 10 *Origanum* species, based on five nuclear (ITS1, ITS2, EXT, MAPKK1, AdK) and four chloroplast (psbA-trnH, psbK, rps16, trnL-trnF) genetic loci. Furthermore, maps created with program ArcGIS will be displayed, showing the geographical distribution of the species based mostly on personal field collections, but also on bibliographic and unpublished data.

Sharing the researches on the genus *Ulva* Linnaeus along the Italian coasts

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The cosmopolitan genus *Ulva* Linnaeus includes species of green macroalgae found in marine, brackish and some freshwater environments. Several species show their rapid proliferous growth and their capacity to tolerate a wide range of environmental conditions, producing in some cases “green tides”, and constituting environmental indicators. Although there is a wide literature for the determination of *Ulva* taxa, they are known for their morphological plasticity and cryptic nature that makes their morphological identification indefensible, so that many synonyms have been generated over time. At present, the knowledge of both diversity and distribution of the genus *Ulva* in the Mediterranean Sea is almost entirely based on morphological studies and there is only a few published papers dealing with molecular data. However, accurate biodiversity assessment is essential for monitoring biological introductions, and is critical for environmental management as well as for adequately evaluating temporal changes. In this context, preserved specimens of institutional herbarium are a fundamental tool for monitoring these variations.

Research conducted on the herbaria PHL (University of Messina) and ISMAR (Institute of Marine Science of Venice), as well as on new collections, allows us to progress on compiling a DNA barcode inventory of most critical taxa in the Mediterranean.

Using the plastid marker *tufA*, new molecular data have been obtained for *Ulvaceae* samples adding information to the list of *Ulva* species of the Italian coasts. In order to aid the consultation of the identified samples, digitized specimens and metadata, compiled using Dublin Core and Simple Darwin Core formats, are available on the the open access repository “Archive of Adriatic Studies” (www.archiviostudiadriatici.it) of the Institute of Marine Sciences (CNR-ISMAR) of Venice.

Natural products: a new era towards antibiotics resistance: the case of *Rosmarinus officinalis*

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Antimicrobial resistance (AMR), in common bacterial pathogens has reached alarming levels, indicating a post-antibiotic era, as many of the available treatment options become less effective. A growing number of infections, are becoming harder to treat with current antibiotic treatment. Thus, urgency is added by the lack of new therapeutic options in the development pipeline to replace those that lose their efficacy. To this end, Traditional Medicine, may offer a plethora of possibilities to combat drug resistance. Plants produce a wide range of biologically active compounds, called secondary metabolites, that could be of great importance in therapeutic treatments. The objective of the present work is to investigate the possible antimicrobial effect of an hydroalcoholic extract of *Rosmarinus officinalis*, against *Enterococcus faecium* and *Staphylococcus aureus*, two pathogens that are considered as high priority pathogens, according to antibiotic-resistant “priority pathogens” list, published by WHO. Results of our study are encouraging, as they indicate the effectiveness of the plant under study, against both microorganisms tested. The minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) of the above-mentioned pathogens were evaluated. More accurately, the MIC for both pathogens was calculated at 6 mg/mL, while the MBC ranged between 6 and 8 mg/mL. Of primary importance for the efficacy of a plant material, is its chemical composition. Chemical analysis of *Rosmarinus officinalis* performed with liquid chromatography combined with time-of-flight high-resolution mass spectrometry, indicated the abundance of carnosol a phenolic diterpene, followed by the remarkable presence of hesperidin, a flavanone glycoside.

La Flore endémique du Littoral d'Oran: Aspects Systématiques et Ecologiques

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Dans le but d'étudier les groupements floristiques du littoral d'Oran, nous avons effectué cent (100) relevés de végétation couvrant une distance d'une centaine de kilomètres depuis Terga-plage à l'ouest jusqu'à la Macta à l'est. De cette distance, les falaises et milieux rocheux couvrent (70 %), les dunes et milieux sableux représentent (30%). Les sites urbanisés (villages, ports, stations balnéaires) couvrent 60 km. Le climat général est de type méditerranéen avec un bioclimat semi-aride chaud.

L'identification de nos taxons récoltés a été faite à partir de Quezel & Santa (1962) et actualisée selon Dobignard & Chatelain (2010). Ainsi, nous avons identifié 340 espèces réparties en 59 familles. Les gymnospermes sont représentées par 4 familles. Les monocotylédones apparaissent à travers 11 familles où dominent les *Poaceae* avec 53 espèces. Les dicotylédones comptent 44 familles dont 5 dominent : *Asteraceae* (52 espèces), *Fabaceae* (29 espèces), Caryophyllacées 20 espèces (5,75%), Brassicacées 18 espèces (5,14%), les Amaranthacées avec 17 espèces (4,85%).

Le spectre biologique de cette flore est dominé par les thérophytes avec 170 espèces (50 %). D'autre part, la chorologie de la flore observée présente une dominance remarquable de l'ensemble méditerranéen avec 200 espèces.

Enfin, nous avons noté la présence de 18 espèces endémiques que nous allons détailler et présenter dans ce travail.

Mots clés: Flore, Littoral, Halophytes, Psammophytes, Rupicoles, Endémisme, Oran.

Micromorphological study of the seed coat surface of some *Trifolium* L. taxa in Greece and its systematic significance

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The genus *Trifolium* L. is represented in Greece by 95 taxa (species and subspecies), some of which are important not only from an ecological but also from an economical point of view. The present study aims to describe the seed coat surface patterns of 23 *Trifolium* taxa and their taxonomic implications. The seeds were obtained from herbarium specimens collected in various localities of southern Greece. Their coat surface was examined using Scanning Electron Microscope (SEM). The main seed coat patterns recognized in this study are the following: reticulate, foveolate, papillose, tuberculate, papilloso-tuberculate, smooth and rugose. Our results are in agreement with current bibliography. However, some unusual micromorphological features are observed that enhance the deviation from the patterns which have been described until now and increase considerably their diversity. These features are a criterion to distinct the investigated taxa and may be proved useful for delimiting taxa with dubious status at species rank. Examining more species will enable us to reassess these patterns and to describe new ones.

Our results suggest that taxonomic implications of seed surface characters are confined to ranks lower than subgenus and section and concerns only some groups of species. This finding is in accordance with other relative studies.

A more holistic approach of the study of the seed coat surface and its patterns will take into consideration not only its taxonomic and evolutionary significance but also its ecological one.

Karyological study of some *Centaurea* species (*Compositae*) from the Bulgarian flora

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Centaurea L. (*Compositae*) is a second larger genus in the Bulgarian flora (after the apomictic genus *Hieracium* L.) and is among the most taxonomically intricate groups in the Euro-Mediterranean region. One of the main evolutionary mechanisms of the genus is the descending dysploidy. In the scientific literature, 7 basic chromosome numbers were reported for the *Centaurea* species ($x = 8, 9, 10, 11, 12, 13, 15$). Polyploidy also plays a significant role in the evolution of the genus. This study is part of a more extensive investigation of the genus in connection with the development of the 12th volume of the Flora of the Republic of Bulgaria and provides new information on the chromosome numbers of 10 species (11 populations). Four species were studied for the first time, *C. kamciensis* Kocev & S.Gančev, *C. jankae* Brândză, *C. gracilenta* Velen., *C. sakarensis* Bancheva & Raimondo, and thus the data were new to science. For *C. besseriana* DC. a tetraploid chromosome count was established, which was also communicates for the first time. In total, four of the studied populations are tetraploid. All studied taxa are of conservation significance, being endemic or threatened with extinction. In this sense, the data from the current study can be used in defining conservation policies for the target species.

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PhytoKaryon: A karyological database of the Flora Hellenica

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Greece is characterised by a remarkable plant diversity (~6500 species and subspecies), that has been the focus of intense scientific interest for a long time.

PhytoKaryon (www.phytokaryon.gr) is an online database, conceived and built to allow the accumulation of karyological data from all available bibliographical references concerning Greek flora. The database currently includes more than 3500 records, corresponding to approximately 1600 plant taxa of Greece. Each entry provides information for every karyological record as it appears in the original publication on taxonomy, chromosome number, karyotype morphology, specimen details and information on collecting locality of the studied material. Moreover, the IUCN status, as given by the authors, and information on habitat, life form and chorology of the taxon are also noted. PhytoKaryon will be used extensively in the future for continuous recording of all plants of Flora Hellenica.

PhytoKaryon is web based application that is designed and developed with the Laravel PHP framework.

Distribution patterns of endemic and range restricted taxa on Lesbos island (East Aegean, Greece)

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Lesvos is the largest island of the Eastern Aegean region and the third largest Greek island covering an area of approximately 1630 km². Its geology is diverse; its largest part is characterized by the presence of volcanic rocks, while ophiolites and schists also have significant appearances. Despite the absence of high mountains, Lesbos has intense horizontal and vertical fragmentation and a large variety of habitats. These factors, combined with the geological history of the island and its geographical position, have contributed to the presence of a flora very rich in taxa (c. 1600 species and subspecies) and phytogeographically interesting. The island is considered to be one of the floristically very well-studied areas of the Aegean. The most important phytogeographical aspect of Lesbos is the presence of plant taxa with a limited geographic range and particularly taxa predominately or exclusively restricted to the coasts of Asia Minor and the East Aegean islands. However, the number of Greek endemics is low compared to other islands of central or southern Aegean.

The aim of our study is to examine the distribution patterns of Greek endemic and range restricted taxa on Lesbos. Anatolian taxa with their westernmost occurrence on Lesbos (and perhaps other East Aegean Islands) are also considered. In particular, our targets are: a) to investigate whether the distribution of the endemic and range restricted taxa on the island is sufficiently known or there are areas still insufficiently explored; b) to identify the areas with the highest presence of endemic and range restricted taxa and to compare them with the protected areas of the island and c) to investigate the phytogeographical links of Lesbos with the largest islands of the East Aegean floristic region. To this end, the European Environment Agency (EEA) 10x10 km reference grid was divided into 5x5 km cells, 97 of which cover Lesbos and its offshore islets. The presence or absence of each taxon considered was recorded on every cell. In total, forty-one endemic and/or range restricted taxa were recorded (out of the 297 present in the EAe floristic region), together with another twenty Anatolian taxa whose distribution border lies on the Eastern Aegean islands. The data used were extracted from literature sources; our own field investigations have also been included in the analysis. The presence of *Pterocephalus pinardii*, an East Mediterranean species, on Lesbos is confirmed with a herbarium specimen.

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Ecology, identification and symbiosis of desert truffles from northeastern algerian coastal dunes

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Throughout the Mediterranean basin, North Africa, Saudi Arabia and the United Arab Emirates, desert truffles (species of different hypogeous Ascomycetes genera, among which *Terfezia*, *Tirmania*, *Picoa* and some *Tuber* species) play an important role in both folklore and cuisine. Besides their culinary and medicinal properties, they are also an important role in terrestrial ecosystems and their potential use as mycorrhizal partners has been encouraging both in accelerating plant growth and reducing their mortality rate.

In Algeria, for several years, greater attention has been focused on desert truffles of Southern and Western of the country, no studies are as yet, however, available on the northeastern sands of the country. The current work is the first to be concerned on desert truffles from northeastern Algerian littoral dunes. Its aim is to review knowledge on ecology, symbiosis and diversity of desert truffles of those coastal dunes, where collection and sale provides a growing seasonal trade.

We required two years field prospection's, soil analysis, ascocarps morpho-anatomical and molecular analysis.

We concluded that the 10 prospected truffle fields share an acid sandy-loam soil and a notable abundance of many subspecies of *Tuberaria gutatta* (L.) Fourr. (1868), who proved as desert truffles symbiotic partner. Three sandy truffle species are recorded: *Terfezia arenaria* (Moris) Trappe (1971), *Terfezia fanfani* Mattiolo (1900) and *Tuber gennadii* (Chatin) Patouillard 1903.

This data is the first to review knowledge on desert truffles of Northeastern coastal dunes and to report *Tuber gennadii* and *Terfezia fanfani* in Algeria.

Keywords: Northeastern Algeria, littoral dunes, desert truffles, *Terfezia arenaria*, *Terfezia fanfani*, *Tuber gennadii*, *Tuberaria gutatta*.

Phytochemistry and biological activities of *Lycium* from Algeria

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Lycium is one of the genera of the *Solanaceae* family, including about 80 species. The species of this genus have long been used as a traditional medicine and functional food around the world. Previous phytochemical studies on the genus *Lycium* indicated the presence of alkaloids. The objective of this study was to evaluate in vitro the antioxidant and anti-enzyme activities of crude ethanolic extract and fractions from the leaves and roots of *L. europaeum* L. Phenolic compounds and flavonoids were quantitatively analyzed. The antioxidant effect was determined by the β -carotene bleaching, DPPH and FRAP methods. The anti-enzyme activities of the extracts were tested against acetylcholinesterase and butyrylcholinesterase which are the key enzymes involved in the pathogenesis of Alzheimer's disease. High phenolic and flavonoid contents were detected in the polar extracts. For what, concerning the antioxidant activities, the n-butanol fraction showed high activity in all assays. Moreover, the n-butanol fraction exhibited also anti-cholinesterase activity. The obtained results indicate that the plant extracts can serve as a potential source of natural antioxidants and cholinesterase inhibitors.

Keywords: *Lycium europaeum*, antioxidant activity, anti-cholinesterase activity, flavonoids, phenolics.

Exploring a method for the conservation of *Juniperus phoenicea* at two sensitive ecosystems in Greece and Croatia

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Schinias National Park constitutes part of the Natura 2000 network and is a unique habitat within Attica Greece. It is the most significant coastal ecosystem within Attica. It constitutes a rare forest ecosystem of *Pinus pinea* that is a priority species for protection in accordance to Directive 92/43/EEC, as the plant communities it forms are particularly important for the conservation of Mediterranean biodiversity. The Croatian site is a coastal lowland of Zadar County, in the Ninski Stanovi municipality. According to Habitat Directive, the area is inside the SPA Ravni kotari, a Nature 2000 site of 651.17 km². Raising and grazing sheep and goats are relevant economic activities in the area, so vegetation structure and composition are affected by the pasture, above all the herbaceous layer, which is open and patchy. *Juniperus phoenicea* L. is an evergreen shrub or small tree, used in Landscape Architecture, as well as the pharmaceutical and timber industry. In coastal areas, populations of this species are, affected negatively by human activities and housing development. The limited ability to regenerate after a fire and the introduction of other species raise concerns for its conservation. Poor fertilisation and poor vitality of pollen often lead to reduced production of seed and seeds with poor germination. Plant production through asexual propagation is generally, considered difficult. Considering all of the above *in vitro* propagation of *J. phoenicea* seems to be appealing for study. Seeds, were cultured *in vitro* on half strength Murashige and Skoog (MS) at 4 different temperatures, under 16 h light or dark without producing any results and were cultured immediately after, 0-, 30- and 60-days exposure under 4 °C. None of the seeds germinated, possibly due to the inability of the embryos as the seed coat was removed and could no longer effect germination. Explants excised from nodes of native plants were cultured on four solid mediums (8 g/l agar) i.e. Murashige and Skoog (MS), Woody Plant Medium (WPM), Rugini Olive Medium (OM) and Juglans Medium (DKW), containing 30 % sucrose and 1 mg/l BA. The shoot percentage was 38-53%, but the developed microshoots were short in length. Explants developed 2-3 shoots and subcultures followed to examine the produce of more shoots of satisfying length on the same mediums, however the length remained short. Further research is needed regarding the seasonal effect on the cultures as well as the use of other cytokine instead of BA.

Planning above species level is sometimes better for effective plant conservation

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New data on demography, niche modeling, genetic diversity (including allozymes, cpDNA, and chromosome numbers) and phylogeography of closely related taxa of *Delphinium* ser. *Fissa* (*Delphinium fissum* subsp. *fissum* and subsp. *sordidum*, *D. bolosii* and *D. mansanetianum*) in the W. Mediterranean are given. New scientific information suggests that in certain cases, conservation plans at supraspecific level better addresses appropriate threat evaluation and effective protection measures when taxa are closely related and subject to unconnected multiple local, regional and national administrations, beyond territorial borders.

Study of the therapeutic power of the methanolic extract of an endemic plant (*Hammada scoparia*) from southeastern Algeria on the oxidative effect induced by an organophosphorus pesticide in albino Wistar rats

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The objective of this study was to determine the phytotherapeutic potential of the methanolic foliar extract of the plant *Hammada scoparia* following toxicity induced by a synthetic chemical, chlorpyrifos-ethyl (insecticide of the organophosphorus family). To do this, male albino Wistar rats weighing between 180 and 200 grams were divided into six lots (n = 5): two batches were considered as controls receiving daily gavage a volume of 1 ml of sterile physiological saline or chlorpyrifos-ethyl insecticide (9 mg / kg) respectively. The rats of the third batch received a dose of 400 mg / kg of the foliar methanolic extract of the species *Hammada scoparia*. The remaining three batches were subjected to daily gavage of the same dose of chlorpyrifos-ethyl, followed by a dose of the foliar extract of the plant species studied (3 doses were tested: 100, 200 and 400 mg / ml). kg). After two weeks of treatment, the blood samples taken from the sacrificed rats were analyzed for serum lipid parameters (cholesterol, triglycerides), transaminases (ALAT and AST) and cholestatic enzymes (PAL and GGT). Some convincing results have been recorded. The rats reacted differently depending on the insecticide dose and the leaf extract received. Already, we can say that the extract of the plant *Hammada scoparia* has therapeutic virtues that seem interesting. A difference in the recorded values of lipid parameters (cholesterol, triglycerides), Transaminases (ALAT and ASAT) and Cholestatic enzymes (PAL and GGT) was observed in the treated rats compared to those of the controls. However, these results obtained should be taken up again and deepened by using a larger number of rats and with more repetition over a longer period of time.

Keywords: therapeutic potency, chlorpyrifos-ethyl, *Hammada scoparia*, oxidative effect activity, leaf extract.

Chromosome Number and karyomorphologic analysis of Endemic *Muscari sivrihisardaghlarensis*

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The genus *Muscari* Miller s. l. is fairly popular worldwide because some of its species have attractive and fragrant flowers. The genus is represented by 41 taxa in our country. The latest taxonomic arrangements of *Muscari* genus are based on karyological data. In this study, rare endemic *Muscari sivrihisardaghlarensis* Yıldırımli & B. Selvi (*Asparagaceae*) were examined in terms of karyomorphology.

Plant materials consisted of bulbs belonging to the genus *Muscari* were collected from natural populations of Turkey. Root tips were pre-treated in 0.002 M 8-hydroxyquinoline at 4°C for 8h. The material was fixed with Carnoy for 24 hat low temperatures (+4°C). Before staining, the material was hydrolyzed with 5 N HCl for 1 h at room temperature, stained with 1% aceto-orcein and mounted in 45% acetic acid. At least 10 metaphases were examined per taxa; the best metaphase plates were photographed (100x) with a digital camera (Olympus DP-72), mounted on an Olympus BX53 microscope. Idiograms and karyotyping analyses were carried out using KAMERAM 2.9.4.0. We took into account five different asymmetry indices to analyze the karyomorphologies of the endemic *Muscari* species using KAMERAM.

According to our counts, *Muscari sivrihisardaghlarensis* has a diploid chromosome number of $2n = 18$ and its karyotype formula is $2sm + 16m$. The karyotypes had a predominance of metacentric (m) chromosomes. Five quantitative asymmetric indices were used to evaluate karyological features of the species. In conclusion, this is the first report which describes the karyotypes and chromosomal asymmetry indices of Turkish endemic *Muscari sivrihisardaghlarensis*.

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Keywords: Chromosome count, endemic, karyomorphology, asymmetry, Turkey.

Alimurgical plants database in Italy

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In recent years, interest in the consumption of spontaneous edible plants has grown exponentially. Meanwhile, for various reasons, the preservation of popular culture is scientific research, but also the preservation and enhancement of local traditions and "popular knowledge".

The consumption of fruit and vegetables, characteristic of the Mediterranean diet, has led to many ethnobotanical studies (Leonti et al. 2006, Rivera et al. 2006, The Consortium of Food and Local Nutrition 2005). Wild plants have been studied in the course of a year of history (for example Pieroni et al. 2002, Tardío et al. 2005), considered an integral part of the basin diet. of the Mediterranean (for example Vanzani et al. 2011).

Although many species considered alimurgical are wide dissemination throughout the Mediterranean basin, only a few (about 30) are currently used in human food (Rivera et al. 2006).

The creation of a database of the Italian alimurgical flora has therefore the aim of creating the system of the extensive (and often disordered) knowledge of the spontaneous edible plants acquired in Italy in the last one hundred years. The idea was therefore to create a tool for easy consultation, not only for purely speculative purposes but also for practical ones (eg cultivation, presence of active compounds, etc.).

The preparation and structuring of the database were possible through the recovery and insertion of bibliographic sources from 121 ethnobotanical and phytoalimurgical works written in Italy from 1918 to today. For each of the 200 alimurgical species considered and reported in the database, 95 fields related to taxonomic, morphological, geographical and food use characteristics were considered.

The organization of this database and its internal structure allow the retrieval of information through the online query, an "evidence - based" information resource useful for scientific communities that can gain an advantage by having a common electronic database.

The aim of this study, in short, is to provide an interesting tool to be used with the aim of re-evaluating, putting in the right light those alimurgical species, not commonly or rarely used but of great nutritional and organoleptic value assuming for them the creation of a production chain (from population research to cultivation and marketing).

This process, started with the creation of a database, is an integral part of a research doctorate currently in progress, which deals specifically with 4 alimurgical species (*Sonchus asper*, *S. oleraceus*, *Crepis vesicaria*, *Blitum bonus-henricus*).

A cretan song on Taurus Mountains: medicinal and edible plants of Ihsaniye village (Mersin -Turkey)

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During an ethnobotanical study of Mersin, the village of Ihsaniye situated in the southern part of Turkey between Taurus mountains and Mediterranean sea drew attention due to their traditions of long distance. Peasantry were of origin of the Crete Island. They were trying to preserve the cultural heritage in many aspects. This paper reports the ethnobotanical investigations performed between 2018 and 2019 to determine medicinal and wild food plants of Ihsaniye village. A total of 30 individuals were interviewed (18 women, 12 men). Totally, twenty-two plants are recorded as used as traditional folk medicine for the region. Furthermore, twelve taxa were naturally distributed sources for nutrition in the area. The plants most commonly used medicinal remedies of the village were *Hypericum perforatum*, *Salvia fruticosa*, *Ficus carica* and *Origanum vulgare*. Plants were used for the treatment of stomach ailments, wound healing and the common cold. The species most commonly used for food was found to be; *Foeniculum vulgare*, *Salvia fruticosa*, *Rhus coriaria* and *Papaver rhoeas*. This ethnobotanical study conducted in this village will enable the traditional usage of wild plants both as food sources and herbal remedies. The knowledge has been recorded in order to keep it for future generations.

Keywords: Ethnobotany, Traditional medicine, Wild food plants, Ihsaniye, Mersin, Turkey.

Taxonomic remarks on *Daphne oleoides* s.l. (Thymilaeaceae) from Sardinia

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Daphne oleoides Schreb. is a chamaephyte found in the mountains of North Africa, Europe and Middle East. The range of this species includes Albania, Algeria, Bulgaria, Corse, Greece, Italy, Kriti, Lebanon, Morocco, Sardinia, Sicily, Spain, Syria, Turkey, and Yugoslavia.

Recent observations of the natural populations of Albania, Sicily and Sardinia, have allowed to appreciate diagnostic characters in the Sardinian populations well distinguished from that of Sicily and Albania – according to the images of this taxon reported in the illustrated floras of other countries – Sardinian populations are differentiated from those of the rest of the distribution range. This suggests that the population of the Tyrrhenian island, so far attributed to *D. oleoides* subsp. *oleoides*, actually diverges for some characters that are lost in the dried material and that therefore escape the descriptions based on herbarium materials. The most obvious are the plant's habit, the colour and shape of the flowers.

D. oleoides has been described with white flowers and this character is confirmed in the direct observation of the populations of Sicily and Albania. The white colour also results from the images of this species reported in the most recent illustrated floras of other countries such as Lebanon and references to even purple flowers are not rare. The flowers of the Sardinian population are instead markedly purple-violet in colour and even more accentuated outside the teeth of the calyx, while they are rosy-whitish inside. The length of the same triangular-shaped teeth appears much shorter compared to that of the populations of Sicily and Albania. The leaves are clearly hairless, 20-30 mm long. All this led the authors to critically examine the population so far attributed to the taxon described in 1776 by the German naturalist I.C.D. von Schreber (1739–1810). On this basis, morphometric investigations have been undertaken which have meanwhile allowed us to establish that these are characters uniformly distributed in the same population, which has suggested a karyological analysis in order to establish whether the observed variation could lead to a different taxonomic treatment. On the basis of the first observations, we are inclined to treat the Sardinian population as subspecies of *D. oleoides* of which two different subspecies have already been accepted in addition to the nominal: they are *D. oleoides* subsp. *baksanica* (Pobed.) Halda and *D. oleoides* subsp. *transcaucasica* (Pobed.) Halda.

The results of the karyological analysis in progress, could suggest a different taxonomic level that in this case would lead to the establishment a new specific taxon.

An ethnobotanical study in Pöhrenk (Çiçekdağı-Kırşehir/Turkey)

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An ethnobotanical study was carried out in Pöhrenk (Kırşehir-Çiçekdağı) village between July 2018–June 2019. The village is in the Central Anatolia region of Turkey. The aim of the study was mainly to collect and identify the useful plants and to make available information about traditional knowledge of wild plants in the region.

The information including the traditional uses of wild plants was obtained from local people through face to face interviews. During this study, 36 people (25 female and 11 male) were interviewed. It was determined that 46 wild taxa belonging to 21 families were used by local people. The most common families are *Rosaceae* (24%), *Asteraceae* (25%), *Lamiaceae* (7%) and *Fabaceae* (7%). Among the used plants, 7 taxa are used as traditional folk medicine, 31 taxa as food, 11 taxa as making tools, 4 taxa as feed. In addition, the life forms of the plants are herbs (72%), trees (17%) and shrubs (11%) in descending order.

Also, the cultural importance index (CI), and use report (UR) were calculated for each species. Based on the cultural importance index (CI), the most important plants were *Polygonum cognatum* Meissn. (0.86), *Teucrium polium* L. (0.83), *Mentha longifolia* subsp. *typhoides* (Briq.) Harley (0.79), *Prunus cocomilia* Ten. (0.75), *Prunus divaricata* var. *divaricata* Ledeb. (0.75), *Prunus spinosa* L.(0.73), *Capsella bursa-pastoris* (L.) Medik. (0.65), *Rosa canina* L. (0.62), *Onopordum turcicum* Danin (0.58).

Through this study, the floral potential of a limited area and the richness of the traditional knowledge of plants was documented to provide clues to ethnobotanist (or botanist), pharmacologists, and perhaps to the planners of future local development projects.

Keywords: Ethnobotany, Traditional knowledge, Pöhrenk, Çiçekdağı, Kırşehir.

European annual species of *Alyssum* (*Brassicaceae*): phylogenetic relationships and origin of polyploids

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Genus *Alyssum* (*Brassicaceae*) comprises about 114 species. Twenty eight of them are annual herbs with native distribution in Eurasia and North Africa. In the present study, we examined phylogenetic relationships and evolutionary history of European annual *Alyssum* taxa (16 species) using one chloroplast and two nuclear molecular markers (including the cloning of PCR products to detect within-individual allelic polymorphism). The study is based on 230 population samples mostly from the Balkan Peninsula and Aegean islands, but also from the Apennine and Iberian Peninsulas, Central Europe, Morocco, and a few samples from Turkey and Iran. Ploidy levels of plants were determined by chromosome counting and flow cytometry. Molecular analyses revealed relationships of particular diploid species and origin of several (allo)polyploids, including *A. granatense*, *A. hirsutum*, *A. siculum*, *A. simulans*, and *A. turkestanicum*. In addition, the genetic variation of *A. simplex* and *A. fulvescens* indicated their non-monophyletic nature and the need of further taxonomic research.

Digging botanical history with digital tools: the Thessaloniki Aristotle University Herbarium case

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Small Herbaria sometimes hold a significant number of historical specimens, but few of them are digitized and even fewer are organized into a botanical collection software. As a result, the data is confined and not available to the broader scientific community. Thessaloniki Aristotle University (TAU) Herbarium is a relatively small Herbarium (approximately 50,000 specimens mainly from Greece) divided into two sections; modern and historical. In the latter, around 6,000 specimens, from the 19th century up to the first half of the 20th century, are kept. More than half of them belong to the collections of Dimitrios Zaganiaris, dating from 1920 to 1940. During a previous work c. 3,000 of these specimens were nomenclatural updated and georeferenced and the data found in their labels were digitized. Moreover, the annotation and imaging of about 80 specimens has been completed. In the frame of the present work the above procedure is continued, targeting to the completion of Zaganiaris' collections. However, the value of these specimens triggered the necessity of a collection management software into which their data would be stored and made available to the scientific community. Specify 6 is a biological collection management software that corresponded to that necessity. Thus, the software was adapted to fit the needs of the TAU Herbarium. Each specimen's unique barcode corresponds to an identical catalog number in the collection object sheet. Each specimen is given an accession number so that the duplicata are easily spotted. A field called "Project Name" was added so that specimens belonging to different collections (historical, modern etc.) can be distinguished. Furthermore, the software was adapted to the needs of the Greek flora, e.g. the 13 floristic regions of Greece were incorporated in the Geography tree of the software. The data can be imported into Specify 6 through a spreadsheet file, so a general spreadsheet format was created to accommodate the needs of TAU. This file can be filled up by any scientist that wishes to deposit specimens into the TAU Herbarium facilitating the data import process. So far, about 1,500 of Zaganiaris' specimens are in the process of being imported into the Specify 6 software. Upon completion, the data of these specimens will be published into a GBIF-compatible format.

Presence of *Lactuca acanthifolia* (Willd.) Soják in Turkey

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Lactuca acanthifolia was recorded for flora of Turkey based on a sterile specimen collected from Marmaris. In the course of “Revision of Turkish Lactucinae”, we performed field trips at Marmaris and Datça between 2014 and 2017 to determine its distribution in Turkey. During the revisional study, we examined plenty of specimens collected from the relevant areas in Turkey and type specimens of *L. acanthifolia* stored at K and LD from photos and several specimens of *L. acanthifolia* collected from locus classicus (Rhodos) stored at B. Although *L. acanthifolia* is characterized with vivid yellow flowers and pale brown achenes, the Turkish specimen (D. 41122, stored at E) belonging to *L. acanthifolia* is sterile and only contains basal leaves previously identified as *L. eburnea* by an anonymous author and later as *L. acanthifolia* by Jeffrey. On the other hand, most of specimens collected from Marmaris and Datça during the first field trip easily key out as *L. viminea* and the remaining specimens without flowers and achenes belong to *L. eburnea*. Although the specimens collected at the beginning of the vegetation period are looking healthy with dense decurrent and cauline leaves, they do not bloom and therefore do not produce any achenes and stay sterile during the year. A. Carlström also reported *L. acanthifolia* from Marmaris and Datça during her floristic study. However we only collected lots of specimen belong to *L. viminea* and sterile specimens belong to *L. eburnea* from the Carlström’s locations. Although *L. eburnea* is listed among the heterotypic synonym of *L. acanthifolia*, achene features of *L. eburnea* is not mentioned in the its protologue. Furthermore type specimens of *L. eburnea* do not contain any flowers and achenes. Therefore, we concluded that *L. eburnea* is a sterile and separate taxon, not a synonymous taxon of *L. acanthifolia*. Additionally Davis’s, Carlström’s and our own sterile specimens originated from Turkey should be *L. eburnea* and *L. acanthifolia* is not distributed in Turkey.

Keywords: Lactucinae, *Lactuca eburnea*, Rhodos, *Scariola*, systematic.

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Ethnobotany of the Island of Korčula (Croatia)

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The island of Korčula (area 276 km², shoreline length 182 km) is a part of the South Dalmatian Archipelago situated in southern Croatia. The island was first inhabited in prehistoric times and was colonized by the Greeks, Illyrians, Romans and Slavs (Croats). Korčula is the second most populous island in Croatia with a population of 15 522 people (2011).

The aim of this study was to record information on the traditional knowledge of wild plants used by the indigenous inhabitants of Korčula Island, who, according to our preliminary observations, have best preserved this knowledge out of all the Croatian Islands.

Between 2016 and 2018 we carried out 39 semi-structured interviews (60% of informants were female and 40% male, mean age 66). In total, 1650 citations of plant uses were registered. The mean number of species per interview was 35. The most commonly used wild food taxa are *Sonchus* spp., *Foeniculum vulgare* Mill., *Reichardia picroides* (L.) Roth, *Allium* spp., and *Daucus carota* L. (all of them used as vegetables), the fruits of *Arbutus unedo* L. (mainly eaten raw), and the leaves of *Salvia officinalis* L. (used for making recreational teas). The most interesting edible species used on the Island of Korčula is *Posidonia oceanica* (L.) Delle. *Ceratonia siliqua* L. is most commonly used to flavour a traditional alcoholic drink (rakija) and *Hypericum perforatum* L. as a medicinal plant. The other most frequently used taxa are *Pinus halepensis* Mill. (bark – used for dyeing fishing nets) and *Olea europaea* L. (a ritual plant – blessed on Palm Sunday).

The inhabitants of the island still have a rich tradition of using wild plants.

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Keywords: traditional knowledge, wild food plants, ethnobotanical heritage, South Dalmatia.

Names of Italian vascular plants published by P. Gabriel Strobl

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P. Gabriel Strobl (Unzmarkt 3 November 1846–Admont 15 March 1925) was an Austrian naturalist, devoted principally to botany and entomology. Accepted in 1866 at the Benedictine monastery of Admont, in 1870 he was ordained monk. In 1872 he enrolled at the University of Innsbruck under the guide of Anton Kerner, who provided him with the funds to undertake, in the summer of the same year, a journey through Italy to Sicily on the Madonie (at the time called Nebrodi) and Etna mountains. On Easter and in the summer holidays of 1873 and 1874, he again travelled to these Sicilian mountains.

Strobl was able to pay for these trips by selling by subscription the plants he was collecting to a series of friends and botanists from all over Europe, including P.E. Boissier (1,100 specimens), E. Burnat (900), S.F.L. Haynald (800), E. Fenzl (750), etc. His personal collections of vascular plants, divided into Italian herbarium (about 2,950 specimens) and general herbarium (more than 20,000 specimens including collections from Austria, Dalmatia, France, and Spain), were donated to the Monastery of Admont, where they are still housed. The botanical interest in Strobl is mainly related to his works on the flora of Madonie ("Flora der Nebroden" and "Die Dialipetalen der Nabroden") and on the flora of Etna ("Der flora des Aetna"), outcomes of his explorations conducted between 1872 and 1874 and of his study on the main herbaria including collections from these places (Herbarium Minà Palumbo in Castelbuono, Herbarium of Palermo, Herbarium of Catania, Herbarium of Gussone in Naples, Herbarium Centrale Italicum in Florence, Herbarium Presl in Prague). The "Flora der Nebroden" was published in installments in the journal "Flora oder Botanische Zeitung" between 1878 and 1885. "Der flora des Aetna" was published in installments in the "Österreichische Botanische Zeitschrift" between 1880 and 1885. The "Die

Dialypetalen der Nebroden" was published in installments in "Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien" in 1903.

Overall, 41 new taxa and 11 new combinations were published and part of them is still currently accepted. On the basis of collections from Strobl and other authors, six species were described, three of which dedicated to him (*Cirsium stroblii* Hayek, *Rosa strobliana* Burnat & Gremler, and *Rubus stroblii* Sabr. ex Hayek).

This survey is a first step towards the typification of the names of Italian taxa published by P. G. Strobl, as one of the actions of PRIN (Project of Relevant National Interest funded by the Italian Ministry of Education, University and Research) "PLAN.T.S. 2.0 - towards a renaissance of PLANT Taxonomy and Systematics" (Principal Investigator: L. Peruzzi).

The Genus *Aethionema* Aiton s.l. (*Brassicaceae*) in Turkey

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Aethionema is represented by 60-70 species in the world, and the most of these are distributed in Irano-Turanian phytogeography region. *Aethionema* represented by 55 taxa, four of which are subspecies in Turkey. Numbers of endemic taxa are 31 and the endemism rate is 60.7 %. Turkey is not only the main gene center but also the main diversification center together with Iran. It is one of taxonomically baffling genus in Turkey. Many plant specimens couldn't be identified or misidentified because of requirements of mature fruit for identification of some taxa, taxonomic status of some species in the genus is unclear, so some species were transferred to different genera. Taxonomy of the genus has become even more complicated by recently describing many new taxa for genus. Descriptions of *Aethionema* taxa, many of which are known from the type or a small number of specimens in Flora of Turkey, are inadequate. In addition, chromosomal studies on these species are few. Because most of the chromosome counts were made many years ago, some of them are unreliable and insufficient to determine basic chromosome number in genus and most of these counts are questionable.

In this study, by revised up *Aethionema* taxa in Turkey and the list of valid taxa were revealed.

Are there any Mediterranean polypore fungi in Iran?

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Polypore fungi are an important group of wood-inhabiting macrobasidiomycetes and have significant roles in biomass recycling in forests and woodland ecosystems. Several species are bio-indicator of areas with high conservation value, and a considerable number of species possess bioactive compounds with diverse biotechnological and pharmaceutical applications. Analyses of species composition of wood fungi in Iran have shown a close resemblance to Europe. Here, the influence of Mediterranean climate in Iran is discussed and comparisons is made between polypore composition in Iran and the Mediterranean area, also taking adjacent territories in the Caucasus region into account. The majority of polypores of Iran (87%) are shown to be shared with the Mediterranean region. Many of the shared species are found throughout Europe, but there are also several rare to very rare, and even extra European species. About 5% of the Iranian species seem to be 'true Mediterranean', mostly distributed in the Mediterranean region: *Antrodia serpens*, *Ceriporia aurantiocarnescens*, *Fomitiporia rosmarini*, *Fomitopsis iberica*, *Fomitopsis spraguei*, and *Trametes ljubarskyi*. *Phellinus rimosus* also takes a Mediterranean distribution in Europe, yet is widespread in Eurasia, Africa, and Australia. Some remarkable shared species are discussed here.

The recent neophyte *Opuntia aurantiaca* Lindl.: distribution and potential invasion in Spain

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The *Cactaceae*, and especially its most emblematic genus, *Opuntia*, have become one of the groups of plants with greater invasion potential in Spain. In fact, this area is considered one of the three global hotspots of invasion of cacti, together with South Africa and Australia. In our country, one of the most recently detected species is *Opuntia aurantiaca* Lindl, a small cactus with an enormous capacity of dispersion by means of cladodes and (sterile) fruits, which are easily detached and adhere to animals, clothes, and footwear. Probably native to the Southern Cone (Argentina and Uruguay), it behaves as a very aggressive invader in Australia and South Africa. In Europe, it only occurs on the Mediterranean coast of the Iberian Peninsula (Catalonia and Valencian Community). In this study, the geographic range of the species is updated at the peninsular level. Firstly detected at the beginning of the last decade in Navajas (Castellón), it has been subsequently observed in other places of the province of Castellón, but also in Valencia, Tarragona and Barcelona. With all occurrence data, its potential distribution is estimated using the algorithm of maximum entropy implemented in the program MaxEnt. Distribution models are built for the current climatic conditions as well as for different scenarios of global warming. Due to its possible invasive nature, it is necessary to eradicate the existing populations at this initial stage. Legislation should consider the prohibition of trade and transport of this plant to avoid new introductions.

Karyological studies in Greek *Anthemis* s.l. (*Anthemideae*, *Asteraceae*)

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The genus *Anthemis* L. s.l. (including *Cota* J. Gay) is one of the richest members of tribe *Anthemideae* (*Asteraceae*). Approximately 190 species can be found mainly around the Mediterranean basin, whilst the distribution centre of the genus is located in SW Asia. According to present knowledge, the genus is represented in Greece by 53 taxa (species and subspecies), including 19 endemic and 27 range-restricted taxa, recorded in all floristic regions.

Previous karyological studies in *Anthemideae* have shown that $x = 9$ is the most common base chromosome number of the tribe. Despite the fact that polyploidy occurs frequently among *Anthemideae*, in *Anthemis* it is mostly restricted to the taxonomically problematic *Anthemis cretica* group, in which some members can reach hexaploid or even octoploid cytotypes. Although there are chromosome counts for several *Anthemis* species, the chromosome number of c. 25% of the Greek taxa, including several Greek endemics, remains unknown. Greek populations have rarely been examined, with the exception of the *A. tomentosa* group. Moreover, there are very few published karyotypes, with karyomorphometric analyses included, based on Greek *Anthemis* populations.

In this study, chromosome number and karyotype morphology of almost all Greek taxa are investigated, as part of our effort to understand taxonomy and evolution of *Anthemis* taxa in Greece. So far, we have cultivated 294 *Anthemis* populations that correspond to 47 taxa all over Greece. To elucidate taxonomy, more than 450 plant specimens have been examined. Emphasis was given to endemic, range restricted or protected taxa, as well as those representing the difficult, yet intriguing *Anthemis cretica* group.

Our preliminary results confirm that $x = 9$ is the common base number in the genus, with most taxa examined being diploid ($2n = 2x = 18$). Still, tetraploid and hexaploid cytotypes occur in Greece, in members of the *Anthemis cretica* group. Chromosome number and karyotype morphology are provided for some local Greek endemics, for the first time. Patterns and traits of karyotype morphology are presented and karyotype asymmetry is investigated in several Greek taxa and populations.

Comparative study of antioxidative activity and phytochemical composition of two seaweeds *Ulva lactuca* (green algae) and *Halopithys incurva* (red algae)

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The aim of this work was to compare the antioxidative potential as well as the phytochemical composition of two seaweeds, red algae *Halopithys incurva* and green algae *Ulva lactuca* collected from the Mediterranean coast in west of Oran (Bousfer Sea).

From the algae powder, aqueous, methanolic and ethanolic extracts were prepared. The polyphenols quantification was realized by Folin-Ciocalteu method. The antioxidative activity was evaluated by DPPH scavenging test and ferric ion reducing power (FRAP). The phytochemical study was determined by colorimetric and fluorescent methods.

The results showed that phenolic compounds concentrations were 3.39-fold higher in red algae compared to green algae in aqueous extract while this content was 0.44-fold lower in red algae compared to green algae in ethanolic extract. Furthermore, phenolic compounds in methanolic and ethanolic extracts of the two algae decreased compared to aqueous extract.

The antioxidative power by the DPPH test revealed that two algae extracts showed antiradical activity significantly lower compared to the standard. Moreover, the both algae aqueous extract had a low DPPH scavenging capacity compared to the other extracts. This capacity of red algae aqueous extract was 1.45-fold higher compared to that of green algae. The reducing power by FRAP test in the all extracts and for both algae did not vary significantly and approximates to that of gallic acid (standard antioxidant). The phytochemical study for all samples revealed the presence of some chemicals compounds as phenolic compounds, saponosides, coumarins, and sterols and triterpenes

In conclusion, these seaweeds, particularly the red one, were considered as an important source of biologically active compounds which can be used in health, especially in mitigating oxidative stress associated with certain pathologies.

Keywords: *Ulva lactuca*, *Halopithys incurva*, anti-radical activity, phytochemical screening, polyphenols, DPPH test, FRAP test, oxidative stress.

Contribution to the karyological knowledge of Moroccan Flora

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Chromosome number and ploidy level are among the key genomic variables in plant taxonomy, systematics and evolution. On Moroccan flora, karyological studies are quite limited. The aim of our study is to provide the georeferenced chromosome number of some spontaneous taxon in the region of Rabat-Salé-Kénitra that belong to the *Asteraceae*, which is the richest family worldwide and also the richest Moroccan family at the genus and species level, and to compare it with the chromosome numbers found in other populations and countries. After morphological analyses, the chromosome number of eight wild species belonging to this family has been investigated for the first time in the region of Rabat-Salé-Kinéma, using the root-tip squash. As a result, all these species show a diploid level, which varies between $2n = 10$, 14 , 16 and $2n = 18$. Thus, we obtained for the following species: *Anacyclus radiatus* Loisel. $2n = 18$, *Cichorium intybus* L. $2n = 18$, *Glebionis segetum* (L.) Fourr. $2n = 18$, *Hedypnois rhagadioloides* (L.) F. W. Schmidt $2n = 14$, *Pallenis spinosa* subsp. *maroccana* (Aurich & Podlech) Greuter $2n = 10$, *Reichardia tinjitana* (L.) Roth $2n = 16$, *Lactuca serriola* L. $2n = 18$, *Phagnalon rupestre* (L.) DC. $2n = 18$.

Notes on *Tragopogon fibrosus* a restricted endemic to Turkey

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T. fibrosus Freyn & Sint. is perennial plant with yellow flowers. It is one of the twelve endemic taxa of *Tragopogon* grown in Turkey. It known only type locality. Samples of *T. fibrosus* gathered from the type locality and examined. *T. fibrosus* morphologically is very similar to *T. dshimilensis* K.Koch that another endemic species to Turkey. *T. dshimilensis* has wider distribution than *T. fibrosus* at North East of Anatolia and its distribution is overlap with *T. fibrosus*. There are some morphologically similarities between these two endemics. They both have fibrous leaf remains at base of the stem, the flowers are equally or longer than phyllaries and beaks are shorter than achene bodies. However *T. fibrosus* can be discriminate from *T. dshimilensis* with linear leaves and much dense fibrous remains at the base of the stem. Achenes of the *T. fibrosus* are scaly or not, but those of the *T. dshimilensis* with ten longitudinal rows of separate short scales. Achenes of both species have papillae on their surfaces. Besides, according to molecular data based on internal transcribed spacers (ITS) these two species are located at same clade. As a result of this study, *T. fibrosus* and *T. dshimilensis* are bearing close morphological features and they are close relatives.

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Keywords: Anatolia, nrDNA, Rare, *Tragopogon*.

Multiplication d'*Atriplex halimus* par la culture des tissus *in vitro*

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La dégradation des sols par la salinité dans les régions arides et semi arides enregistrée ces dernières décennies exige la mise en place d'un ensemble de nouvelles stratégies pour leur réhabilitation. De ce fait, une grande importance doit être attribuée aux espèces du genre *Atriplex* qui, grâce à leur caractère xérohalophyte, peuvent être utilisées pour réhabiliter les sols dégradés par la salinité et l'augmentation de la production fourragère dans les régions arides et semi arides. Dans ce cadre, l'utilisation des techniques biotechnologiques telle que la culture des tissus *in vitro* constitue un outil très efficace et rapide pour la multiplication de ces plantes et la reconstitution du couvert végétal.

Une micropropagation d'*Atriplex halimus* est réalisée par la mise en culture des explants d'apex et de nœuds sur les milieux MS additionné ou non par différentes balances hormonales [(2,4-D, TDZ) ; (2,4-D, BAP) ; (2,4-D, BAP, TDZ) et TDZ seul].

Les taux de micropropagation obtenus sont fortement influencés par les phytohormones ajoutées ainsi que le type d'explants. En effet, l'utilisation de la balance TDZ seul à différentes concentrations permet une régénération importante (100%) à partir des explants d'apex accompagnée dans la majorité des cas par une callogenèse des extrémités excisées dont la fragmentation et le repiquage induit une organogénèse indirecte.

Dans le cas des explants de nœuds une micropropagation importante (90%) est observée seulement sur le milieu MS sans hormones alors qu'aucune réactivité n'est obtenue en présence des différentes balances hormonales testées.

Mots clés: *Atriplex halimus* L., balance hormonale, explant, micropropagation, milieux de culture, phytohormone.

New alien taxa in the rice-fields of the National Park of the Delta of Axios-Loudias-Aliakmon (N Greece)

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The presence of alien taxa, mostly of tropical origin, are particularly common in the rice-fields all over the world, presumably because they can be easily introduced as seed contaminants of imported rice stocks. Rice cultivation in the Delta of Axios – Loudias – Aliakmon (NC Greece), started in c. 1950, and has been largely expanded ever since. A floristic-phytosociological study was conducted in 1965 and published in 1972, by G. Lavrendiades. Since then, there were only a few reports of the occurrence of new alien taxa. Recently, we have studied the rice field weed flora (the fieldwork was done in 2012, 2016 and 2019) and recorded the presence of sixteen alien taxa. Among these, only two were found in 1965, the tropical *Najas graminea* Delile and *Paspalum distichum* L. Besides those, we have recorded the American *Ammannia coccinea* Rottb., *Heteranthera rotundifolia* (Kunth) Griseb., *Bacopa rotundifolia* (Michx.) Wettst. and *Lindernia dubia* (L.) Pennell, the Asiatic *Diplachne fusca* (L.) Roem. & Schult. and *Echinochloa crus-galli* subsp. *hispidula* (Retz.) Honda, the tropical *Ammannia auriculata* Willd., *A. baccifera* L., *Echinochloa colonum* (L.) Link, *E. oryzoides* (Ard.) Fritsch. *Heteranthera limosa* (Sw.) Willd., *H. reniformis* Ruiz & Pav. and *Rotala ramosior* (L.) Koehne, and the cosmopolitan *Eleusine indica* (L.) Gaertn. Some of them were already recorded in the study area, mainly after 2000. To our knowledge, there is no other report of the presence of five taxa, not only in the study area but also in NC Greece, i.e. *Bacopa rotundifolia*, *Echinochloa oryzoides*, *Ammannia auriculata*, *A. baccifera* and *Rotala ramosior*. The degree of naturalisation of the above aliens in Greece remains uncertain (except *Lindernia dubia*, *Paspalum distichum* and *Eleusine indica*, which are established in freshwater and other habitats). We intend to continue our work, looking whether these species have started to spread in the natural freshwater habitats of the National Park.

Micropropagation in vitro d'*Atriplex halimus*

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La culture des tissus *in vitro* constitue un outil important pour la multiplication des plantes dans le but de la conservation de ces espèces et leur utilisation dans la réhabilitation des sols dégradés.

Dans ce contexte, une importance est accordée aux espèces fourragères du genre *Atriplex* dans les programmes de réhabilitation des sols dégradés des zones arides et semi arides algériennes vu leur caractère xérohalophile.

Une micropropagation d'*Atriplex halimus* est réalisée à partir de nœuds prélevés de plantes âgées de 4 mois obtenues sous serre et d'apex caulinaire de vitro plants âgés de 15 jours. Ces deux types d'explants sont caractérisés par l'existence de méristèmes prédéfinis.

Ces différents explants sont mis en culture sur le milieu Gamborg (B5) enrichi d'un régulateur de croissance, le thidiazuron (TDZ) à différentes concentrations (0.05 ; 0.1 et 0.5 mg/l). Le lot témoin est dépourvu de TDZ.

Les résultats obtenus montrent la néoformation de plusieurs pousses aussi bien sur le milieu sans hormone qu'en présence de TDZ avec un taux de régénération et un nombre de pousses variables. Dans le cas des apex, le taux moyen de débourrement est de 25 ± 0 en absence de TDZ, 76 ± 4.79 ; 98 ± 5 et 100 ± 0 en présence, respectivement, de 0.05, 0.1 et 0.5 mg/l de TDZ. Concernant les explants de nœuds, seul le milieu sans hormone semble favorable à leur débourrement (20 ± 0).

Le nombre moyen de pousses obtenues est variable avec un nombre important en présence de 0.5mg/l de TDZ.

Mots clés: *Atriplex halimus*, micropropagation, TDZ, apex, nœuds, milieu Gamborg, régénération.

Seed surface micro/macro-morphology of the genus *Crocus* L. (*Iridaceae*): A preliminary taxonomic study

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The genus *Crocus* L. (*Iridaceae*) consists of c. 250 taxa in its whole distribution, excluding the cultivated species *Crocus sativus* L. which is the source of saffron, according to the most recent taxonomy with some amendments. This is a preliminary study of the seed-surface micro-morphology of 36 taxa, 6 of them reported for the first time (*C. kotschyanus*, *C. versicolor*, *C. caspius*, *C. hartmannianus*, *C. reticulatus*, *C. vitellinus* and *C. hyemalis*), using scanning electron microscope (SEM).

The primary goal of this study is to amend new limitations among the most relative species. Our first micromorphological results (mostly physical size i.e. length and width) states that we should treat the former members of *C. kotschyanus* aggregate (i.e. subsp. *kotschyanus*, subsp. *cappadocicus*, subsp. *hakkariensis* and subsp. *suwarowianus*) as distinct species. This result coheres with the molecular and classical taxonomy and is in accordance with recent studies.

Dimitrios Zaganiaris' botanical collections in the Thessaloniki Aristotle University (TAU) Herbarium

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Dimitrios Zaganiaris (1901-1940) served as Associate Professor of Systematic Botany and Phytogeography in the University of Thessaloniki during the period 1936-1940. He published about nine floristic works during the 30s among which are the "Flora of Mani" and his most memorable work "Herbarium Macedonicum", both awarded by the Academy of Athens. Not much is known about his life, but part of his life story is told by his specimens. Zaganiaris was a keen and tireless collector and it seems that he was the founder of what is known today as the TAU Herbarium. He collected numerous specimens from different areas of Greece and apart from his own collections he also enriched the herbarium with specimens of other herbaria. Unfortunately, many of his specimens were destroyed during the World War II and a great part of the material substantiating his publications was lost. The remnants of his collections are held, to the best of our knowledge, only in TAU, but they were, to-date, largely inaccessible. In light of modern developments in the field of museum collections, we have started to digitise TAU specimens, aiming for the mobilisation and sharing of the collections. To this end, around 3,500 of Zaganiaris' specimens organized into four collection groups were retrieved: (a) "Herbarium D. Zaganiaris" (b) "Herbarium Universitae Thessalonicae" (c) "Herbarium Laconicum" and (d) "D. Zaganiaris. Herbarium Macedonicum". There is also another group of specimens with draft labels having his characteristic signature. The information on the specimens' labels shed light on his botanical travels. Zaganiaris travelled almost all over Greece and his collections cover the floristic regions of North East and North Central Greece, Northern and Southern Pindos, East Central Greece, Sterea Ellas, Peloponnisos, the North and the West Aegean Islands, Kiklades, Kriti and the Ionian Islands. To-date the indexing and cataloguing of his collections is almost completed, while the nomenclature update annotation and imaging are ongoing. By the end of this project, valuable information on the Greek phytodiversity will have been revealed.

Endemic chasmophytes' richness and phytogeographical patterns in Greece: The family of *Asteraceae*

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Plant communities colonizing the rock fissures show great diversity and are extremely rich in endemic species. Rocky formations with inclination of 65-90°, are shelters for important and rare plant species. In a total of more than 935 plant taxa occurring on cliffs, the 50.38% of the taxa are Greek endemics, while of the exclusive chasmophytes, the 63.52% are Greek endemics. In the framework of our studies concerning chasmophytic species richness, a database has been created concerning chasmophytic plant taxa found exclusively or occasionally in rocky formations in Greece. Based on the different subsets of this database, phytogeographical patterns concerning different families and their contribution to the chasmophytic species richness has been carried and in the present study, an analysis of endemic chasmophytes belonging to the family of *Asteraceae* and their phytogeographical patterns is presented. *Asteraceae* is the richest in taxa family of the Greek chasmophytic flora, consisting of 206 species and subspecies, of which 120 are Greek endemics and range-restricted and 40 are Balkan endemics. Exclusive chasmophytes represent the 43% of the *Asteraceae* chasmophytes. 70 taxa are Greek endemics and range-restricted exclusive chasmophytes of which 42% belong to the genus of *Centaurea*. Five taxa are included in Annexes II, IV and V of the Directive 92/43/EU and have a priority for protection, 17 are included in the Red Data Book of Rare and Threatened plants of Greece and 6 are in the IUCN Red List. Sterea Ellas followed by Peloponnisos and North East (NE) are the richer, in *Asteraceae* chasmophytes, floristic areas of Greece while Kriti – Karpathos, Peloponnisos and Sterea Ellas are the richer ones concerning exclusive chasmophytes.

Phylogeny, biogeography, and diversification patterns of *Limonium* (sea lavenders)

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Species richness varies across habitats, regions and taxonomic groups, raising long-standing questions about the ecological and evolutionary mechanisms underpinning this variation. Particularly for angiosperms, the Mediterranean basin is one of the world's biodiversity hot spots. It covers only 2% of the earth's surface, but accommodates 20% of the total plant richness. Moreover, the Mediterranean basin is characterized by a turbulent geological and climatic history, and high habitat heterogeneity (e.g. different island systems, variety of substrates etc.). These historical and ecological factors have been proposed as major drivers of diversification in the region. Here we explore the spatio-temporal evolution of *Limonium* (*Plumbaginaceae*) and assess the role of different drivers of diversification for the genus. *Limonium* is a cosmopolitan plant genus with ca. 600 species mainly restricted in the Mediterranean region (ca. 70% of the total number of species). The genus consists of facultative halophytes that occur predominately in salt and metal rich soils of mainland and coastal areas, and occupy variable island systems (both continental and oceanic). We aim at shedding light in the evolution of the genus and answering the following questions: 1) what are the phylogenetic relationships within *Limonium*? 2) when and where did the genus originate and diversify? and 3) can we detect any shifts of diversification rates and are they linked to major geological and/or climatic events?. We sample about one third of the species for *Limonium*, spanning its taxonomic and geographical variability, and several outgroup taxa. We use one nuclear and three chloroplast markers to infer and time calibrate the molecular phylogeny. *Limonium* phylogeny is divided into two major clades, with one of them divided into three subclades: the monospecific *L. sect. Limoniodendron* sister to a clade comprising a mostly non-Mediterranean subclade and a Mediterranean subclade. *Limonium* originated in the early Oligocene and the large Mediterranean clade started diversifying in the late Miocene. In agreement with the ecology of the genus, the early diversification events for the Mediterranean clade coincide with the Messinian Salinity Crisis, while most of the speciation events are placed within the Quaternary sea-level oscillations.

Evolution and biogeography of members of the genus *Cardamine* in the Asia Minor, Near East and Caucasus

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Biomes of the Easternmost Mediterranean restricted predominantly to Asia Minor and Near East but extending also to the Caucasus represent one of the biodiversity hotspots in the Northern Hemisphere. Nevertheless, there are still substantial gaps in geographic coverage for comprehensive plant diversity studies concerning these regions assumed to be a cradle for diversity and source of gene pools for colonization of the European continent. To shed more light on evolutionary history and biogeographic pattern in these regions we focused our investigation on suits of closely related taxa of the genus *Cardamine* (*Brassicaceae*) endemic to Asia Minor, Near East and Caucasus, namely *C. tenera* group – *C. seidlitziana* Albov., *C. uliginosa* M.Bieb. and *C. tenera* J.G.Gmel. ex C.A.Mey. and *C. amara* group – *C. wiedemanniana* Boiss. and *C. lazica* Boiss. & Bal. Although they have been reported to be morphologically and ecological distinguishable entities their evolutionary history and phylogeographic patterns remain unclear. Only the diploid level with $2n=2x=16$ has been reported for *C. tenera* so far, which seems to be in sharp contrast to their European relatives characterized by frequent evolution of polyploid entities complexes. With comprehensive population sampling and utilizing combination of NGS based genetic analyses, cytogenetic, multivariate morphometric and ecological niche modelling we will test the hypothesis whether these taxa from Eastern Mediterranean and adjacent region represent ancestral entities serving as a source of colonization of Europe and subsequent diversification events. We will study whether these presumably ancestral, diploid lineages gave rise to more derived European polyploid *Cardamine* complexes.

Acknowledgement: This study is supported by the Slovak Research and Development Agency APVV-17-0616 and Grant Agency of Czech republic GAČR 19-06632S.

Hyperaccumulators, native in Northern Pindus (Greece) used as “Metal Crops” for nickel recovery

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The importance of the floristic diversity of serpentine ecosystems is well known. The use of native species of the local serpentine floras in nickel agromining has been proven particularly effective in recent years not only in Europe but also in the tropics. The use and conservation of the local floristic diversity as cultivated agroecosystems are among the ecosystem services that Ni agromining could provide. The species *Odontarrhena muralis* (syn. *Alyssum murale*), *Bornmuellera emarginata* (syn. *Leptoplax emarginata*) and *B. tymphaea*, native to the Pindus mountain range and closely related to serpentine substrates in Greece were cultivated in 50 m² and 25 m² plots (in triplicate) on an abandoned field on serpentine substrate in order to evaluate their potential for use in nickel agromining. After two harvests in 2018 and 2019, the results are particularly encouraging in terms of biomass production and nickel yield. The agronomic practices which have been applied are also discussed.

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The type specimens of the Halácsy Graecum collection

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Eugen von Halácsy (1842–1913), a Viennese medical doctor and outstanding botanist, contributed significantly to the exploration and documentation of the Greek flora. His own collecting activities together with extensive exchange of plant material with numerous leading botanists and collectors in Europe, predominantly in the Balkan Peninsula, resulted in a comprehensive herbarium collection. Especially his friendship with Theodor von Heldreich, director of the Botanical Garden in Athens, formed the basis of his collection of plants originating from Greece within its borders during this period. This part of Halácsy's herbarium, the Herbarium Graecum is kept as a separate collection in the herbarium of the University of Vienna (WU) and comprises roughly 26.000 specimens. He was the first and so far the last botanist to publish a complete flora of Greece, his *Conspectus Flora Graecae* (Halácsy 1900–1912). His extensive taxonomic work was the basis of our study on the type material in Halácsy's Greek collection. Label information and type status of the entire retrieved type material was data-based including high-resolution photographs and georeferencing and made openly available via Virtual Herbaria JACQ. Our research gained over 1.400 type vouchers for more than 1.000 taxa. These specimens were gathered by more than 50 collectors, besides Halácsy the main contributors were Theodor von Heldreich, Theodoros Orphanides, Antonio Baldacci, Basilios Tuntas and Christos Leonis. Halácsy himself has described approximately 300 taxa, the remaining original material corresponds to taxa described by others, most important among them Edmond Boissier, Theodor von Heldreich and Theodoros Orphanides. Halácsy's Herbarium Graecum is of utmost importance, not only due to its taxonomic value but also representing the enormous biodiversity of Greece.

The Ethnobotany and Biogeography of Wild Vegetables in the Adriatic Islands

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Archipelagos of islands have played an important role in shaping some of the paradigms of biology, including the theory of the evolution of species and the theory of island biogeography. Although ethnobotany is a well-established discipline, patterns of knowledge about plant uses in archipelagos have never been quantitatively analysed, and the whole concept has been only briefly mentioned in the ethnobiological context.

The aim of our study was to record which taxa of wild vegetables have been consumed in the Adriatic islands and to establish if such variables as island size, population size, flora or its isolation are correlated with the number of wild vegetables used. We interviewed 225 people (fifteen from each island). Altogether the use of 89 species of wild vegetables has been recorded. The largest number of wild vegetables is eaten on the islands of Korčula, Vis and Šolta, and the lowest on Ugljan, Cres and Dugi Otok. The studied variables had a small and statistically not significant effect on the wild vegetable list length. The most visible effect was an increasing trend from north-west to south-east, overrunning the typical biogeographical island patterns. Moreover, one of the large and well-populated islands, Korčula, showed an 'unusually' high level of wild vegetable use. Most interesting edible species used in the Adriatic Islands are *Bunium alpinum*, *Cytinus hypocystis* (both mainly on Pašman), *Lotus edulis* (on Vis) and *Posidonia oceanica* (on Vis and Korčula).

The recorded relationships between the demographic and geographical features of islands were statistically not significant. We assume that cultural and historical factors diversifying the use of plants in particular islands are stronger than the above mentioned measurable variables.

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Keywords: wild edible plants; wild food plants; ethnobiology; leafy vegetables; Mediterranean diet.

“Mediterranean plant germination reports”: a new series available in Flora Mediterranea journal

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RIBES, the Italian network of seed banks for native species conservation, was established in December 2005 and today it includes 19 members which operate throughout the Italian territory (14 out of 20 regions). It is, in turn, a member of other wider networks, such as ENSCONET (European Native Seed Conservation Network), GENMEDA (Network of Mediterranean Plant Conservation Centres) and INSR (International Network for Seed-based Restoration), thus providing an active connection with the international context.

The main goal of the network is the general improvement of the quality and safety of the germplasm reserves of native plant species in Italy to ensure the long-term conservation and protection of the endangered and/or endemic flora. Here, we focus on seed germination, an important and crucial step for an effective conservation activity, particularly launching two new closely related initiatives, as part of the RIBES conservation strategy to 2020.

First of all, a new series of germination accounts for the Mediterranean flora (*sensu* Med-Checklist) will be published since 2019 in *Flora Mediterranea*. Each contribution of the “*Mediterranean plant germination reports*” series will present all the relevant details of tested germination protocols: pretreatments (e.g. scarification, priming, stratification, sterilization), germination media, number of sown seeds and replicates, culture conditions (temperature and photoperiod) and results described as germination percentages (> 80%), together with other common germination indices (e.g. T_1 , T_{50} , T_{max} , and MTG). A Note section will be used for additional information, also including unsuccessful tests.

Moreover, in order to make these and other published germination data available to a wider audience, we are building an online, open access database within the RIBES website, that typically includes sections on taxonomy, location data, storage behaviour, beside germination results.

There are currently no special series devoted to seed germination in other scientific journals, so “*Mediterranean plant germination reports*” could surely become a useful tool for conservationists, botanists, and other specialists.

Presence of *Scorzonera hispanica* (Asteraceae) in Turkey

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Scorzonera hispanica L. described from Spain was recorded from European part of Turkey based on Stajanov record (Tekirdağ) and vegetable sellers at Pera (İstanbul). The specimen that collected by Stojanov from Tekirdağ was not seen by any authors up to now. In order to re-collect the plants belong to *S. hispanica*, numerous field trips and observations were carried out in Mürefte (Tekirdağ) and adjacent areas in Turkey. During the field trip, lots of samples were collected. However none of them keys out as *S. hispanica* but easily keys out *S. mollis* M.Bieb. which is the closely related taxa in Turkey. Field studies and herbarium observations showed that the plant samples collected from Turkey and sold in bazaar should belong to *S. mollis*. So, we concluded that *S. hispanica* is not distributed in Turkey.

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Keywords: Flora, *Scorzonera hispanica*, Tekirdağ, Turkey.

Morphological differentiation of *Juniperus excelsa* in the Sub-Mediterranean part of Crimea

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The first description of the Greek Juniper *Juniperus excelsa* M.Bieb. of the Sabina section comes from the Crimea and was made by Pallas in 1800. Despite the separation from the Mediterranean biome, the vegetation of the southern coast of the Crimean Peninsula is referred to as Sub-Mediterranean Shrublands. The Mediterraneanization of this regions is most probably connected with warm periods of Pleistocene/Early Holocene. The long lasting isolation of the Crimean junipers may cause differences of their characteristics when compared to populations from other parts of their range in the Eastern Mediterranean.

Our goal was to characterize the Crimean populations of *J. excelsa* on the base of the morphological features, with methods used in similar examinations of other junipers, to make comparisons possible. Cones and small parts of twigs were collected from 7 population in summer 2017. Due to problems with the collection and transportation, a sufficient number of cones, that is at least 20, were collected from only 5 populations. The collected material was characterized with eight simple and five calculated features. The descriptive statistics were performed and populations were compared with the ANOVA and the discrimination analysis.

Most of the analysed characteristics had normal distribution. Only the dimensions of cones were strongly correlated. Cv of features were low, only seed number had higher Cv=28%. The average cone length was 9,3 mm and diameter 9,01mm what made cones almost spherical. Seed number ranged from 3-11 with the mode 5. Seeds were slightly elongated with length 4,93 and width 3,22 mm. The thickness of shoots measured 5 mm from their end equalled 0,73 mm. These measurements are consistent with the data in Floras. There were differences between populations, despite the small distances between them. In the northernmost population the cones and seeds were more spherical, while in the southernmost – more elongated then the average. Branches of the most inland population were the thickest. Discrimination analysis showed the northernmost population as the most separated from the others.

Differentiation between populations showed by our results prove some variability within this long isolated part of the species range. The planned supplementation of the research with genetic analyses will allow the full characterization of the *J. excelsa* in the Crimea. Further comparisons with populations from other localities of the species should help to explain the origin of the Greek juniper populations in the Crimea.

CardaBase - online karyological and nomenclatural database of the tribe Cardamineae

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The *Brassicaceae* family is well-known for the common occurrence of polyploids and considerable variation in chromosome numbers. Despite decades of research, the origin of polyploids and various base chromosome numbers, as well as their evolutionary significance, have not been yet sufficiently understood. To address these questions, a detailed summary of the current knowledge on karyological variation across all tribes and genera of the family is an essential starting point. For this purpose, chromosome number and ploidy-level databases are the most convenient information tool.

After the release of Alybase (karyological and nomenclatural database of the tribe Alysseae) in 2015, we are now working on **CardaBase** – database summarizing published chromosome numbers and ploidy-level estimates of one of the largest and worldwide distributed tribe **Cardamineae** (12 genera and more than 330 species). The most common base chromosome number in the tribe is $x = 8$, less frequent are $x = 6, 7$ and 10 , and both diploid and polyploid cytotypes are known from almost all genera. The database will provide also the list of accepted names and their synonyms and reflect the most recent taxonomic and phylogenetic studies in the tribe Cardamineae including complete information on the origin of analysed material, voucher specimens and revision of the identification of plant material according to the collection place or voucher specimens (if available).

Inhibition of Acetylcholinesterase enzyme with autochthonous fungal species from Serbia

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In the last decades, a large number of novel compounds merely primary metabolites such as polysaccharides and proteins or secondary metabolites, including phenolics and terpenoids with significant biological effects have been isolated from mushrooms. Moreover, fungi have been recently recognized as producers of acetylcholinesterase inhibitors, agents that inhibit the enzyme acetylcholinesterase from breaking down acetylcholine, influencing on increase of both the level and duration of action of this neurotransmitter. Hence, they can be used in the treatment and prevention of neurodegenerative diseases, including Alzheimer's, which is on the rise worldwide. Accordingly, the aim of this study was to examine and compare the acetylcholinesterase inhibitory activity of the methanol, ethanol and aqueous extracts (in the range from 0,01 to 100 µg/ml) of lyophilized fruiting bodies of five autochthonous species originated from the Fruška Gora mountain, *Trametes versicolor*, *Pseudotrametes gibbosa*, *Fomes fomentarius* and *Chondrostereum purpureum* (Basidiomycota) and *Geospora sumneriana* (Ascomycota). The percentage of inhibition of acetylcholinesterase enzyme was determined using Ellman's method and results are presented as IC₅₀ (50% inhibitory concentration) and IC₉₀ (90% inhibitory concentration) value, where the lower value indicates a stronger inhibitory activity. The strongest potency was observed for methanol extracts of *T. versicolor* where the highest concentration range overtake IC₉₀. The inhibitory activity of methanol extracts of *G. sumneriana* and *C. purpureum* was very high (IC₉₀ = 1.00 µg/ml), while extracts of *F. fomentarius* (IC₅₀ = 2.48 µg/ml) and *P. gibbosa* (IC₅₀ = 8.83 µg/ml) exhibited lower activity. All ethanol extracts, with *T. versicolor* being the most active (IC₅₀ = 0.47 µg/ml), displayed lower inhibitory activity: *F. fomentarius*, IC₅₀ = 1.40 µg/ml; *C. purpureum*, IC₅₀ = 1.75 µg/ml; *P. gibbosa*, IC₅₀ = 1.95 µg/ml and *G. sumneriana*, IC₅₀ = 2.90 µg/ml. Aqueous extracts of all species exhibited lower inhibitory activity compared to methanol and ethanol extracts (*T. versicolor*, IC₅₀ = 6.77 µg/ml; *C. purpureum*, IC₅₀ = 7.85 µg/ml; *F. fomentarius*, IC₅₀ = 9.87 µg/ml; *G. sumneriana*, IC₅₀ = 9.99 µg/m) while *P. gibbosa* did not reach the IC₅₀. In comparison to previous study, we assume that not only phenols and flavonoids are responsible for enzyme inhibition and less polar extracts and compounds should be further analyzed and chemically characterized. In summary, all examined fungal species represent a promising resource of natural acetylcholinesterase inhibitors that might improve palliative therapy of Alzheimer's disease in the future.

Keywords: mushrooms, Alzheimer's disease, acetylcholinesterase inhibition.

Proposals for rural landscape and archaeological site flora management: the contribution of archaeobotany through the BRAIN network research

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Archaeobotanical data suggest that models of a multiple land use have always contributed to the fruitful management of environmental resources, and this is among the most interesting results obtained from the reconstructions of past landscapes in the Mediterranean. The development of Historical Ecology, an historical approach that promotes interdisciplinary studies involving several research fields (like botany, archaeobotany, history, archaeology, geography, cartography, forestry, geology, climatology, landscape genetics), is carrying out proposals for applications in agricultural management and environmental conservation based on rigorous land use reconstructions. Several members of the BRAIN community are involved in these topics thanks to the interdisciplinary plant-based studies carried out on archaeological sites and other human-influenced contexts (Environmental Archaeology). Some of them attended to the 5T.ERA MEETING (May 23-26th 2019), an international workshop devoted to the rural landscape, promoted by the Laboratory LASA of the University of Genoa, Italy. The meeting was an opportunity to reflect on the links between historical and palaeoenvironmental disciplines. In the last decades, in fact, this multidisciplinary approach has dealt with the problem of characterization and management of our environmental and cultural heritage.

This approach can be also fruitfully combined with the management of flora at archaeological parks. Floristic studies on archaeological areas in the Mediterranean had the greatest development in the last 40 years, and are aimed at providing useful information for the protection of monuments from weeds. In recent years, these studies have also been used as a basis for selecting which plants have to be introduced

in archaeological sites with the aim to support a current fruition compatible with historical landscapes.

In this framework, we identified two main applications of archaeobotanical results to the Historical Ecology research: the application of historical-environmental studies to the Parks management (e.g. Cinque Terre National Park) on one side, and studies on vegetation at archaeological sites on the other side. BRAIN finality, as it concerns the past of Italian vegetation, cultivation and plant exploitation, can actually give new input to the knowledge of history of rural landscapes, and the cooperation with historians and plant ecologists can build a bridge between past practices and future perspectives.

Intraspecific differentiation of *Juniperus sabina* L. (Cupressaceae) – morphology versus DNA

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Juniperus sabina L. is a variable species of shrub, widely distributed from Spain, through Europe to Kazakhstan, Siberia, Mongolia and China. Recently the new variety *J. sabina* var. *balkanensis* was described from the Balkan and Apennine Peninsulas. The new variety differs from the typical one in having *J. thurifera*-like chloroplasts.

The aim of our study was to find out if the new variety differ also in morphology. Material from populations previously genetically assigned to the variety were used: three populations of the '*balkanensis*' variety from Turkey and Macedonia and eleven populations of the typical variety from Spain, Crimea, Alps and Apennines. Ten characteristics of lateral branches, cones and seeds were statistically analyzed. Descriptive statistics, student's T test, the discrimination and cluster analyses were performed.

Eight characteristics differed the varieties statistically significantly, but there was no a single feature that could be used to recognize them. All analyses proved the '*balkanensis*' variety was characterized by a higher average number of seeds, larger seeds, and larger cones.

Concluding, the morphological differences don't allow to recognize the two varieties, e.g. in the field. The history and range of the '*balkanensis*' variety, which is treated as the track of the ancient hybridization, still need further examinations.

New Records of Three Plant Species in Albania

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Records of three plant species are reported for the first time in Albania, with notes about their known European and Balkan distribution. The newly found species are *Pimpinella major* (*Apiaceae*), that is found in the northeastern part of Albania, close to the border of North Macedonia; whereas *Helianthemum jonium* (*Cistaceae*) and *Spartina maritima* (*Poaceae*) are recorded in the western Albania, along the coastal areas of Adriatic Sea, mostly found in the sand dunes. The most interesting finding is the so far described as Italian endemic *Helianthemum jonium*, that makes it a sub-endemic species for both countries. The new findings increase the number of plant species documented in Albania.

Keywords: new records, plants, Albania.

Geographic variation of essential oils: The case of *Origanum onites* and *O. vulgare* subsp. *hirtum* in East Mediterranean

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Two taxa of the genus *Origanum* (family *Lamiaceae*), *O. vulgare* L. subsp. *hirtum* (Link) Ietsw. (known commercially as Greek oregano) and *O. onites* L. (Turkish oregano), endemic of SE Mediterranean are the most widely used as oregano. The first grows wild in countries of Balkan Peninsula and Turkey, while the latter has a narrower distribution in Turkey, Greece, and Italy (Sicily). Members of two different Sections, *Origanum* and *Majorana* (Miller) Bentham respectively, are easily distinguished morphologically by their inflorescence type. Data from scientific articles published in the last 30 years (1988-2018) referring to the essential oils (EOs) of the two oregano taxa were extracted through three scientific databases (Scopus®, Web of Science™ and Google™ Scholar). A total number of 51 published articles includes 210 localities geographically distributed in E Mediterranean countries. Among them, 114 localities concern EOs of *O. vulgare* subsp. *hirtum* plants; these are geographically scattered in four countries: Greece 56, Turkey 50, Albania four, Croatia three and Serbia one locality. On the other hand, EOs of wild growing *O. onites* plants have been published from 96 localities scattered in three countries: Greece 67, Turkey 28 and a locality from Sicily. Both oregano taxa have a strong smell: *O. vulgare* subsp. *hirtum* [up to 8,8 mL 100 g⁻¹ dry weight (on Crete), mean from total localities 3,82 ±1,58] and *O. onites* [up to 7% (on Chios), mean 4,09 ±1,12]. The EOs composition of Greek oregano seem to have higher diversity dominant compounds carvacrol (up to 93,8%, mean 55,67% ±25,44) or thymol [up to 90,2% (on Evoia), mean 16,83% ±23,34]; besides the two phenols, linalool is once reported as dominant EO (96,31%) component in south Turkey (Ermenek-Karaman). The EOs of Turkish oregano have a rather stable composition, with carvacrol [up to 92,6% (on Chios), mean 71,76% ±20,49]. Besides, linalool is reported as the dominant compound in three localities (50,53%, 90,9% and 91,9%, respectively) of southern Turkey. The mapping of the today published information suggest two geographical opposite trends in EOs variation of the two taxa across their wild range in East Mediterranean. *O. onites* is more variable towards the Eastern part of its range where it could be an oregano (carvacrol) or lavender (linalool) plant, whereas *O. vulgare* subsp. *hirtum* is more variable towards a NW direction of its wild range and it could be characterized as oregano (carvacrol) or thyme (thymol) plant.

New records, taxonomic updates, and new locations for some alien species occurring in the Maltese Islands

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The uncontrolled importation of plants are the principal drivers for the proliferation of alien species in the Maltese Islands as in many other Mediterranean countries. Lack of awareness by a large portion of the public who unknowingly spread alien plants in natural ecosystems is a major problem. In addition, a larger population density as is in Malta, indirectly results in an increasing demand of alien horticultural plants or seeds (including bird seeds) and inadvertently, the escape of horticultural propagules into natural areas is then proportionally at a higher risk. Moreover the excessive use of horticultural plants in traffic islands and embellishment areas is another major problem for the spread of alien species. *Pennisetum setaceum* (Forssk.) Chiov. was in fact introduced as a plant from traffic embellishments. It is no surprise that reports on the local occurrences of alien flora had increased drastically in the last 20 years, resulting here in another significant addition of alien species for Malta.

The present work provides first records of the following alien species for the Maltese Islands: *Asparagus africanus* Lam. (*Asparagaceae*); *Opuntia lindheimeri* Engelm. and *Opuntia streptacantha* Lemaire (*Cactaceae*); *Drosanthemum hispidum* (L.) Schwantes (*Aizoaceae*); *Nymphaea* sp. L. (*Nymphaeaceae*); *Monstera deliciosa* Liebm. (*Araceae*) *Acacia koa* A. Gray (*Fabaceae*); *Freesia alba* (G.L.Mey.) Gumbel. and *Freesia leichtlinii* Klatt (*Iridaceae*). In addition, new localities for some infrequent alien species and observations on naturalised populations of other alien species which have been known for long as casual introductions are also given in this communication. This communication should assist central authorities, Natura 2000 site managers, NGOs, horticulturists and relevant stakeholders in promoting the awareness, management and control of alien species in accordance to Malta's national environment policy.

***Silene flavescens* subsp. *thessalonica*: The landmark of the Byzantine Walls of Thessaloniki**

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Silene L. of *Caryophyllaceae* family, is one of the larger genera of the Worlds flora. It comprises more than 700 species (allocated in 39 sections) which are mainly distributed in temperate zones of the Northern Hemisphere. About half of them occur in the Mediterranean area. The S. Balkan Peninsula and S.W. Asia are two of the main centers of diversity for the genus. In Greece, *Silene* is by far the largest genus of *Caryophyllaceae* family, in which 148 taxa are included with 58 of them being endemic. Among them, there is the Balkan endemic *S. flavescens* Waldst. & Kit. subsp. *thessalonica* (Boiss. & Heldr.) Nyman. This taxon was firstly described by Boissier in "Diagnoses plantarum Orientalium novarum"., ser.(1):74 (1854) based on specimens collected by Heldreich from Chortiatis mountain near Thessaloniki-Greece, in 1851. It is a member of the section *Brachypodae* and it is considered as a range restricted taxon of the Balkan peninsula. The occurrence of *S. flavescens* subsp. *thessalonica*, was recorded on the Byzantine Walls of Thessaloniki twenty years ago, and it was found again this year, during collection for an ongoing project entitled "The Flora of the Paleochristian and Byzantine Monuments of Thessalonika". These monuments are included in the World Heritage List of UNESCO. The occurrence of the taxon on the Byzantine Walls is mapped and supported by photographic material. Finally, it is proposed that *S. flavescens* subsp. *thessalonica*, could be recognized as the plant "landmark" of The Byzantine Walls of Thessaloniki.

The xerophytic parterre of the historic botanical garden of Agricultural University of Athens

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Botanical Gardens have a major role in conservation of biodiversity, as well, as of endangered species with a decreasing rate of their population. At the same time, they can be used for both entertaining and educational aims. The Botanical Garden of the Laboratory of Floriculture and Landscape Architecture, Agricultural University of Athens (AUA), has a history of about 150 years and it is mainly used for teaching purposes. A recent aspiration of the Laboratory was to enrich the Garden with native, xerophytic plants of the Mediterranean basin. The species *Anthyllis barba-jovis*, *Anthyllis hermanniae*, *Asphodelus fistulosus*, *Asteriscus maritima*, *Atriplex halimus*, *Ballota acetabulosa*, *Clinopodium nepeta*, *Clinopodium creticum*, *Convolvulus cneorum*, *Dictamnus creticus*, *Globularia alypum*, *Limoniastrum monopetalum*, *Scabiosa cretica*, *Scabiosa hymettia* and *Teucrium capitatum* were selected for this purpose. Propagation material of most of the above species was collected from plants grown in large wild populations in the prefecture of Attika, Greece, apart from *A. maritimus*, *C. creticum*, *C. cneorum*, *D. creticus* and *S. cretica*, and propagation took place at the historical Greenhouse of the Garden. In April 2015, a number of rooted cuttings of all species, apart from *A. barba-jovis* and *A. fistulosus*, where micropropagated plantlets and seedlings had been used respectively, were planted in the selected parterre, following a naturalistic design, after existing weeds were removed and soil surface was covered with black geotextile and white small gravel for weed control. Plants were irrigated sparsely during the first summer period (June to September), while from the second summer onwards were irrigated once a week during the dry hot period. Hand weeding was applied to manage unwanted vegetation. Four years after planting, all species are growing successfully (90-100%) apart from *D. creticus*, *C. creticum*, *G. alypum*, and partly *T. capitatum* (10, 10, 30, 60% establishment, respectively). Time to flower varied depending on the species and took place after 1.5 to 4 years. The latest entry into flowering (after 3-4 years) had *A. barba-jovis*, *A. fistulosus* and *L. monopetalum*. The xerophytic parterre is now one of the best attractions of the Botanical Garden, and it is used for research and teaching aims of students. Apart from students, all year round, pupils are visiting the Garden, approximately 200 pupils per week (6-18 years old), from schools of south Attika, Peloponnese, Euboea and Central Greece. Through touring in the collection of native plants in the Botanical Garden, are informed about the properties of the plant species and their use.

Lake islands: Floristic composition of a habitat island in the protected area of Kastoria lake (NW Greece)

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Kastoria lake is a protected area according Natura 2000 (GR1320001). The peninsula in the site of Kastoria lake, neighboring the city of Kastoria and surrounded by the lake is a habitat island hitherto unexplored. The main aim of the present paper is to fill a gap of the floristic information available for the protected area concerning the study of the floristic composition of this lake habitat island that is affected by the neighboring urban area and has not been investigated. In the framework of a research study concerning lake islands, field work and collection of field data and plant specimens in different seasons during 2018-2019 and from all different habitat types occurring on the island have been realized in order to have a complete registration of plant taxa diversity in combination with environmental and spatial variables and the human interference. Results concerning the floristic composition of the habitat island and spatial turnover per habitat type are presented in the present work. Topographical factors and human interference affect floristic patterns. 298 different plant taxa have been registered, showing a high α -diversity for this habitat island, belonging to 73 families and 196 genera. The richest in taxa families are: *Asteraceae* (30 taxa), *Fabaceae* (27 taxa), *Poaceae* (26 taxa), *Brassicaceae* (22), *Rosaceae* (12), *Lamiaceae* (12), *Caryophyllaceae* (11), reflecting the Mediterranean character of the area. The richest in taxa genera are: *Allium* (7 taxa), *Medicago* (6 taxa), *Prunus* (6), *Geranium* (5), *Poa* (5), *Rumex* (5) and *Trifolium* (5). Results including biological and chorological analysis are analysed and discussed.

The Database of the Italian Alimurgical Flora (AlimurgITA): First results

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In the recent years, the interest in consumption of edible wild plants - called WEP or alimurgical flora - has grown exponentially. Meanwhile, for various reasons, the preservation of rural culture has been scientifically researched together with the preservation and enhancement of local traditions and "folk knowledge".

The creation of a database of the Italian edible wild plants - called AlimurgITA - has therefore the aim of organizing the wide and chaotic knowledge of spontaneous edible plants acquired in Italy in the last 100 years. Our idea about the Database of the Italian Alimurgical Flora is therefore to create a tool for easy consultation, not only for purely speculative purposes, but also for practical ones (eg cultivation, presence of active compounds, etc.).

The organization of this database and its internal structure allow the retrieval of information through an online query, an "evidence - based" information resource useful for scientific communities that can gain an advantage by having a common electronic database.

This communication presents the first results of a survey that focuses on WEP traditionally used in Italy. In order to maintain this memory, the alimurgical plants and the traditional food culture have been studied and organized through the existing scientific and ethnobotanical documentation. Through the analysis of the bibliographical resources of 174 ethnobotanical and phytoalimurgical works published in Italy from 1918 to date, this survey has allowed us to collect, analyze and evaluate the ethnobotanical information of the involved WEP. The information collected relate to 860 WEP included in the database. For each of the 860 studied WEP entities, we have built 96 fields relating to the taxonomy, morphology, geographical distribution, chorological spectra, the utilisable parts of the plants (root, stem, leaves, flower, fruit), and the relative methods of preparation and use (fresh, cooked, dried, in oil, pickled).

Plant species diversity and cultural environment of the habitat island of Ancient Messini archaeological area (SW Peloponnisos, Greece)

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In the framework of research concerning the floristic composition of cultural areas including archeological sites, the study on “natural and cultural environment: the example of the plant species diversity of the habitat island of Ancient Messini archaeological area” aims to contribute to the investigation and deeper knowledge of the flora, vegetation and cultural elements of the area of Ancient Messini. The area is located in south west Peloponnisos, it belongs to the prefecture of Messinia, in the western foothills of Mountain Ithomi and it lies over a large area being one of the most important archaeological sites in Greece. It is a rare archaeological site, with theater, stadium, temples, houses, walls and public buildings, preserved in good condition. It is characterized as a habitat island since it is protected and has totally different physiognomy and ecosystem services of the surrounding areas. For the field work, the area has been divided using the the so-called Hippodameian system’ layout of Ancient Messini where all buildings have the same orientation and the space is divided into horizontal and vertical axes. Field investigation and collection of floristic data held during multiple visits in the study area from May 2018 to May 2019. The floristic composition and the analysis of the chorological and biological types are given together with a reference to the plant species used since antiquity in the area studied.

Finding and identifying *Hypericum* L. plants in North and South Greece

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Hypericum L. is one of the largest genera of vascular plants and includes about 484 taxa (herbs, shrubs and infrequently trees) placed in 36 taxonomic sections with worldwide distribution in warm temperate, subtropical and mountainous tropical regions. Although the genus is thoroughly explored, new taxa are still described. In commercial terms, plants of *H. perforatum* s.lat. and its infraspecific taxa, are registered in North Europe and USA and widely sold under the name "St. John's wort", as the main ingredient of food supplements or herbal medicines. *Hypericum* is represented in the flora of Greece by over 40 taxa (species and subspecies), members of 13 sections. Among them 15 taxa are Greek endemics. Known since antiquity, several *Hypericum* taxa are nowadays collected from the wild by local people of the Balkan peninsula and Turkey and are widely used, in oil or alcoholic extracts and teas in traditional therapeutics. The present study was carried out in two geographically distant areas of the Greek mainland, North Central Greece (Regional Unit of Pella, Municipality of Edessa) and the Eastern part of Peloponnese (Regional Unit of Argolis, Municipality of Epidaurus). Flowering *Hypericum* plants were frequently found and collected in different habitat types of both areas. The adventure of their taxonomic identification had as reference points, two standard floras, the Flora Europaea (Tutin *et al.*, 1968: Vol.2), and the Mountain Flora of Greece (Strid, 1984: Vol. 1), and well as the *Hypericum* monographs of Robson (1977, 2002, 2010, 2013). Due to differences in topography and climate (Continental-Mediterranean and Mediterranean climatic zone, respectively), different taxa were recorded which are presented with simplified identification photo - key. Difficulties have emerged during the taxonomic identification indicating that *Hypericum* plants are rather easy to find but hard to identify at a species or subspecies level.

Discrimination of species of the genus *Hypericum* L. using DNA barcoding

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The genus *Hypericum* L. (*Hypericaceae*), containing about 500 species, is one of the largest angiosperm genera with worldwide distribution and complete taxonomic treatment. The therapeutic properties of these species have been known since antiquity, with reports from Hippocrates, Dioscorides, Galen and Paracelsus. During the last 20 years there has been an increased interest in the study of their active compounds, hypericine and hyperforin with antidepressant, antimicrobial and antiviral activity. Because of these properties, the commercial demand of *H. perforatum* (St. John's Wort) products such as herbal teas, extracts, tablets and capsules, has also been increased, a matter which renders the commercially traded species identification important. DNA barcoding is a molecular method that uses small genome sequences of organisms to identify them and study their diversity. The aim of this study was to examine whether DNA barcoding could discriminate species of the genus *Hypericum* and if so, which DNA barcode could provide better results. For this purpose, sequences of *Hypericum* species found around the globe were searched in GenBank. A total of 35 unique sequences corresponding to species that could also be found native in Greece were retrieved, 12 for *rbcL*, five for *matK* and 18 for *trnH-psbA*. The DNA barcoding results indicated that the three barcodes could be used effectively for the separation of the examined *Hypericum* species. Furthermore, the discrimination power of *trnH-psbA* region was higher than the other barcodes.

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An exploration of the historical collection of TAU Herbarium: the specimens from the 19th century

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TAU (Thessaloniki Aristotle University) is a relatively small Herbarium, associated with the Laboratory of Systematic Botany and Phytogeography, School of Biology, and mainly containing taxa of the Greek flora. It is divided into two sections, the New (specimens collected after 1950), which is constantly enriched, and the Historical, which holds more than 6.000 specimens dating back to the 19th century. The aim of the present work was to record, digitise and document the specimens of TAU with a collection date up to 1889. About 812 specimens were found and their identity and nomenclature were updated. They belong to 599 species and subspecies of 289 genera and 82 families, mostly of angiosperms. Most of the specimens were collected in South Greece, i.e. the part of modern Greece which constituted the Hellenic state in the 19th century and was extensively explored at that era, mainly from Sterea Ellas (319), the Peloponnese (224) and the Cyclades (102). They mostly derive from the collections of: a) Theodor von Heldreich (343 specimens, including 34 nomenclatural types), collected during his expeditions to Mounts Kyllene (1848), Olympus (1851) and Parnassos (1852 and 1855), to Attica (1852-1889) etc., b) Theodoros Orphanides (125 specimens, including 9 types), collected during his expeditions to Mounts Parnon-Malevo (1850-1860), Taygetus (1868, 1870, 1872) etc., c) Joseph Sartori (118 specimens, including 2 types) collected from Attica (1834-1875), Euboea (1847), the Cyclades (1847-1859) etc. d) Vasileios Tuntas (32 specimens) collected by him or others (e.g. J. Sartori, Th. Heldreich, Th. Aphentoulis, E. Psaridis). The digitisation of the examined specimens is complete and their data will be soon available online.

Disentangling the Macaronesian riddle in Rand Flora disjunctions using population-level genomics: the sweet tabaiba

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Biogeographic relationships between the Canary Islands and northwest Africa are common, often explained by oceanic dispersal and geographic proximity. Sister-group relationships between Canarian and Eastern African/Arabian taxa are more rare, and correspond to a disjunct "Rand Flora"-type distribution spanning thousands of kilometers on opposite sides of Africa. One hypothesis is that the Macaronesian component of the Rand Flora originated from a recent dispersal event from a northwestern African population that went later extinct, leaving a large spatial "gap" between the east and western disjunct taxa. Yet, no phylogenetic evidence supports this event. The sweet tabaiba (*Euphorbia balsamifera*), comprising three subspecies, shows the Rand Flora disjunction with populations in Macaronesia-northwest Africa, Eastern Africa/Arabia and Western Sahel. We focus here on subspecies *balsamifera*, distributed in all Canary Islands and in a few scattered enclaves along the coast of Morocco and Western Sahara. Using target enrichment of low-copy nuclear markers with plastid genome skimming (HybSeq), a comprehensive population-level sampling, and Bayesian MCMC methods we reconstructed phylogenetic and biogeographic relationships among populations of subsp. *balsamifera*. We further compared demographic patterns between mainland and island populations to test for the signal of extinction. Our aims were to examine: a) whether the coastal populations in northwest Africa are sister to the Canarian populations; b) the number, direction, and timing of potential colonization events between the continent and the archipelago; c) signals of demographic bottlenecks in African populations connected to aridification and range contractions; and finally, d) the relative role of island age, geographic distance, and topographical complexity on the dispersal and diversification history of the sweet tabaiba within the Canary Archipelago.

Diversity of *Lathyrus ochrus* (L.) DC. in Lam. & DC. landraces in island regions of Greece

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Genus *Lathyrus* is represented in Greece by 32 indigenous species with the majority of them found in nature and quite a few cultivated in a small scale as pulses, fodder crop or vegetables. The multiple landraces of cultivated species formed by farmers' practical and observational selection in addition to the impact of the microenvironmental variation and conserved *in situ*. The present study focuses on the characterization of the phenotypic diversity of four Cyprus vetches (*Lathyrus ochrus* (L.) DC. in Lam. & DC.) local populations collected from various island regions in Greece (Andros, Lemnos, Evvia, Skiros) aiming to determine the uniqueness of the studied genetic material and evaluate the potential for further utilization. Research methodology was based firstly on the conduction of collecting expeditions in order to determine the geographical distribution of cultivated *L. ochrus* local populations and to preserve *ex situ* the collected accessions. Secondly, field experiment was conducted during the 2016-2017 growing season designed as a randomized complete block with three replications. Characterization of the accessions was made according to Descriptors list for *Lathyrus* spp. developed by IPGRI using 71 agro-morphological traits. Finally, the collected data were analyzed statistically and the genetic material was classified into four groups indicating that Lemnos and Andros *L. ochrus*' accessions are distinct landraces while Skiros and Evvia were overlapped in a small degree showing that they can be regarded as two differentiated local populations. Overall a significant level of phenotypic diversity was recorded among and within the studied local populations (according to both vegetative and reproductive parameters such as seed coat colour, seed coat pattern, pod curvature and shape, flowering time, flower calyx colour, number of leaflets per leaf). The results indicate that those populations are unique landraces, they form a valuable gene pool for future exploitation in breeding programs and moreover this genetic material is needed to be conserved on-farm.

Approach to the invasive potential of *Senecio pterophorus* using SDMs and niche comparison analyses

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Senecio pterophorus DC. (*Compositae*) is a perennial shrub native to eastern South Africa (Eastern Cape and KwaZulu-Natal provinces) that inhabits forest margins, grasslands, and fynbos. One hundred years ago, *S. pterophorus* expanded into Western Cape in South Africa, but also cross-continently into Australia. A more recent expansion occurred 25–30 years ago in the Mediterranean Europe, concretely in Liguria (NW Italy) and Catalonia (NE Spain). In the introduced ranges, it mainly occurs in disturbed areas such as railroads or roadsides, although can also be found in natural areas. During the late 19th and the early 20th centuries, *S. pterophorus* was recorded in Belgium and the United Kingdom, respectively, although it is now considered extinct in both countries.

We used species distribution models (SDMs) [geographic (G) space] and niche comparisons analyses [both in geographic and environmental (E) spaces] aimed to: (1) determine whether the species has changed its niche during the invasion process, and (2) ascertain why the species has not succeeded neither in Belgium nor in United Kingdom. In the G-space we used the maximum entropy algorithm (implemented in MaxEnt) to build niche distribution models, which are projected and evaluated in the native area vs. the invaded ones, and vice versa. Possible niche differences between native and invaded ranges were also assessed by several approaches (including the McCormack analysis and the PCA-env method of Broennimann). Additionally, metrics of niche overlap, similarity, expansion, and stability were calculated for each pairwise comparison native vs. invaded areas. An UPGMA dendrogram was performed to examine clustering groups and relationships between all realized niches. Finally, significant differences in means of environmental layers among niches were tested to determine which variables may explain the obtained niche shifts. The outcomes of this study would contribute to understand in which conditions *S. pterophorus* can lead to behave as a potential plant invasion.

Sand-dune and wetland vegetation of Schinias National Park (NE Attica, Greece): preliminary results

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The sand-dune and wetland vegetation of the European Natura 2000 protected area of Schinias National Park (NE Attica, Greece) was studied during 2012 and 2017-2019 following the Braun-Blanquet approach. The main sand-dune and wetland vegetation types of Schinias National Park include (1) Pioneer halo- nitrophilous communities of drift line (*Euphorbion peplidis*) (2) Tall grass perennial swards of shifting dunes (*Ammophilion*) (3) Ephemeral sand dwelling communities (*Maresion nanae*, *Malcolmietalia*) (4) Aegean coastal phrygana on stabilized hind dunes (*Helichryso barrelieri-Centaureion spinosae*) (5) Maritime Juniper scrub vegetation (*Asparago orientalis-Juniperion macrocarpae*) (6) Mediterranean pine forest with *Pinus halepensis* (*Pistacio lentisci-Pinion halepensis*) and/or *P. pinea* (*Pinion pineae*) (7) Thermomediterranean sclerophyllous evergreen macchia (*Ceratonio-Pistacion lentisci*) (8) Mediterranean tall humid herb grasslands (*Molinio-Holoschoenion*) (9) Pioneer vegetation of annual succulent halophytes (*Therosalicornion*) (10) Mediterranean and thermo-Atlantic halophilous scrub (*Salicornion fruticosae*, *Arthrocnemion glauci*, *Limonietalia*) (11) Mediterranean salt meadows (*Juncion maritimi*, *Agropyro-Plantaginion maritimae*) (12) Reed beds (*Phragmition communis*, *Scirpion maritimae*), (13) Mediterranean riparian scrub (*Tamaricion dalmaticae*) and (14) Aquatic macrophyte vegetation of brackish ponds (*Ruppion maritimae*). A first interpretation of the vegetation units identified and of the related habitat types is attempted. Twenty nine communities were discerned and ranked into eighteen alliances, sixteen orders and twelve phytosociological classes of the EuroVegChecklist hierarchical syntaxonomic system. The distinguished communities were subsequently classified into fourteen different habitat types. Of the identified habitat types that are included in Annex I of the Council Directive 92/43 EEC, three have a scattered presence in the Natura 2000 network in Greece (1310, 1420, 6420), two are rare (2230, 2270) and three (1150, 2250, 2270) are priority habitat types. Standardized cross-walks between alliances of the EuroVegChecklist and the accepted habitats of the European Nature Information System (EUNIS) were used for the identification of habitat types.

Propagation and domestication of wild, rare-endangered endemic plants of Greece for *ex situ* conservation purposes and sustainable use in the Balkan Botanic Garden of Kroussia

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Loss of biodiversity due to climate change and human activities create the need to preserve the rare and threatened endemic species of the Greek flora. As these plants are unique, the knowledge of their propagation is essential for conservation purposes, creation of mother plants and high added value products. The Balkan Botanic Garden of Kroussia, N. Greece has formulated a conservation strategy for the collection and documentation of wild plant material for sustainable utilization, prioritizing firstly the Greek endemic, rare and threatened plants found in different regions of Greece and secondly other socio-economic plants with aromatic-medicinal properties or edible parts.

Plant propagation was carried out through seeds, cuttings and *in vitro* culture. Seed germination trials *in vivo* (11 species, in autumn) and *in vitro* (21±2°C, 16h photoperiod) (8 species) (different storage life in seed bank ranging between 0-10 years for *in vivo* and 2.5-11.5 years for *in vitro*) were conducted in the following species: *Centaurea paxorum*, *Dianthus ingoldbyi*, *Erysimum naxense*, *Erysimum krendlii*, *Thymus plasonii*, *Dianthus fruticosus* ssp. *occidentalis*, *Dianthus juniperinus* ssp. *bauhinorum*, *Silene fabaria* ssp. *domokina* (*in vivo*, *in vitro*) and only *in vivo* for *Stachys ionica*, *Teucrium halacsyanum* and *Thymus holosericeus*. The optimum germination percentage, seed age and duration of the highest response in days for all species were ranged between 8.33-100%, 2-10 years-old and 7-25 days (*in vivo*) and 15.38-94.12%, 2.5-11.5 years-old and 5-50 days (*in vitro*), respectively. Vegetative propagation protocols were developed for 13 species: *C. paxorum*, *D. ingoldbyi*, *E. naxense*, *E. krendlii*, *T. plasonii*, *D. fruticosus*, *D. juniperinus*, *S. fabaria*, *S. ionica*, *T. halacsyanum*, *T. holosericeus*, *Astragalus suberosus* ssp. *haarbachii* and *Hypericum empetrifolium* Willd. ssp. *empetrifolium*. The most appropriate season of the year, height of cuttings, best treatment of IBA concentration, highest rooting percentage and duration of root emergence for each species were reported and ranged between 28.57%-100%, 3-8.5 weeks and 1.5-8 cm, accordingly. Winter was the best season for *D. juniperinus* cuttings, spring for *D. fruticosus* and *A. suberosus* and autumn for the other 10 species. *In vitro* propagation protocols were established in the same 13 species propagated through cuttings.

The dissemination plan included a list of potential stakeholders of the project's innovation, brochure distribution, training manual, publication of articles in scientific journals and announcements in conferences. The whole research was carried out in the

framework of the sustainable exploitation of plant genetic resources, conservation and protection of the endemic biodiversity of the Greek flora.

Acknowledgments: The postdoctoral research and scientific publication was carried out within the framework "Strengthening of Postdoctoral Researchers" of the OP "Development of Human Resources, Education and Lifelong Learning", 2014-2020, which is being implemented from the National Scholarships Foundation (NSF) in Greece, and is co-funded by the European Social Fund and the Hellenic Republic.

The DNA collection of Sicilian Plant Germplasm Repository of Palermo University

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The role of herbarium-voucher collectors has constantly developed following the growing need to ensure complete information on the collected samples and its associated information. The use of new technologies, especially the high-throughput methods, can melt the evolving scientific applications and practical uses for herbarium data, while contributing to the routine germplasm conservation practices in genebanks. An additional source of accessions is the DNA deposited as reference repository of voucher as classified by expert taxonomists or derived from species of uncertain morphological characterization, thereby representing an invaluable source for future researches. Furthermore, the DNA bank promotes storage of reference DNA samples, obtained and characterized as a result of scientific projects or peer-reviewed publications from individual researchers or academic institutions. Similarly to conserve phenotypic types, total DNA samples can be considered molecular types. The Sicilian Plant Germplasm Repository of Palermo University (SPGR/PA) stores seeds, tissues and DNA collections of endemic or endangered species, as well as local historical cultivars now endangered due to the spread of commercial varieties. Indeed, tissues and DNA banks are of paramount utility as a primary resource for conservation research, since they provide the raw material for molecular genetic applications, hence facilitating the assessment and analysis of diversity (e.g. genetic diversity, molecular evolution), thus combining research and conservation. The DNA samples stored in the SPGR/PA were collected from new material harvested from the wild, from seeds or plants represented within the germplasm collection of the *Herbarium Mediterraneum* and from cultivated species preserved in Plant Conservation Centers. These DNA storage activities are not systematically planned, but rather resulting from diverse ongoing projects. The total DNA extracted and quantified belongs predominantly to southern Italian taxa, Sicilian taxa or Sicilian local cultivars. The collected plant material belongs to seventy-four families. Establishing a high quality of DNA collections has been particularly challenging from an economic standpoint, due to the intrinsic multidisciplinary nature of the required professional expertise (including for instance taxonomists, conservation biologists and molecular biologists). However, molecular biologists and modern farmers require access to a wide genetic diversity to support genomics projects and develop innovative applications with pharmaceutical, agricultural and industrial implications. The DNA Bank of SPGR/PA, established in 2012, has played an important role in ensuring quality of source documentation so that

researchers can access data for basic and applied research. An economical support could derive from shared projects between biodiversity analysts and biotechnologists, aiming to identify and collect relevant genotypes, and extract, preserve and manage DNA accessions. Some herbaria now list their DNA sample collections via the internet so that researchers can access material that would otherwise not be available to them.

Les adventices et les envahissantes dans les vergers d'agrumes et d'oliviers de la région de Mostaganem

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Le travail s'inscrit dans un projet d'identification des mauvaises herbes dans tous les types de cultures à savoir les vergers d'agrumes et d'oliviers dans la région de Mostaganem.

A partir des premiers 60 relevés effectués en début de saison printanière de 2019 et selon la méthode sigmatiste, dans quatre différentes stations pour chaque type de plantations, au moins 70 espèces d'adventices sont identifiées où la majorité sont des thérophytes.

Plus de 50 taxons sont recensés dans les vergers d'agrumes appartenant à 22 familles botaniques dont 48 espèces dicotylédones. La famille *Asteraceae* représente 30 % de la flore et que les espèces *Centaurea aspera* L. et *Sonchus oleraceus* var *lacerus* L. sont les espèces les plus représentées.

Par ailleurs, plus de 60 taxons sont inventoriés dans les oliveraies représentées par 25 familles dont 46 espèces dicotylédones. Les familles *Asteraceae*, *Poaceae* sont les plus dominantes avec plusieurs représentants des *Solanaceae*.

Au moins deux espèces exotiques considérées comme envahissantes apparaissent dans les relevés dont *Salpichroa organifolia* (Lam.) Tell et *Solanum elaeagnifolium* Cav. Le taxon *Chrozophora tinctoria* Juss est une nouvelle dans le secteur d'après les agriculteurs.

Pour certains vergers privés, l'exotique *Senecio angulatus* L. est utilisée comme haie artificielle d'occultation des vergers d'agrumes et entre autres des jardins privés depuis plusieurs années déjà.

Mots clefs: Biodiversité, adventices, *Senecio angulatus*, arboricultures, Algérie.

Importance of *vip3* Proteins on the Conservation of Plant

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Vegetative insecticidal proteins (Vip) are produced during the vegetative growth stage of *Bacillus thuringiensis* (Bt) and a novel group of insecticidal proteins. There are a lot of endemic and economic plants in Black Sea Region. The caterpillars interfere with plants development by destroying growth points and flowers. In this study we characterized the *vip3Aa* genes in local Bt isolates (BnBt and MnD). After obtaining good insecticidal activity with Vip3 proteins of these isolates were purified from supernatants of bacterial cultures by ion exchange chromatography. Purified proteins were subjected to SDS-PAGE analysis and 90 kDa band of proteins were determined. These purified proteins were tested against *S. littoralis* larvae as test organism. Results showed that Vip3 proteins of BnBt and MnD produced 86.66% and 83.33% insecticidal activity against the larvae of *S. littoralis*, respectively. The lethal concentrations (LC₅₀) of BnBt and MnD were determined as 41.860 ng and 55.154 ng, respectively. Also these proteins may be used for the plant conservation. This research is supported by KTU-BAP (Project No: FBA-2018-7879).

Keywords: Microbial control, plant conservation, *S. littoralis*, *vip3* gene.

Karyomorphological Analysis of *Muscari adilii* and *M. comosum* from Turkey

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The genus *Muscari* Miller is fairly popular worldwide because some of their species have attractive and fragrant flowers. The genus is represented by 50 species and displays a broad distribution along the Caucasus, temperate Europe, Africa, and north-western and south-western Asia. Karyotype features, like the chromosome number and morphology, can be used as taxonomic data for classification. Chromosomal counts and especially karyomorphological features are very important to the taxonomy of the plant species. By this study, we aimed to determine the chromosomal features of Turkish *Muscari adilii* M.B.Güner & H.Duman and *Muscari comosum* (L.) Mill.

Healthy bulbs were chosen and germinated for chromosomal counts and karyotyping analyses. First, the samples were placed into 0.002 M 8-hydroxyquinoline at 4 °C for 8 h and then fixed with Carnoy for 24 h at a low temperature. Before staining, they were hydrolysed with 5 N HCl for 1 h at room temperature, stained with 1% aceto-orcein, and mounted in 45% acetic acid. At least 10 metaphase plates were examined for each taxon; the best ones were photographed (100×) with a digital camera (Olympus DP-72) mounted on an Olympus BX53 microscope. The chromosome nomenclature was done as proposed by Levan et al. (1964). Karyotype asymmetry was determined using the mean centromeric indices, the ratio of the shortest/longest pair, and according to the A₁ and A₂ indices (Zarco 1986). Moreover, the coefficient of variation of the chromosome length (CV_{CL}), coefficient of variation of the centromeric index (CV_{CI}), and karyotype asymmetry index (AI) were counted according to the method proposed above.

The chromosomal counts confirmed the results of previous reports, that the *Muscari* has same basic chromosome numbers. According to our results discussed, chromosome numbers of studied taxa have been identified 2n = 18, x=9 and also both have the diploid number of chromosomes. We found predominance of metacentric chromosomes in karyotypes. Five quantitative asymmetry indices were used to evaluate our karyological results in all species and elucidate the chromosomal alterations of *Muscari* taxa. The karyotyping analyses belonging to *M. adilii* were described for the first time in this paper.

Acknowledgments: We would like to thank TUBITAK (Project No: 117Z222) for their financial support.

Keywords: Karyomorphology, *Muscari*, Turkey.

Whole genome duplication directly effects reproductive strategy of polyploids in a primary contact zone

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Studies using neopolyploids from natural systems to elucidate direct consequences of autopolyploidization on reproductive traits are still uncommon although such systems are ideal for studying the divergence of plant traits in an evolutionary context. Here we search for the evidence of direct impact of whole genome duplication (WGD) on reproductive strategy in neopolyploids of diploid-polyploid *Pilosella rhodopea* in order to understand mechanisms underlying their distributional success.

Using material from natural populations we compared reproductive behavior and potential spreading ability of the diploids, triploids and tetraploids of *P. rhodopea*. In a combination of laboratory and greenhouse experiments, we assessed gametogenesis processes, fertility (seed set and germinability) and extent of clonal growth for the three main cytotypes.

The quantification of reproductive behaviour in diploids and polyploids cytotypes showed that in *P. rhodopea* WGD induces (i) meiotic irregularities leading to reduced fertility of polyploids, (ii) initialization of apospory (although all cytotypes still reproduce sexually) and (iii) evolutionary novelty - divergence in clonal traits in terms of considerably increased clonal growth by formation of special organs, root sprout accessory rosettes, present exclusively in polyploids. Also we found a trade-off tendency when polyploids invest more to clonal while diploids to sexual reproduction.

Pilosella rhodopea represents a rare well-documented example when WGD resulted not only in quantitative (number of accessory rosettes) but also qualitative (origin of accessory rosettes hypocotyl meristems / root sprouts) alteration of clonal ability. Emergence of the exclusive morphological trait likely enables establishment and effective spreading of polyploids with otherwise severely reduced fertility.

Cyanus tuberosus group revisited

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The *Cyanus tuberosus* group (= *Centaurea napulifer* group) is an example of a rapidly and recently diversified plant group, whose evolved in spatio-temporal isolation in the topographically complex Balkan Peninsula. Recently, the group has been revised based on analyses of its genetic (amplified fragment length polymorphisms; 240 individuals), morphological (48 morphological traits, 611 individuals), ecological (42 studied sites) and phenological (281 individuals) variability, supplemented with field observations and a study of relevant herbarium specimens. We found that the studied group comprises nine almost allopatric genetic lineages which show only little congruence with the current taxonomy. The *C. tuberosus* group, as newly defined, comprises eight Balkan endemic species, namely *C. adamovicii*, *C. nissanus*, *C. orbelicus*, *C. tuberosus*, *C. velenovskyi* and newly described *C. austrobalcanicus*, *C. vichrenensis* and *C. vorasanus*. Within *C. austrobalcanicus* two subspecies have been recognised and newly described, namely *C. austrobalcanicus* subsp. *austrobalcanicus* and *C. austrobalcanicus* subsp. *prisadanus*. Allopatric speciation within the *C. tuberosus* group has been accompanied by long-term isolation and hybridization. The genetic admixture was detected mainly in contact zones between some members of the group.

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The genetic structure of Central European populations of the *Cardamine pratensis* complex is resolved after seven decades of extensive research

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Genetic structure of the *Cardamine pratensis* complex, comprising a number of species and genetic lineages from the diploid to higher polyploid levels (including numerous aneuploids and dysploids), was addressed in its Central European distribution area using microsatellite markers. Acquired results enabled us to compare differences in evolutionary histories among closely related species. In diploid *C. matthioli* we identified two genetic lineages, probably a remnant of allopatric differentiation during the Last Glacial Maximum. *Cardamine majovskyi* (autotetraploid derivative of *C. matthioli*) originated at least once in each of the two genetically and geographically defined groups. After that, these plants did not spread beyond the distribution area of the diploid lineage from which they originated. Time of the origin of tetraploids is unknown, and we cannot rule out hypothesis that this species arises continuously until nowadays. For hypotetraploids of *C. pratensis*, on the other hand, monotypic origin is favourable. Polyploidization event and chromosome fusion, which resulted in the origin of hypotetraploids, apparently predate the postglacial differentiation of Central European populations of *C. pratensis* s. str., and since that time, these plants spread widely. *Cardamine pratensis* is also much more variable than *C. majovskyi*. This admirable morphological, ecological, and cytological variability was reflected in taxonomic concepts. Several taxa and informal units were recognized in the past: *C. nemorosa*, *C. udicola*, *C. rivularis* auct. and morphotype “ucranica”. However, our molecular data did not support existence of these taxa. We identified three genetic lineages, which are likely maintained by spatially restricted gene flow. Their spatial segregation could be attributed to the long-time isolation of founder populations in multiple glacial refugia. There are no strict borders among lineages, potentially serving as a basis for a new taxonomic concept, leading to the splitting *C. pratensis* into more segregate taxa. *Cardamine rivularis* was considered to be a diploid species for a long time, however, our results uncover its complicated cytogenetic pattern, and it became rather multi-cytotype complex than single ploidy species. We found that both polyploidization and hybrid speciation shaped variability in this complex, but our data did not allow us to capture all consequence of these processes.

Disentangling complex evolutionary patterns in snowbells (*Soldanella* L.) The extensive interspecific hybridization events triggered by Quaternary climatic oscillations

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Quaternary glacial-interglacial cycles caused massive extinction and migration of organisms, however, they served also as an effective driver of the diversification processes, especially in the high mountain biota. Together with the complex geomorphology of mountains, they facilitated horizontal and vertical migrations of populations, accompanied by the niche shifts along elevational gradients. Such range dynamics facilitated secondary contacts and gene flow among allopatric/parapatric species and lineages. We studied here the evolutionary history of the model genus *Soldanella* L. (snowbells, *Primulaceae*), including approximately 24 taxa, endemic to the European mountain system. The crown diversification and species radiation of snowbells have been dated to the Quaternary era, however, the evolutionary history and mutual relationships among taxa and lineages remind unresolved. By reconstructing the intra-generic phylogeny based on the combination of whole plastome and RADseq and FISH data, we attempted to reconstruct the evolutionary history of snowbells and to identify key factors shaping their present-day diversity. Our data provided the high phylogenetic resolution but the interpretation of certain interspecific relationships left ambiguous because of the recurrent and extensive hybridization. This acted even among ecologically and morphologically divergent taxa. Outcomes of our study indicate obvious predisposition of snowbells to particular evolutionary parallelisms. We evidenced the recurrent formation of the same dysploid cytotype ($2n=2x=38$) and colonisations of the alpine zone by numerous taxa and their lineages during different time horizons of the genus evolutionary history. The Carpathians and closely adjacent mountain ranges served as an important secondary diversification center for snowbells.

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Characterization and phytochemical analysis of the ethanolic extract of *Fumaria capreolata* L. collected from North-east of Algeria

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The objective of this study is the knowledge of Algerian natural resources in medicinal plants. Our work focused on a phytochemical study of the species *Fumaria capreolata* L. from North-east of Algeria.

Fumaria capreolata L. is a medicinal plant belonging to the family *Papaveraceae*, it is spontaneous and widespread in North Africa, particularly in Algeria. It is used in traditional Algerian medicine in case of hepatobiliary dysfunction, gastrointestinal disorders and for the treatment of cutaneous pathologies (Gilani et al. 2005).

The phytochemical screening carried out on the powder, the macerate and the extract of the of the aerial part of *Fumaria capreolata* L. species revealed the richness of this plant in secondary metabolites, such as flavonoids, catechin tannins, sterols, terpenes and alkaloids. On the other hand we have noticed the absence of cardinolides, leuco-anthocyanins, quinones and starch in all parts of the plant.

The ethanolic extract of *F. capreolata* L. was analyzed by gas chromatography coupled to a mass spectrometer (GC-MS).

The results obtained show that this extract comprises 18 compounds, four of which are in the majority such as protopine and parfumine, etc. These results are in agreement with several phytochemical investigations carried out on European, Asian and African species of the genus *Fumaria*, where different types of isoquinoline alkaloids, in particular protopine, have been isolated (Preininger 1986, Sousek et al. 1999, 2000, Suau et al. 2002, Maiza-Benabdesselam et al. 2007).

Keywords: *Fumaria capreolata* L., phytochemistry, GC-MS, analysis, alkaloids.

Comparison of Chestnut and Mad Honey of Two Different Honeybees (Yığılca Honeybee Ecotype and Anatolian Honeybee) in Turkey

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Turkey with rich plant diversity and high endemism proportion, it is quite favorable for beekeeping. This plant variety makes it possible to produce different honey type. The geography of Anatolia there is different elevations, the three sides are covered with seas and its climatic conditions affect that endemism in plants and also provide that formation of subspecies and ecotypes in bee races. Yığılca honeybee which is a new ecotype has been identified from Düzce province (Black Sea region). Yığılca honeybee is separated from others according to morphometric data and formed a different group. *Apis mellifera* subsp. *anatoliaca* (known as Anatolian honeybee) is also common subspecies in Düzce but Yığılca district is isolated part from other district in Düzce.

In this study it is aimed to compare botanical source of honeys between Yığılca honeybee ecotype and Anatolian honeybee. It can be provide insight into plant selection of different honeybee types. For this purpose, two important honeys in the Düzce province, chestnut honey and mad honey were examined. According to field trip around beehives, 104 plant specimens were collected and identified 54 taxa belonging to 23 families as honey plants. Mellisopalynological and physicochemical analyses of chestnut and mad honey produced by Yığılca Honeybee Ecotype and Anatolian Honeybee was performed and compared.

Keywords: Yığılca honey bee, *Apis mellifera*, melliferous plants, melissopalynology, Düzce, Turkey.

Strategies of active conservation for threatened plants: the case of *Centaurea erycina* (Asteraceae) from Sicily

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Centaurea erycina Raimondo & Bancheva is a beautiful plant endemic to Sicily where it occurs in a restricted area around the summit of Mount Erice, a calcareous coastal relief of western Sicily overlooking the city of Trapani. The locality, at about 300 m a.s.l., is subject to a meso-mediterranean climate, with high atmospheric humidity also in summer due to the frequent, dense fogs. It is a chamaephyte flowering in late spring up to summer. The capitula are enough flashy also thanks to their flowers with purple-colored ligules. Leaves are wide, cinereous as the whole plant. Due to the reduced size of the population, this species falls into the category of critically endangered plants. Depending on this *status*, actions for *ex situ* conservation have been undertaken.

In one experimental site, a plant reproduced by seed in a regional center of conservation was placed. It has lived there for four years, has flowered and also has produced fertile seeds, proving to be self-fertile. In winter, vegetative activity stops or lightly regresses. In summer, for the maintenance of vitality, the plant needed periodical irrigations. In these conditions, cutting the mature capitula, the plant reacted not only producing vegetative sprouts but also new capitula.

The example case is thus the demonstration of how *ex situ* conservation can be made also through simple ways. In our case, the experimentation regarded only one plant and a period of four years. In the observation period, the plant showed to respond well to the cultivation cares, maintaining an extraordinary vegetative growth in the period of maximum hydric stress in nature.

Thanks to the actions and the practices carried out, plants of *C. erycina* were obtained for a potential reinforcement of the natural population. Horticultural practices have stressed also the economic potentiality of a species threatened in nature. We realized about a new resource to be used for decoration of gardens and of green spaces in general.

The case presented shows the efficacy of the strategy of active conservation of plant resources: it becomes a winning strategy when it is possible to combine naturalistic and productive needs, coming through the enhancement of wild biodiversity.

Typification of names and their taxonomic assignment within the *Brachypodium distachyon* complex (*Poaceae*)

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The *Brachypodium distachyon* complex includes three annual species, whose taxonomic identities have recently been demonstrated by cytological, molecular and morphological data. The initial taxonomic studies contained no nomenclatural revision of the twenty or so heterotypic synonyms at species rank, while the authors needed to describe two species as new. Indeed, the impossibility to study molecularly the herbarium type materials of these names precluded the analysis of these samples. An improvement of the morphological methods, including new criteria relevant both in situ and in herbarium, now allows us to do this nomenclatural synthesis, according to the current taxonomic treatment. Fresh French and Algerian material from the three species has been calibrated with DNA genome size (2C) and molecular barcoding (ITS + trnLF). We found that several valid previous names are available for *B. stacei* (whose distribution is more widespread than expected), of which *Festuca rigida* Roth is the older and yet has been used to combine *Brachypodium rigidum* (Roth) Link, the priority name of the species. Admissibility to propose a conservation or a rejection of one of these names is in debate. In order to fix their interpretation, nomenclatural types of a dozen other names will be designated at the end of this work, including lectotypes and neotypes. We found that the herbarium lectotype of *Bromus distachyos* L. (LINN93.48) corresponds to *Brachypodium hybridum* according to our current morphological analysis. In virtue of what a proposal to conserve and retypify the name *Bromus distachyos* L. could be a consensual solution in order to conserve the uses of both *B. distachyon* and *B. hybridum* in their current senses. Field investigation also revealed other possible annual species of hybrid origin – at least one sensu *Trachynia platystachya* (Coss.) H.Scholz – but with an inversed parental combination than *B. hybridum*, which are currently investigated also genomically.

Chemical composition and antioxidant activity of two endemic taxa: *Salvia brachyodon* Vandas and *Salvia pratensis* var. *varbossania* Malý

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Two endemic taxa, *Salvia brachyodon* Vandas from Croatia and *Salvia pratensis* var. *varbossania* Malý from Bosnia and Herzegovina, were analysed for the total phenolic and total flavonoid content. In addition, HPLC-ED analysis was performed to determine the content of gallic, chlorogenic, caffeic and rosmarinic acid. The total flavonoid content was similar, while the total phenolic content was higher for *S. brachyodon*. In general, aqueous extract of *S. pratensis* var. *varbossania* had a significantly higher amount of all phenolic acids analyzed than aqueous extract of *S. brachyodon*. The most abundant phenolic acids were gallic and caffeic, in an amount of 0.129 mg/mL and 0.079 mg/mL respectively, in *S. pratensis* var. *varbossania* extract. The rosmarinic acid had the lowest amount (0.0013 mg/mL) in *S. brachyodon* extract. Antioxidant activity was determined by DPPH, ABTS, RP and ORAC methods, where *S. pratensis* var. *varbossania* showed better antioxidant activity, probably due to the higher content of phenolic acids as well as total flavonoids, which are known as good antioxidants.

Keywords: *Salvia*, endemic taxa, phenolic compound, HPLC, antioxidant activity.

Phytoalimurgic species in Italy: richness, cultural value and advanced uses

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The use of wild edible plants in Italy has always been a relevant aspect of local cultures, but this traditional knowledge seems to be declining under the influence of urbanization, globalization of agriculture and abandon of rural areas. The present investigation aims at improving the knowledge of the dietary use of spontaneous flora across Italy as a tool for enhancing local plant resources. The results of this study could be a tool for the preservation of the cultural heritage and biocultural diversity and, on the other hand, for developing sustainability projects focused on local foods and eco-gastronomy.

Data on Italian phytoalimurgic species has been extracted from the database built on all references available in ethnobotanical literature since 1918 up to now (Paura et al., 2019). Plant nomenclature is according to Pignatti (2017).

Some synthetic indexes, such as Relative Frequency of Citation (RFC), Cultural Importance Index (CI) have been used.

To deep the knowledge of the phytoalimurgic uses and to assess how it is distributed within italian districts, a region by region comparison has been performed and it has been analyzed along with socio-economic traits. This allows us to understand if traditional knowledge is being equally threatened by current trends of socio-economic and land use changes.

The current research helps to identify a set of wild edible plants suitable for developing dietary patterns against several food-related diseases and to elaborate nutritional models focused on health benefits. Finally, advanced uses of wild plants could link together the safeguard of the popular fast disappearing traditions with the health assurance.

A frequent use of wild local plant species as food sources could offer a lot of complex benefits, such as a greater production of active and nutritional substances, the rediscovery of traditional recipes and their cultural enhancement as traditional heritage and the local plant diversity conservation. In addition, if these species could be cultivated, an easier growing due to their reduced needs of phytochemicals, fertilization and water demand could be ensured, and consequently a reduction of agronomic costs for the farmers and a wholesomeness of the food products and of the environment.

Effect of Salt Stress on Growth Parameters, Relative Water Content, Relative Water Loss and Photosynthetic Pigments of Okra (*Abelmoschus esculentus* L.)

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Increasing soil salinity is a major threat to global agricultural growth and production, particularly in arid and semi-arid regions. In order to study the effects of salinity stress on growth indices and physiological parameters in okra (*Abelmoschus esculentus* L.), an experiment was arranged as a factorial in completely randomized design (CRD). Plants were subjected to three salt treatments (50, 100 and 200 mM of sodium chloride). After one month, plants were stressed for 15 days with different NaCl concentrations. Various parameters such as shoot and root length, fresh and dry weight, Relative Water Content (RWC), Relative Water Loss (RWL) and photosynthetic pigments were analyzed. Salinity caused significant reduction in all measured parameters. Thus, increasing NaCl concentrations caused a great reduction in growth parameters such as shoot length that was decreased by half from 41 cm (control) to 19.5 cm (200 mM) and fresh and dry weight in shoots and roots, while root length was less affected. These changes were associated with a decrease in the relative water content. At 50 mM and 100 mM NaCl the RWL was significantly decreased while it was found to increase at 200 mM. By increasing NaCl levels from 0 to 200 mM, the content of chlorophyll a, b and carotenoids reduced. Maximum reduction was observed at 200 mM of NaCl. Overall study concluded that okra is sensitive towards higher concentration of salts.

Keywords: Growth, Okra, Photosynthetic pigments, Salinity, water

Allelopathic effect of *Tetraclinis articulata* (Vahl) Mast (from Algeria) on germination and growth of *Lactuca sativa* L.

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The present study deal with an endemic medicinal plant from western Algeria extract allelopathic activity (*Tetraclinis articulata*) on germination and growth for *Lactuca sativa* L.

The tested seeds were germinated in petri dishes. Increasing concentrations (0.25, 0.50, 0.75 and 1%) extracts effect was tested on germination and growth of *Lactuca sativa* L. Germination test of different fractions from liquid- liquid partition of *Tetraclinis articulata* (chloroform, ethyl acetat and butanolic fractions).

At the same time, three *T. articulata* extracts at different concentrations (10%, 30% and 50%) were prepared and tested on *Lactuca sativa* seeds in pots.

We also tested these extracts at different concentrations 1.5 and 3% on *Lactuca sativa* seedlings (foliar spray).

Inhibitory effects with variable intensities were observed on *L. sativa* the seeds germination and growth. The aqueous extract of *T. articulata* exhibits the strongest inhibition activity on *L. sativa* seeds at all tested concentrations.

T. articulata ethyl acetate and chloroform fractions exhibit *Lactuca sativa* germination inhibition while butanolic fraction exhibits growth inhibition.

Germination in pots mixed with crude extract of *T. articulata* for all tested concentrations shows inhibition on germination and for the foliar spraying, growth inhibition is observed for different fractions and all the concentrations tested.

It is noted that *Tetraclinis articulata* contains allelopathic compounds that can replace synthetic bioherbicides.

The selective allelopathic effects can be of considerable interest for the control of weeds in the crops cultures. Indeed, the allelopathy may replace nefast phytosanitary products for the environment.

Keywords: Allelopathy activity, *Tetraclinis articulata*, germination, growth, *Lactuca sativa*.

The genus *Pleurotus* (Fr.) P. Kumm. (*Pleurotaceae*, Basidiomycota) in Greece – Distribution, ecology and exploitation potential

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The genus *Pleurotus* comprises ca. 30 species and subspecific taxa of edible mushrooms with a world-wide distribution. *Pleurotus* species diversity in Greece has been extensively studied for more than three decades through the use of morphological, biochemical, molecular and compatibility approaches revealing the presence of seven species. They include wood-saprotrophs and/or weak parasites, such as the widely distributed *P. ostreatus* and *P. pulmonarius* recorded on a large variety of hardwood and coniferous trees throughout mainland and insular Greece, the less common to rare *P. dryinus* and *P. cornucopiae*, and the temperate/subtropical *P. fuscusquamulosus* recorded to date only on trees of the genera *Ficus* and *Morus* in a few Aegean islands and in Attica. In addition, two *Pleurotus* species associated with plants of the family *Apiaceae* occur in Greece: *P. eryngii* (comprising two varieties, i.e. var. *eryngii* on *Eryngium* spp. and var. *ferulae* on *Ferula communis* and *Smyrniolum olusatrum*) and *P. nebrodensis* (characterized as ‘endangered’ by IUCN) growing on roots and lower stem parts of *Prangos ferulacea* in remote mountainous localities of North Peloponnese and Sterea Ellas. Information related to ecological preferences/requirements as well as pure cultures obtained from a large number of *Pleurotus* specimens are exploited towards the development of cultivation processes on novel production substrates which could support not only higher yields but also mushrooms with enhanced content in bioactive compounds and improved functional properties.

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Life forms, reproductive traits and habitat preferences in the endemic flora of Peloponnisos (S Greece)

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Endemic vascular plants, often having small populations and a few sites for conservation intervention, are inherently vulnerable to extinction and therefore, important targets of global conservation efforts. Driving forces that shape endemism are certainly of importance, as they may be used in various models that predict endemism and/or decide on conservation priorities.

Peloponnisos (also known as the Peloponnese) is the southernmost part of the Greek mainland and comprises several adjacent islands. The Corinth Canal, constructed in 1893, transformed Peloponnisos into an artificial island. Its total surface area (including islands) reaches approximately 22,140 km². The highest altitude is found on Mt. Taigetos, at 2,407 m.

Peloponnisos is considered a biodiversity hot spot in the Mediterranean. According to updated estimations, Peloponnisos houses at least 3,212 vascular plant taxa (species and subspecies), which constitute almost half of the Greek flora. At least 475 taxa are Greek endemics, i.e., distributed within the political borders of Greece. At least 518 taxa are considered as range-restricted, i.e., their populations grow within a linear distance of 500 km or less, irrelevant to political borders. The chorological category of local endemics, i.e. those plants that are distributed within a c. 50 km radius, is also notable with 77 taxa.

An investigation of life form spectra shows a clear predominance of the hemicryptophytes followed by the chamaephytes in the endemic taxa, as opposite to therophytes and hemicryptophytes in the total flora. The drop of therophyte percentage among endemic taxa is dramatic. With respect to fruit characters and dispersal modes, fleshy fruits are rare in the flora of Peloponnisos and ever rarer in its endemic flora. Diaspores are predominately seeds or single-seeded fruits, a trend even more pronounced in the endemic flora. A preliminary investigation of dispersal syndromes showed that within specialized genera the percentage of endemism may vary considerably. For example, endemism in the myrmecochorous genera *Euphorbia*, *Viola* and *Crocus* ranges from 3% (*Euphorbia*) to almost 43% (*Crocus*). The allocation of annual seed production into three classes (i.e., few, medium or many seeds produced per plant per year) does not present a significant variation between local and widespread species. With respect to habitat preferences, the majority of the Peloponnesian endemics are inhabitants of rocky, calcareous habitats and cliffs. Dry, phryganic formations are also rich in endemics, followed by the grasslands at the lowland or at subalpine areas.

***Graecobolanthus*: a superfluous new genus**

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Graecobolanthus was proposed by Madhani & al. (2018) as a new generic name for the Greek species of the genus *Bolanthus*, the latter genus comprising the remaining species from Anatolia and the Levant according to the revising authors. However, the type species of the two generic names, i.e. *Graecobolanthus graecus* from Greece and *Bolanthus hirsutus* from the Levant, undoubtedly belong to the same genus based on overall morphological resemblance and *B. hirsutus* matches the circumscription of *Graecobolanthus*. Importantly, *B. hirsutus* was not included in the molecular analysis by the revising authors. In summary, we note that i) *Graecobolanthus* is taxonomically superfluous and *Bolanthus* is the correct generic name of the Greek-endemic species, ii) an extended *Phrynella* and/or a new generic name might accommodate the Turkish taxa currently under *Bolanthus*, which were located on a distinct phylogenetic branch in the study by the revising authors.

The Seed Morphology of Some *Allium* Species Sect. *Codonoprasum* (*Amaryllidaceae*) in Turkey

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The recent taxonomic research in the genus *Allium* has been mainly focused in the Mediterranean area, Southwest Asia and parts of Central Asia and has resulted in the description of several new taxa, increasing the number of the genus *Allium* taxa to more than 900 worldwide. The genus *Allium* L. is the third largest genus in Turkey, comprising about 220 taxa grouped into 14 sections; 86 taxa are endemic to the country (endemism rate 39.1 %). *Allium* sect. *Codonoprasum* (Rchb.) Endl., grouping taxa with two long spathe valves and simple filaments. The second largest and the most taxonomically complicated section in Turkey represented by 55 taxa, with 25 endemic taxa to the country.

In this study, the seed surfaces of 33 *Allium* taxa from the section *Codonoprasum* in Turkey have been examined by scanning electron microscopy (SEM). The seeds were measured as the range of $1.90\text{--}4.20 \times 1\text{--}2$ mm for absolute seed size and the range of 1.62–2.54 for the L/W ratio. In this section, *Allium* species have similar seed shapes and are sectorspheroidal. Seed width and length are also close to each other. The primary and secondary structures of the species in this section are similar. Electron microscopy showed some differences between the morphological groups in this section. They are grouped into 4 series; that have been described for the first in this study as Ser. *Paniculati*, Ser. *Staticiformi*, Ser. *Flavi*, Ser. *Stamineus*.

Genetic structure of Algerian date palm cultivars (*Phoenix dactylifera* L., *Arecaceae*) reveals extensive gene pools admixture in northern-central Sahara

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Date palm (*Phoenix dactylifera* L.) is the mainstay of oasis agriculture in the Saharan region. It is cultivated in a large portion of the Mediterranean coastal area of the Sahara and in most isolated oases in the Algerian desert. We sampled 10 oases in Algeria to understand the structure of date palm diversity from the coastal area to a very isolated desert location. We used 18 microsatellite markers and a chloroplast minisatellite to characterize 414 individual palm trees corresponding to 114 named varieties. We found a significant negative inbreeding coefficient, suggesting active farmer selection for heterozygous individuals. Three distinct genetic clusters were identified, an ubiquitous set of varieties found across the different oases, and two clusters, one of which was specific to the northern area, and the other to the drier southern area of the Algerian Sahara. The ubiquitous cluster presented very striking chloroplast diversity, signing the frequency of haplotypes found in the most eastern area of the occurrence of the date palm in Saudi Arabia. Exchanges of Middle Eastern and Algerian date palms are documented and might have led to the introduction of this particular chlorotype. However, Algeria nuclear diversity does not highlight an eastern origin at the nuclear level. Our study strongly suggests that the peculiar chloroplastic diversity of date palm is maintained by farmers and could originate from date palms introduced from the Middle East a long time ago, which since then, has been strongly introgressed. This study illustrates the complex structure of date palm diversity in oases and the role of farmers in shaping such cryptic diversity.

Keywords: *Phoenix dactylifera*, date palm, genetic diversity, chlorotype, microsatellite, chloroplast minisatellite.

Phytomanagement of contaminated soils: A promising perspective

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Soil contamination with heavy metals and metalloids is a widespread problem globally. It is estimated that in Europe there are roughly 640,000 ha of contaminated soils and 5 million of potentially contaminated ones. In recent years increasing attention has been given to the exploitation of contaminated lands via non-food crops since these degraded soils cannot be used for food production.

A promising, cost-effective, efficient and environmentally friendly approach is the phytomanagement of contaminated sites. A key component of phytomanagement is that it is economically advantageous either by a) costing less than other remediation technologies or b) by bringing direct profits as it can enable the production of valuable plant biomass. Thus, the aim of phytomanagement is to produce economic revenue on contaminated land without causing detrimental effects on human health and nature and to progressively alleviate the pollutants.

Non-food plant species suitable for phytomanagement are those possessing a series of characteristics, namely: (i) tolerance to contaminants, (ii) ability to uptake the HM-loids and/or stabilize them in soil fractions in relatively high levels, A(iii) fast growth and high biomass, (iv) widespread highly branched root system, (v) easy harvest ability, (vi) non consumable by humans and animals.

Several high biomass yielding non-food crops have attracted much interest for their phytomanagement potential, such as castor bean (*Ricinus communis* L.), cardoon (*Cynara cardunculus* L.), giant reed (*Arundo donax* L.), kenaf (*Hibiscus cannabinus* L.), switchgrass (*Panicum virgatum* L.), and sorghum (*Sorghum bicolor* L.). Although the metal bioconcentration capacity of these crops is much lower than the corresponding capacity of hyperaccumulator plants, the final metal uptake could be similar. These crops can provide abundant renewable biomass feedstock for the production of high added-value bio-based commodities (bio-plastics, bio-lubricants, bio-chemicals, pharmaceuticals, bio-composites, etc.) and bioenergy. Most of them are multipurpose crops offering the opportunity to follow a cascade bio refinery concept, thus feeding the bio based economy. Prospectively, their cultivation in contaminated land can increase and diversify farmers' income and contribute to the wellbeing of local rural population.

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Halimium as an ectomycorrhizal symbiont. New records and an appreciation of known fungal diversity

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Shrublands cover vast swaths of the Mediterranean basin, both in coastal areas and inland. The plants occurring in this peculiar environment play a critical role in the Mediterranean ecosystem, improving water and light regime, protecting soil from erosion and desertification, acting as nurse species for tree seedlings and thus favoring the establishment of late-successional species. To perform such tasks, the shrubs and small trees that make this vegetation system developed adaptations to withstand harsh conditions and stresses like drought and fire, including the association with a vast number of ectomycorrhizal fungi, mainly associated with *Cistaceae*. While this has been widely recognized for *Cistus*, the allied genus *Halimium* has not received significant attention. The genus, whose centre of diversity is in the western part of the Mediterranean basin, comprises 13 accepted species. *Halimium* species – evergreen or semi-deciduous small to large shrubs, with yellow or white flowers with three locules in each ovary – are generally found in open vegetation types, like matorral shrublands and garrigues, or at the verges of woods, in degraded forest areas, abandoned fields, pasturelands, and also on coastal sandy soils. To fill the knowledge gap on *Halimium* mycorrhizal biology we recently described the morpho-anatomical and molecular features of the ectomycorrhizae formed by *Halimium halimifolium* with *Scleroderma meridionale* as collected from coastal dunes in Sardinia (Leonardi et al, Symbiosis 76: 199-208, 2018). We also performed a study of the ectomycorrhizal community in pure *Halimium* stands in south-western Sardinia. Our data, along with a thorough analysis of literature records, allowed us to draw a surprisingly rich picture of *Halimium* associated ectomycorrhizal fungi, with more than 70 recorded species, including uncommon or rare taxa, like *Gyroporus pseudolacteus*, *Cortinarius coeruleopallascens* and *Lactifluus brunneoviolascens*.

New insights on the conservation status of the endangered coastal endemic plant *Astragalus berytheus* (Fabaceae) in Lebanon

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Astragalus berytheus Boiss. & Blanche is a narrow endemic species of the Eastern Mediterranean coast. It is one of the most threatened taxa in Lebanon due to devastation of coastal areas by urban sprawl. This study aims to assess the conservation status of this taxon according to IUCN criteria considering its vulnerability and its uniqueness relatively to the history and biogeography of *Astragalus* genus. Only one population of *A. berytheus* remains in Lebanon and is protected in Tyre coastal nature reserve. The last population in Beirut was in Jnah near the Lebanese International Airport and disappeared in 2015 due to the destruction of its habitat. *Astragalus berytheus* meets the criteria CR A2ac; B1B2ab (i,ii,iii,iv) and is categorized as critically endangered according to IUCN criteria. Combination of data leads to the inference that *A. berytheus* is prone to extinction in Lebanon if adequate conservation measures are not implemented immediately. A pilot study of *circa situm* conservation approach is foreseen. It consists in planting seedlings of *A. berytheus* obtained from seeds rescued from Jnah-Beirut population in Tyr archeological site.

Keywords: *Astragalus*, conservation, critically endangered, endemic, habitat degradation, IUCN, Lebanon coast, extinction.

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ABSTRACTS

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