XIV MEDECOS
&
XIII AEET meeting

Human driven scenarios for evolutionary and ecological changes

Abstract book

31st January - 4th February 2017
Seville, Spain

XIV MEDECOS & XIII AEET meeting

AEET
ASOCIACIÓN ESPAÑOLA DE ECOLOGÍA TERRESTRE

Estación Biológica Doñana CSIC

EXCELENCIA SEVERO OCHOA

UNIVERSIDAD DE SEVILLA

Abstract book of the XIV MEDECOS & XIII AEET meeting,
Seville, Spain, 31st January - 4th February 2017

Doi.: 10.7818/MEDECOSandAEETCongress.2017

Editorial deadline: 20th December, 2016.

Publisher: Asociación Española de Ecología Terrestre (AEET)
C/ Tulipán s/n, 28399, Móstoles, Madrid, Spain

Layout: Imprenta Sand, S.L. Seville. Spain.

XIV MEDECOS & XIII AEET meeting

MEDECOS is an international conference organized by ISOMED, the International Society of Mediterranean Ecology, which aims to bring together the scientific community interested in Mediterranean ecosystems. **AEET** is the Spanish ecological society mainly devoted to terrestrial systems.

The origins of MEDECOS date back to March 1971, when an international group of scientists convened in Valdivia, Chile, to discuss their work on Mediterranean-climate ecosystems. MEDECOS has been hosted every 3-4 years in different locations of the five Mediterranean areas of the world (Mediterranean Basin, SW Australia, California, Central Chile and the Cape Region in South Africa). In 2017, MEDECOS will be at the University of Seville (Spain), in the "*Reina Mercedes*" Science Campus, simultaneously with the biennial meeting of the Spanish Association for Terrestrial Ecology (AEET).

The main focus of the joint conference is the ecology and evolution of Mediterranean ecosystems and their species, from plants to animals and also microorganisms. By uniting scientists and students whose research focuses on Mediterranean ecosystems, we expect to gain insights into the similarities and differences in how they function, change and evolve. The conference will also host a regular AEET meeting, thus more general topics on any aspect of ecology will be also considered.

The Conference main topics are:

- Comparative ecology and evolution
- Historical biogeography of Mediterranean lineages
- Current species conservation challenges
- Biodiversity: species interactions, networks, communities and phylogenetics
- Evolutionary and ecological drivers of Mediterranean ecosystems as biodiversity hotspots
- Ecophysiology and functional traits
- Ecosystem functioning and services: challenges and risks in a changing world
- Consequences of biotic and environmental global changes for Mediterranean ecosystems

This meeting is co-organized and supported by the Spanish Association for Terrestrial Ecology (AEET), the Doñana Biological Station (EBD-CSIC) and the University of Seville (US).

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- Cyrille Violle (Centre for Evolutionary and Functional Ecology, CEFE-CNRS), France

Daily Schedule

Tuesday 31st January, 2017					
XIV MEDECOS & XIII AEET meeting	**Room A** **ETSI Informática** **(School of Informatics)**	**Room B** **Facultad de Matemáticas** **(School of Mathematics)**	**Room C** **Facultad de Biología** **(School of Biology)**	**Room D** **CITIUS-2** **(Celestino Mutis building)**	**Research building** **CITIUS-2 Terrace** **(Celestino Mutis building)**
09:00-17:00			**REGISTRATION** (School hall)		
17:00-17:30	**Opening ceremony**	**Opening ceremony and lecture by Streamming**	**Opening ceremony and lecture by Streamming**	**Opening ceremony and lecture by Streamming**	
17:30-18:30	**Opening lecture*: William Bond, University of Cape Town, South Africa**				
18:30-20:00				**Mentoring meeting**	
20:00-22:00	**Welcome reception & MEDECOS-wine tasting at the Hall of Silken Al-Andalus Palace Hotel** (Avda. de la Palmera, s/n, 41012 Seville)				

* Opening Lecture is funded by the Severo Ochoa Program for Centres of Excellence in R+D+I (SEV-2012-0262) at EBD-CSIC
Sessions color code: Blue: Mediterranean-oriented session or symposium (MEDECOS); Yellow: General session or symposium (AEET)

Wednesday 1st February, 2017

	Room A ETSI Informática (School of Informatics)	Room B Facultad de Matemáticas (School of Mathematics)	Room C Facultad de Biología (School of Biology)	Room D CITIUS-2 (Celestino Mutis building)	Research building CITIUS-2 Terrace (Celestino Mutis building)
08:00-09:00			**Please Install posters B**		**Please Install posters A**
09:00-10:30	**Session 1 (part 1)** **"Comparative ecology and evolution"** Special Invited Lecture*: Ran Nathan, Hebrew University, Israel Chairs: E. Revilla & A. Pauw	**Session 2** **"Historical biogeography of Mediterranean lineages"** Special Invited Lecture*: I Sanmartín, RJB-CSIC, Spain Chairs: J. Leonard & F. Forest	**Session 8** (part 1) **"Consequences of biotic and environmental global changes on MTEs"** Special Invited Lecture*: Guy Midgley, Univ. Stellenbosch, South Africa Chairs: W. Cramer & A. Traveset	**Symposium 1** **"Across-kingdom mutualistic interactions of Mediterranean endemic plants: are they ecologically distinctive?"** Keynote speaker: Tia-Lynn Ashman, University of Pittsburgh, USA Organizers: C. Alonso & F. Balao	
10:30-11:30			Coffee break / **POSTER SESSION 1-B**		Coffee break / **POSTER SESSION 1-A**
11:30-13:00	**Session 1 (part 2)** **"Comparative ecology and evolution"** Chairs: E. Revilla & A. Pauw	**Session 5** **"Evolutionary and ecological drivers of MTEs as biodiversity hotspots"** Special Invited Lecture*: S. Harrison, UC Davis, USA Chairs: P. Vargas & H. Lambers	**Session 8** (part 2) **"Consequences of biotic and environmental global changes on MTEs"** Chairs: W. Cramer & A. Traveset	**Symposium 3** **"Mediterranean Ecosystem Services"** Organizers: I. Geijzendorffer & E. Cohen-Shacham	
13:00-14:30	**Pic-nic lunch** (CITIUS-2 terrace & Hall of School of Biology)				
14:30-16:00	**Session 7 (part 1)** **"Ecosystem functioning and services: challenges and risks in a changing world"** Special Invited Lecture*: Lohengrin Cavieres, Univ. Concepción, Chile Chairs: C. Moura & Berta Martín-López	**Symposium 5** **"Insights on the fourth dimension: the palaeoecological approach to modern ecological questions and vice versa"** Keynote speaker: Lourdes López-Merino, Brunel University, UK Organizers: G. Gil-Romera, P. González-Sampériz & A.R. Gómez Cano	**Symposium 2 (part 1)** **"Filling current knowledge gaps: understanding the role of plant-soil interactions on the functioning and resilience of Mediterranean ecosystems in a changing world"** Keynote speaker: José Ignacio Querejeta, CEBAS-CSIC, Spain Organizers: J. Curiel Yuste, A. Rincón Herranz, I. Prieto Aguilar & S. Rodríguez-Echevarría	**Symposium 14** **"Fire-driven evolution of MTE floras"** Keynote speaker: Byron Lamont, Curtin University, Australia Organizer: T. Hue	
16:00-17:00			Coffee break / **POSTER SESSION 1-B**		Coffee break / **POSTER SESSION 1-A**
17:00-18:30	**Session 7 (part 2)** **"Ecosystem functioning and services: challenges and risks in a changing world"** Chairs: C. Moura & Berta Martín-López	**Symposium 7** **"Contrasting worldwide functional trait trends in Mediterranean-type ecosystems"** Keynote speaker: Eric Garnier, CEFE-CNRES, France Organizers: A. Gaxiola & FI Pugnaire	**Symposium 2 (part 2)** **"Filling current knowledge gaps: understanding the role of plant-soil interactions on the functioning and resilience of Mediterranean ecosystems in a changing world"** Organizers: J. Curiel Yuste, A. Rincón Herranz, I. Prieto Aguilar & S. Rodríguez-Echevarría		
18:30-19:30	**MEDECOS general meeting**				

* All Special Invited Lectures are funded by the Severo Ochoa Program for Centres of Excellence in R+D+I (SEV-2012-0262) at EBD-CSIC
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Thursday 2nd February, 2017

	Room A ETSI Informática (School of Informatics)	Room B Facultad de Matemáticas (School of Mathematics)	Room C Facultad de Biología (School of Biology)	Room D CITIUS-2 (Celestino Mutis building)	Research building CITIUS-2 Terrace (Celestino Mutis building)
09:00-10:30	**Session 4 (part 1)** **"Biodiversity: species interactions, networks, communities and phylogenetics"** Special Invited Lecture*: M. Verdú, CIDE-CSIC, Spain Chairs: F.T. Maestre & P. Jordano	**Symposium 9** **"Local adaptation in the Mediterranean"** Keynote speaker: Marta Benito-Garzón, Université Bordeaux, INRA, France Organizer: F.X. Picó	**Symposium 10 (part 1)** **"Resilience and criticality in Mediterranean ecosystems"** Organizers: E. Batllori, F. Lloret & Ll. Brotons	**Symposium 19** **"Mediterranean High Mountain habitats: challenges for research and a global conservation concern"** Keynote speaker: Christian Schöb, University of Zürich, Switzerland Organizers: L. Cavieres & A. Escudero	
10:30-11:30			Coffee break / **POSTER SESSION 2-B**		Coffee break / **POSTER SESSION 2-A**
11:30-13:00	**Session 4 (part 2)** **"Biodiversity: species interactions, networks, communities and phylogenetics"** Chairs: F.T. Maestre & P. Jordano	**Symposium 11** **"Evolutionary responses to climate change. Evidence from Mediterranean plant populations"** Keynote speaker: Santiago González-Martínez, INRA, France Organizers: Carlos Lara-Romero & Alfredo García-Fernández	**Symposium 10 (part 2)** **"Resilience and criticality in Mediterranean ecosystems"** Organizers: E. Batllori, F. Lloret & Ll. Brotons	**Symposium 22** **"Plant Invasions in Mediterranean-Type Ecosystems"** Organizer: Ingrid M. Parker	
13:00-14:30	**Pic-nic lunch** (CITIUS-2 terrace & Hall of School of Biology)				
14:30-16:00	**Session 6 (part 1)** **"Ecophysiology and functional traits"** Special Invited Lecture*: David Ackerly, UC Berkeley, USA Chairs: F. Valladares & A. Gallardo	**Symposium 13** **"Investigating ecological and evolutionary processes with NGS"** Organizer: M. Gallach	**Symposium 4** **"Eco-evolutionary dynamics in a changing world: integrating genes, traits and ecosystems"** Keynote speaker: Carlos Melián, EAWAG, Zurich, Switzerland Organizers: J- Moya-Laraño, M. Montserrat & S Magalhaes	**Symposium 20** **"Seed dispersal and frugivory in changing Mediterranean landscapes"** Keynote speaker: Anna Traveset, IMEDEA-CSIC, Spain Organizers: R. Perea & J.M. Fedriani	
16:00-17:00			Coffee break / **POSTER SESSION 2-B**		**Coffee break / POSTER SESSION 2-A**
17:00-18:30	**Session 6 (part 2)** **"Ecophysiology and functional traits"** Chairs: F. Valladares & A. Gallardo	**Symposium 15** **"Plant reproductive ecology and evolution in a changing Mediterranean climate"** Keynote speaker: Rodrigo Medel, University of Chile ("Plant Biology" [Wiley] lecture), Chile Organizers: J.D. Thompson & J. Arroyo	**Symposium 17** **"The role of ecological interactions in recovering self-regulating and diverse Mediterranean ecosystems: is rewilding an option?"** Keynote speaker: Jens-Christian Svening, Aarhus University, Denmark Organizers: G. Escribano-Avila, E.Virgós Cantalapiedra & J. P. Gónzalez Varo	**Symposium 18** **"Origin of the Mediterranean Climate"** Organizers: J.E. Keeley & P.W. Rundel	
18:30-19:30			**AEET general meeting**		
21:00	**Conference dinner at "La Raza" Restaurant** (Avda. Isabel la Católica 2, 41013 Seville)				

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Friday 3rd February, 2017

	Room A ETSI Informática (School of Informatics)	Room B Facultad de Matemáticas (School of Mathematics)	Room C Facultad de Biología (School of Biology)	Room D CITIUS-2 (Celestino Mutis building)	Research building CITIUS-2 Terrace (Celestino Mutis building)
09:00-10:30	**Session 3 (part 1)** **"Current biodiversity conservation challenges"** Special Invited Lecture*: John Thompson, CEFE-CNRS, France Chairs: M.B. García & J. Lahoz-Monfort	**Symposium 6** **"Evolutionary and ecological mechanisms governing the generation and maintenance of plant assemblages in biodiversity hotspots"** Keynote speaker: Sébastien Lavergne, LECA-CNRS, France Organizers: Rafael Molina & Marcial Escudero	**Symposium 8** **"Fire and Plant-Animal Interactions"** Keynote speaker: Juli G. Pausas, CIDE-CSIC, Spain Organizers: F. Ojeda & S. Gómez-González		
10:30-11:30			Coffee break / **POSTER SESSION 3-B**		Coffee break / **POSTER SESSION 3-A**
11:30-13:00	**Session 3 (part 2)** **"Current biodiversity conservation challenges"** Chairs: M.B. García & J. Lahoz-Monfort	**Symposium 21** **"Ecoinformatics: data science brings new avenues for ecology"** Keynote speaker: Roberto Salguero-Gómez, University of Sheffield, UK. Organizers: S. Varela, F. Rodríguez-Sánchez, I. Bartomeus & A.J. Pérez-Luque	**Symposium 12** **"Establishing linkages between species interactions and ecosystem functioning and services"** Keynote speaker: Fernando T. Maestre, Rey Juan Carlos University, Spain Organizers: O. Godoy, I. M. Pérez-Ramos, L. Matías, E. Baraza & L. Gómez-Aparicio		
13:00-13:30			**Please remove posters B**		**Please remove posters A**
13:00-14:30	**Pic-nic lunch** (CITIUS-2 terrace & Hall of School of Biology)				
14:00-15:30	**Workshops 1 "Easy collaboration and version control with Git & GitHub". Classroom 1, Facultad de Biología (School of Biology, 3rd floor)** **Workshops 2 "Reproducible science with Rmarkdown". Classroom 1, Facultad de Biología (School of Biology, 3rd floor)** **Workshops 3 "Audiovisual media toolkit for science divulgation". Classroom 1, Facultad de Biología (School of Biology, 3rd floor)** **Workshops 4 "Communicating to a non-scientific public". CITIUS-2 lecture hall**				
15:30-16:30	**Closing ceremony** **Closing lecture*: Sharon Strauss, University of California Davis, USA**	**Closing lecture and ceremony by Streamming**	**Closing lecture and ceremony by Streamming**	**Closing lecture and ceremony by Streamming**	
16:30-17:45	**"Six-string Flamenco" Guitar Concert by Manuel Miranda & Manuel Berraquero. Poster session awards and Closing ceremony**	**"Six-string Flamenco" Guitar Concert by Manuel Miranda & Manuel Berraquero. Poster session awards and Closing ceremony by Steamming**	**"Six-string Flamenco" Guitar Concert by Manuel Miranda & Manuel Berraquero. Poster session awards and Closing ceremony by Steamming**	**"Six-string Flamenco" Guitar Concert by Manuel Miranda & Manuel Berraquero. Poster session awards and Closing ceremony by Steamming**	

* Closing Lecture is funded by the Severo Ochoa Program for Centres of Excellence in R+D+I (SEV-2012-0262) at EBD-CSIC
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Saturday 4th February, 2017

08:00-20:00	**Field trips** (Departure at 08:00. Estimated arrival in Seville by 20:00). Pick-up and delivery points: Prof. García González St., (next to Campus Science)

Scientific Program

Opening lecture*: "*Mediterranean shrublands and the alternative biome states*" by *William Bond* (University of Cape Town), South Africa.

Closing lecture*: "*Adaptation to a Mediterranean climate: Drought tolerance and plasticity shape trade-offs in the evolution of clade of Mediterranean mustards*" by *Sharon Strauss* (University of California Davis), USA.

Sessions

1. **Comparative ecology and evolution**

Conveners: *Eloy Revilla* (Doñana Biological Station, EBD-CSIC), Spain, and *Anton Pauw* (Stellenbosch University), South Africa.

Special Invited Lecture*: " *Live-and-learn or learn-and-live? How functional performance improves with experience in juvenile birds and impacts their lives*" by *Ran Nathan* (Hebrew University), Israel.

2. **Historical biogeography of Mediterranean lineages**

Conveners: *Jennifer Leonard* (Doñana Biological Station, EBD-CSIC), Spain, and *Felix Forest* (Royal Botanic Gardens), Kew, United Kingdom.

Special Invited Lecture*: "*Parametric approaches for inferring the biogeographic history of Mediterranean lineages*" by *Isabel Sanmartín* (Royal Botanic Garden, RJB-CSIC), Spain.

3. **Current biodiversity conservation challenges**

Conveners: *Begoña García* (Pyrenean Institute of Ecology, IPE-CSIC), Spain, and *José Lahoz-Monfort* (University of Melbourne), Australia.

Special Invited Lecture*: "*Towards a process-based conservation strategy for Mediterranean endemic plants*" by *John D. Thompson* (Centre for Evolutionary and Functional Ecology, CEFE-CNRS), France.

4. **Biodiversity: species interactions, networks, communities and phylogenetics**

Conveners: *Fernando T. Maestre* (University of Rey Juan Carlos), Spain, and *Pedro Jordano* (Doñana Biological Station, EBD-CSIC), Spain

Special Invited Lecture*: "*Plant facilitation and phylogenetics*" by *Miguel Verdú* (Desertification Research Centre, CIDE-CSIC), Spain.

5. **Evolutionary and ecological drivers of Mediterranean Ecosystems as biodiversity hotspots**

Conveners: *Pablo Vargas* (Royal Botanic Garden, RJB-CSIC), Spain, and *Hans Lambers* (University of Western Australia), Perth, Australia.

Special Invited Lecture*: "*Climate and the past and future of Mediterranean-ecosystem plant diversity: a Californian view*" by *Susan Harrison* (University of California Davis), USA.

6. **Ecophysiology and functional traits**

Conveners: *Fernando Valladares* (National Museum of Natural History, MNCN-CSIC), Spain, and *Antonio Gallardo* (University Pablo de Olavide), Seville, Spain.

Special Invited Lecture* by *David Ackerly* (University of California Berkeley), USA.

7. **Ecosystem functioning and services: challenges and risks in a changing world**

Conveners: *Catarina Moura* (University of Coimbra), Portugal and *Berta Martín-López*, (Leuphana University of Lüneburg), Germany

Special Invited Lecture*: "*The importance of facilitative interactions on the diversity of alpine plant communities*" by *Lohengrin Cavieres* (University of Concepcion), Chile.

8. **Consequences of biotic and environmental global changes for Mediterranean Ecosystems**

Conveners: *Wolfgang Cramer* (Mediterranean Institute for Biodiversity and Ecology, IMBE-CRNS), Aix-en-Provence, France, and *Anna Traveset* (Mediterranean Institute for Advanced Studies, IMEDEA-UIB-CSIC), Spain.

Special Invited Lecture*: "Projections revisited: What have we learned about the vulnerability of Mediterranean Systems to global change impacts? by *Guy Midgley* (University of Stellenbosch), South Africa.

* All Special Invited, Opening and Closing Lectures are funded by the Severo Ochoa Program for Centres of Excellence in R+D+I (SEV-2012-0262) at EBD-CSIC

Symposia

1. **Across-kingdom mutualistic interactions of Mediterranean endemic plants: are they ecologically distinctive?**

Conveners: *Conchita Alonso* (Doñana Biological Station, EBD-CSIC), Spain, and *Francisco Balao* (University of Seville), Spain.
Main talk: "*Quantity and quality aspects of pollen limitation in biodiversity hotspots*", by *Tia-Lynn Ashman* (University of Pittsburgh), Pennsylvania, USA.

2. **Filling current knowledge gaps: understanding the role of plant-soil interactions on the functioning and resilience of Mediterranean ecosystems in a changing world**

Conveners: *Jorge Curiel Yuste* (National Museum of Natural History, MNCN-CSIC), Spain; *Ana Rincón Herranz* (Instituto de Ciencias Agrarias, ICA-CSIC), Spain; *Iván Prieto Aguilar* (Centro de Edafología y Biología Aplicada del Segura CEBAS-CSIC), Spain, and *Susana Rodríguez-Echeverría* (Centre for Functional Ecology - University of Coimbra), Portugal.

Main talk: "*Vegetation responses to climate change are driven by plant-soil feedbacks in a semiarid shrubland ecosystem*", by *José Ignacio Querejeta* (Centro de Edafología y Biología Aplicada del Segura, CEBAS-CSIC), Spain.

3. **Mediterranean Ecosystem Services**

Convener: *Ilse Geijzendorffer* (IMBE-CNRS and the Tour du Valat), France, and *Emmanuelle Cohen-Shacham* (International Union for Conservation of Nature, IUCN), New York, United States, and (Tel-Aviv University), Israel.

4. **Eco-evolutionary dynamics in a changing world: integrating genes, traits and ecosystems**

Conveners: *Jordi Moya-Laraño* (Experimental Station of Arid Zones, EEZA-CSIC), Almería, Spain; *Marta Montserrat* (IHSM La Mayora, CSIC), Málaga, Spain, and *Sara Magalhães* (Center for Ecology, Evolution and Environmental Changes - University of Lisbon), Lisbon, Portugal.

Main Talk: "*The Ecology and Evolution of Interdependent Networks: How do we solve that puzzle?", by Carlos Melián* (EAWAG), Switzerland.

5. **Insights on the fourth dimension: the palaeoecological approach to modern ecological questions and vice versa**

Conveners: *Graciela Gil-Romera* (Pyrenean Institute of Ecology, IPE-CSIC), Spain; *Penélope González-Sampériz* (Pyrenean Institute of Ecology, IPE-CSIC), Spain, and *Ana Rosa Gómez Cano* (Complutense University of Madrid), Spain.

Main talk by *Lourdes López-Merino*, Brunel University, UK.

6. **Evolutionary and ecological mechanisms governing the generation and maintenance of plant assemblages in biodiversity hotspots**

Conveners: *Rafael Molina-Venegas* (University of Alcalá), Spain, and *Marcial Escudero* (University of Seville), Spain.

Main talk: "*Ecological and evolutionary assembly of plant communities, analytical and genomic tools (big biodiversity data, full genome sequencing, shotgun)*", by *Sébastien Lavergne*, (University of Grenoble Alpes-CNRS), France.

7. **Contrasting worldwide functional trait trends in Mediterranean ecosystems**

Conveners: *Aurora Gaxiola* (Pontificia Universidad Católica de Chile-IEB), Chile, and *Francisco I. Pugnaire* (Experimental Station of Arid Zones, EEZA-CSIC), Almería, Spain.

Main talk: "*Traits as the basis of ecosystem function in Mediterranean ecosystems",* by *Eric Garnier* (CNRS, CEFE), Montpellier, France.

8. **Fire and Plant-animal Interactions**

Conveners: *Fernando Ojeda* (University of Cádiz), Spain and *Susana Gómez-González* (University of Cádiz), Spain / (Centro de Ciencia del Clima y la Resiliencia), Chile.

Main talk: "*Fire and plant-animal interactions*", by *Juli G. Pausas* (Desertification Research Centre, CIDE-CSIC), Spain.

9. **Local adaptation in the Mediterranean**

Convener: *Xavier Picó* (Doñana Biological Station, EBD-CSIC), Spain.

Main talk: "*The effects of phenotypic plasticity and local adaptation on forecasts of species range shifts under climate change*", by *Marta Benito-Garzón* (University of Bordeaux, INRA), France.

10. **Resilience and criticality in Mediterranean ecosystems**

Conveners: *Enric Batllori* (CREAF- Autonomous University of Barcelona, UAB), Spain / (CEMFOR—CTFC, InForest Joint Research Unit, CSIC-CTFC-CREAF), Spain; *Francisco Lloret* (CREAF- Autonomous University of Barcelona, UAB), Spain, and *LLuís Brotons* (CREAF- Autonomous University of Barcelona, UAB), Spain / (CEMFOR—CTFC, InForest Joint Research Unit, CSIC-CTFC-CREAF), Spain.

11. **Evolutionary responses to climate change. Evidence from Mediterranean plant populations**

Conveners: *Carlos Lara Romero* (University of Rey Juan Carlos), Spain / (Technical Particular University of Loja), Ecuador, and *Alfredo García Fernández* (University of Rey Juan Carlos), Spain.

Main Talk: "*Candidate genes, population genomics and climate"*, by *Santiago González-Martínez* (National Institute for Agricultural Research, INRA), France.

12. **Establishing linkages between species interactions and ecosystem functioning and services**

Conveners: *Oscar Godoy* (Institute of Natural Resources and Agrobiology of Seville, IRNAS-CSIC), Spain; *Ignacio M. Pérez-Ramos* (Institute of Natural Resources and Agrobiology of Seville, IRNAS-CSIC), Spain; *Luis Matías* (Institute of Natural Resources and Agrobiology of Seville, IRNAS-CSIC), Spain; *Elena Baraza* (University of Balearic Islands), Spain, and *Lorena Gómez-Aparicio* (Institute of Natural Resources and Agrobiology of Seville, IRNAS-CSIC), Spain.

Main Talk: "*Biotic controls of ecosystem functioning in global drylands*" by *Fernando T. Maestre* (University Rey Juan Carlos, Madrid), Spain.

13. **Investigating ecological and evolutionary processes with NGS**

Convener: Miguel Gallach (Max F. Perutz Laboratories), Vienna, Austria.

14. **Fire-driven evolution of Mediterranean floras**

Convener: *Tianhua He* (Curtin University), Australia.

Main talk: "*The role of fire in evolution of Mediterranean floras*" by *Byron Lamont* (Curtin University), Australia

15. **Plant reproductive ecology and evolution in a changing Mediterranean climate**

Conveners: *John D. Thompson* (Centre for Evolutionary and Functional Ecology, CEFE-CNRS), France, and *Juan Arroyo* (University of Seville), Spain.

Main Talk: "*Chilean plant communities and their pollinators"* (*"*Plant Biology" [Wiley] lecture), by *Rodrigo Medel* (University of Chile), Chile.

17. **The role of ecological interactions in recovering self-regulating and diverse Mediterranean ecosystems: is rewilding an option?**

Conveners: *Gema Escribano-Avila* (Mediterranean Institute for Advanced Studies, IMEDEA-CSIC-UIB), Spain; *Emilio Virgós Cantalapiedra* (University Rey Juan Carlos), Madrid, Spain, and *Juan P. Gónzalez Varo* (University of Cambridge), United Kingdom.

Main Talk: "*A Quaternary perspective on ecosystems and rewilding in the Mediterranean region"*, by *Jens-Christian Svening* (Aarhus University), Denmark.

18. **Origin of the Mediterranean Climate**

Conveners: *Jon E. Keeley* (U.S. Geological Survey), USA, and *Philip W. Rundel* (University of California), Los Angeles, USA.

19. **Mediterranean High Mountain habitats: challenges for research and a global conservation concern**

Conveners: *Lohengrin Cavieres* (University of Concepción), Chile, and *Adrián Escudero* (University of Rey Juan Carlos), Spain.

Main Talk: "*Interactions in alpine plant communities"*, by *Christian Schöb* (University of Zürich), Switzerland.

20. **Seed dispersal and frugivory in changing Mediterranean landscapes**

Conveners: *Ramon Perea* (Stanford University), California, USA / (Technical University of Madrid, UPM), Spain, and *Jose Maria Fedriani* (Centro de Ecologia Aplicada-University of Lisbon), Portugal / (Doñana Biological Station, EBD-CSIC), Spain.

Main Talk: "*Demographic and evolutionary implications of seed dispersal disruptions"*, by *Anna Traveset,* (Mediterranean Institute for Advanced Studies, IMEDEA-CSIC-UIB), Spain.

21. **Ecoinformatics: data science brings new avenues for ecology**

Conveners: *Sara Varela (*Museum für Naturkunde), Berlín, Germany; *Francisco Rodríguez-Sánchez* (Doñana Biological Station, EBD-CSIC), Spain), Spain; *Ignasi Bartomeus*, (Doñana Biological Station, EBD-CSIC), Spain, and *Antonio J. Pérez-Luque (*Instituto Interuniversitario Sistema Tierra, CEAMA-Universidad de Granada), Spain.

Main talk: "*Low hanging fruits and future directions in comparative demography",* by *Roberto Salguero-Gómez*, (University of Sheffield), United Kingdom.

22. **Plant Invasions in Mediterranean Ecosystems**

Conveners: *Ingrid M. Parker* (University of California), Santa Cruz, USA. / (Doñana Biological Station, EBD-CSIC), Spain.

Abstracts of contributions

Special Invited Lectures

Opening lecture

Mediterranean shrublands and the alternative biome states

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The idea of convergent evolution assumes that the physical environment selects for more-or-less optimal solutions expressed as convergent growth forms. But the shrubby growth forms of the south-western Cape are far older than mediterranean-type climates. Furthermore similar shrublands occur in sub-tropical and tropical regions of Africa and Madagascar in climates very different from those of the Cape. Fynbos and related shrublands, far from being selected to cope with the unique conditions of the Cape, could be considered to occupy a refuge from more competitive growth forms. For fynbos plants, shade from forest trees is lethal so that forests and fynbos are incompatible ecosystem states. Both occur in the Cape region, sharing similar climate and geological substrates yet diverge strikingly in growth forms and functional traits. Savannas and grasslands, dominated by C4 grasses, are the most extensive vegetation in Africa occurring in regions with summer wet, winter dry climates but not in the winter rainfall regions of the south-west. Thus shrubby biomes appear to thrive in climate refugia hostile to C4 grasses. This talk will discuss these alternative forested or grassland states and their implications for ecological and evolutionary understanding of Mediterranean shrublands. Where appropriate, parallels will be drawn with other Mediterranean-climate regions.

Closing lecture

Adaptation to a Mediterranean climate: Drought tolerance and plasticity shape trade-offs in the evolution of clade of Mediterranean mustards

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Mediterranean ecosystems are characterized by irregular bursts of rainfall over a short, cool growing season, followed by long and dry summers. The unpredictability of the timing of rainfall events is a key feature of mediterranean climates. Sessile plants that cannot migrate away from hot dry summers must have biologies reflecting this intense selective pressure. Using a clade of native Californian mustards, we explore the evolution of drought tolerance/ avoidance and its relationship to flowering time, niche breadth and range size to understand the selective pressures and evolutionary responses of plants to mediterreanean climate.

Session 01: Comparative ecology and evolution

S.01-1-Invited Lecture

Live-and-learn or learn-and-live? How functional performance improves with experience in juvenile birds and impacts their lives

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Due to the potentially detrimental consequences of low performance in basic functional tasks, animals are expected to improve performance with age and show the most marked changes during early stages of life. The general observation that juveniles tend to be less proficient than adults in functional tasks associated with foraging and migration has long been attributed to differences in experience, necessary to develop cognitive and locomotion skills. Yet, critical questions about this general phenomenon, its dynamics and underlying mechanisms, remained unknown. This gap in knowledge has recently been addressed by studies utilizing advances in animal biotelemetry, providing both short-term intimate view on animals on the move to reveal the underlying mechanisms, and long-term tracking revealing the underlying dynamics. In this lecture, I will highlight results for recent movement ecology studies addressing these challenges in a variety of bird species, movement phenomena, ecosystems and across different spatial and temporal scales. These results suggest that differences between inexperienced juveniles and experienced adults are most prominent in early stages of life, and especially under challenging conditions which presumably span over different functional tasks such as flight under unfavorable wind conditions, food acquisition in stressful circumstances, lack of parental guidance and the urge to keep up with mixed-age fast migrating groups.

S.01-2-Poster

In situ germination and seedling establishment of Mediterranean riverine forest plant species in S Iberian Peninsula

Andrés Camacho, C.[1], García-Castaño, J.L.[2], Mejías Gimeno, J.A.[3]

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We analysed the conditions affecting in situ germination and seedling establishment of the Mediterranean riverine forest (canuto) plant species in P.N. Los Alcornocales (S Iberian Peninsula), with the aim of testing water availability limitation and the role of moss mats as safe sites. For this purpose, we established eight plots, four of them with an autonomous irrigation system. In each plot, we delimited four subplots, two of them covered by local moss mats and the other two with the bare soil. Along five years, we registered seedling establishment for all the woody and perennial herbaceous species of the riverine community. We recorded high amongyear variability in germination for some taxa (e.g. Quercus canariensis). The germination season varied among species (e.g. spring in Rhododendron ponticum or autumn-winter in Erica spp.). Moreover, both germination and seedling survival were higher in the watered plots. In some species, as Viburnum tinus or Rhododendron ponticum, moss mats facilitated germination and provided better conditions for seedlings to establish and grow. Nevertheless, for those in the genera Erica and Salix, germination and seedlings growth were clearly higher in the bare soil subplots. Since these genera show significantly small seeds among the studied species, we propose that the role of moss mats as regeneration facilitators depends on the size of the propagules, therefore facilitating the maintenance of the plant community structure in the area.

S.01-3-Oral

A spatial modeling approach to assess fire risk and exposure of biodiversity hotspots in Cephalonia island, Greece

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Recent global changes seem to have affected fire regimes by inducing more severe larger fires in the thermomediterranean vegetation zone but also more frequent incidents in territories of higher altitudes. Cephalonia island hosts Mt Ainos, one of the most important National Parks of Greece, focal geographical area of the non-fire adapted endemic fir Abies cephalonica. The island has suffered several fires in the past. The aim of this work is to introduce a framework for assessing spatial fire risk and exposure of biodiversity hot spot areas, using Cephalonia as a pilot case study. Fuel parameters in representative vegetation types were measured across the island for models development as well as for collecting training and validation points for satellite data classification. The Minimum Travel Time algorithm, as it is embedded in FlamMap spatial fire simulation software, was applied in order to assess critical fire behavior parameters and exposure of the island's biodiversity hotspots under three different meteorological and fuel moisture scenarios simulating predicted climate changes. In addition, the risk of change in the island's ecological value due to biodiversity loss was studied under the same scenarios. According to the analysis, loss of all biodiversity values was found under the severe meteorological and fuel moisture scenario and was estimated to be higher in the endemic fir forests. The outputs of this study may be used as an application of quantitative and probabilistic risk assessment for biodiversity conservation planning, prioritization and management of high value natural and cultural resources.

S.01-4-Oral

Temporal patters of acetate and ammonium uptake during leaf litter decomposition of 5 Mediterranean riparian tree species: a stable isotope tracer study

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Riparian leaf litter is a fundamental source of carbon and nutrients to stream ecosystems. Moreover, microbial assemblages colonizing leaf litter can use carbon and nutrients from the water column, though the influence of this uptake on stream metabolism and in-stream nutrient retention capacity is largely unknown. We quantified leaf litter decomposition (k) together with acetate and ammonium (NH4) assimilation rates (acetate-U and NH4-U, respectively) for 5 Mediterranean riparian tree species (common ash, alder, black poplar, black locust and sycamore). To do so, we added 15N-NH4 and 13C-acetate into a stream containing leaf litter mesh bags at 5 different decomposition stages (i.e., previously immersed during 2, 10, 30, 45 and 75 days). Moreover, we quantified cellobiohydrolase (cbh) enzymatic activity as a proxy of microbial activity during decomposition. NH4-U remained quite constant during decay (0.97±0.18 µg NH4 d-1 mgN-1). Acetate-U increased from 0.8 (day 2) to 11 (day 75) mg C-acetate d-1 g C-1. Fast decomposing species (high k) used more acetate throughout the experiment than slow decomposing species (low k), which showed higher accumulated NH4-U. Our results suggest strong links between riparian leaf litter decomposition, and in-stream nutrient cycling, and further that different leaf litter species could influence C and N cycling to a different extend depending on their degree of degradability.

S.01-5-Oral

Habitat characterization, biomass and clonal architecture of invasive hybrid Spartina densiflora x maritima on the Atlantic coast of Iberian Peninsula

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Hybridization is a common and potent mechanism of plant evolution, which can render autochthonous hybrids and invasive hybrids when at least one of the parental species is exotic. Increased invasion ability of hybrids has been hypothesized to arise due to evolutionary novelty, increased genetic variation, fixed heterosis, and dumping genetic load. The formation of invasive hybrids adds to the spread of invasive exotic species that is one of the most important threats for ecosystems conservation. In this context, the production and accumulation of biomass and the growth pattern are key functional traits that play very important roles in the ecological behavior of invasive species. Salt marshes appear as appropriate ecosystems for the study of the role of invasive hybrids and their traits since their plant communities are relatively simple, generally dominated by a few numbers of species, and the abiotic environment expose vegetation to high stress levels. Specifically, cordgrasses (Genus Spartina, Poaceae) colonising salt marshes are an ideal taxonomic group to study invasive hybrids ecology since Spartina species and their hybrids are among the most invasive halophytes, colonising salt marshes all around world. This work describes the abiotic environment and the above- and below-ground biomass and the intratussock structure (clonal architecture integrated by live and dead shoot densities and heights within tussock) for Spartina maritima x densiflora in salt marshes at the Gulf of Cádiz, comparing our results with those recorded previously for its parental species S. maritima and S. densiflora, and for other Spartina hybrids worldwide.

S.01-6-Oral

A novel conceptual framework to understand adaptive evolution in its ecological and historical contexts

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It is increasingly appreciated that organisms do not only adapt to their environment, but can also influence it. This can lead to two-way eco-evolutionary dynamics. Here we present a novel framework to understand how adaptation operates. Mechanisms of adaptation are compared by focusing on how organisms make changes, and on what it is that they change. This framework acknowledges that individuals as well as environments can be changed in order to obtain local adaptation to the environment. Thereby it stresses conceptual similarities between what are superficially very different phenomena (e.g. plasticity and habitat choice), allowing cross-fertilization in empirical and theoretical approaches to study them. It also suggests four distinct ways by which adaptive evolution can happen (and not just by natural selection). It could therefore serve as a conceptual framework around which to organise the discussion and progress towards an Extended Evolutionary Synthesis (an update of the Modern Synthesis), in which ecology and evolution are more fully integrated.

S.01-7-Poster

The role of native and invasive plant hybrids in ecological succession in salt marshes

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In the early ecological succession of salt marshes under Mediterranean climate the development and distribution of species are fundamentally determined by abiotic conditions, being facilitation the main succession mechanism. However, as succession progresses competition become the dominant interspecific interaction and inhibition and tolerance turn into a relevant mechanisms driving succession. In this context, species with high competitive potential such as invasive species or hybrid taxa acquire an important role. In this study we compared the performance in succession of two plant hybrid taxa present in different marshes of the Gulf of Cadiz (Southwest Iberian Peninsula, Spain): the hybrid of native chenopods Sarcocornia perennis and Sarcocornia fruticosa and the hybrids between European native grass Spartina maritima and the invasive of South American origin and ancestral hybrid Spartina densiflora. To do this, we performed a comparative study of measures of plant cover and abiotic variables taken over a range of time up to 30 years in various marshes in the Southwest Iberian Peninsula. Our hypothesis is that the native hybrid promotes tolerance mechanisms with other species, having a structuring role of plant communities, while the invader hybrid promote the inhibition of the succession, altering the dynamics of the invaded ecosystem due to its high competitive ability product of heterosis or hybrid vigor.

S.01-8-Oral

Fire recurrence and microsite effect on nutrient allocation of Mediterranean ecosystems

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Fire recurrence has increased in the Mediterranean basin due to changes in land use and climate. It has been hypothesized that, when fire frequency is abnormally high, the ecosystem nutrient capital does not fully recover, and the long-term balance between fire-related nutrient outputs and succession-related nutrient inputs is upset. Despite the importance of this issue, little is known about the impact of recurrent wildfires on nutrients allocation into different compartments of the ecosystem. This work evaluates the effect of fire recurrence on nutrient content of plants, litterfall and soil under different microsites of burned Mediterranean ecosystems (i.e. under Cistus ladanifer, Retama sphaerocarpa, Erica australis, Phillyrea angustifolia and Quercus ilex, and bare soil as a control). Results show that both the number of fires and the microsite (under different plant species or bare soil), as well as their interaction influenced most of the studied variables (macro and micronutrients). Nutrients like C, N, P, Ca, Mn, S decreased in soil with increased fire recurrence. However, other soil nutrients as Na and K increased with fire recurrence. In general, soil nutrient content was higher under plants than in bare soil, being Q. ilex and P. angustifolia the more fertile microsites. Fire recurrence did not affect the nutrient content of plants or litter. Results suggest that this decline in soil fertility with increasing fire occurrence may be associated to accumulated soil losses through repeated fires, but also could be influenced by losses or alterations of soil organic matter quantity and quality.

S.01-9-Poster

Water Relations of Salix in Southern California and the Western Cape of South Africa

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Mediterranean climate ecosystems (MTE) are characterized by summer drought, but previous research suggests that Southern California has greater yearly and monthly variation in precipitation than other MTE. We hypothesized that increased summer water availability in the Western Cape of South Africa would increase groundwater and result in lower water stress in riparian species. To test this we compared dominant willows in riparian communities in the Angeles National Forest of Southern California (Monte Cristo Creek) and Dwarsberg Trout Haven of South Africa (Holsloot River). These two sites differ significantly in their fluvial regimes; Monte Cristo is a seasonal stream, and the Holsloot River is permanent. We would expected the Salix mucronata, along the Holsloot River, would be under lower water stress and be more vulnerable to cavitation as a result of maximizing water transport, whereas Salix laevigata of Southern California would more resistant to cavitation and be under greater water stress. However, our results reveal there is no difference in vulnerability to cavitation, with P50 values between -3.1 and -3.3 MPa and no difference in midday water potentials. However, significant differences in predawn water potentials, with S. mucronata less stressed compared to S. laevigata, suggests S. mucronata is most likely losing more water throughout the day probably due to higher carbon uptake. Phylogenetic constraints may limit the capacity of water transport in the genus Salix; however, S. mucronata is able to maintain higher stomatal conductance as a result of greater water availability.

S.01-10-Oral

Xylem anatomy and function diverges between sexes in Juniperus thurifera

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Contrasting evolutionary pressures associated to sex can result in sex-related variation in non-reproductive traits such as growth, photosynthetic rate or drought tolerance. This variability may potentially skew the ability of each sex to face climatic constraints. We explored intraspecific differences in stem anatomy and branch hydraulic functionality between Juniperus thurifera sexes in two localities with contrasted climate (drier vs. wetter). Tracheid lumen area was similar between sexes and sites, but female tracheids had lower wall thickness, meaning lower construction costs. Stem anatomical estimates of hydraulic efficiency and safety showed sex-related differences that were particularly evident in the arid site. Here, males reduced their estimated hydraulic conductivity (KS) and increased their Mork's Index, that is, produced safer wood, whereas these parameters did not differ from mesic site in females. In contrast, branch measurements of KS and P50 (xylem pressure inducing 50% loss of hydraulic conductance) showed no sex or site-related differences, albeit males showed higher slope of the vulnerability curve (S, indicating how fast cavitation progresses to P50) than females. This conveys to males potential to maintain higher KS than females in water potentials over P50. Stem anatomical traits explained a large proportion of branch functional variability. Our results provide insight of the interaction between xylem anatomical variability and hydraulic function. Building lower-cost xylem may allow females to have higher secondary growth per carbon invested. However, this strategy may reduce their drought tolerance in their dry distribution edge, what would explain their lower performance in relation to males under these conditions.

S.01-11-Oral

The architecture of lichen-forming fungi-photobiont interaction networks along a latitudinal gradient in continental Antarctica

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Lichens have often been shown in the literature as a paradigmatic case of symbiotic mutualism. However, little is known about the interaction patterns between lichen-forming fungi (mycobionts) and algae (photobionts) at the community level since most studies have so far focused on the range of photobionts interacting with a single species or with few species from the same genus. We used the bipartite interaction network framework to study the architecture of myco-photobiont networks in five different areas in continental Antarctica along a latitudinal gradient from 77ºS to 85ºS. Mycobionts and photobionts were identified using the nuclear ITS as barcoding and mycobiont species hypotheses were obtained through different species delimitation algorithms. We analyzed a total of 756 thalli, recovering 842 interactions. Analyses revealed an anti-nested pattern and high modularity in all networks, and no trends related with latitude. Fungal and algal phylogenies based on four (5.8, nuLSU, mtSSU, RPB2) and two (ITS and rbcL) markers respectively were used to test the influence of phylogeny and geography in the architecture of the recovered interaction network by means of mcmcGLMMs. Coevolutionary interactions (closely related fungi share closely related photobionts) were recovered as the main factor shaping the interaction network, with geography having a small effect.

S.01-12-Oral

Drier habitats formed alfter the rise of the andes: were they determinant for the emergence of new nest strategies in Neotropical parrots?

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Diversification in Neotropical parrots is believed to be associated to the emergence of key innovations resulting from new climatic and geological events linked to the rise of the Andes. During this event lineages where exposed to novel selective pressures that emerged from the formation of new habitats (e.g., replacement of tropical forest for savannah). Thus, it stimulated new ecological opportunities, such as novel nesting strategies and changes in coloniality essential for habitats with lower tree density. Here, we determine whether the occurrence of a new nesting strategy (e.g., excavators) at alternative sites is associated to selective constraints imposed by novel drier habitats; and to the formation of more complex social structures by facilitating larger breeding colonies associated to an independence of arboreal nesting. Using a current phylogeny of the subfamily Arini and stochastic character mapping we conducted an ancestral reconstruction of the excavator behavior and social complexity to associate novel strategies with changes in habitat. Our results show that the excavator strategy is associated with the use of alternative sites indicating adaptive processes to new drier and open habitats. Moreover, we show a linkage between the appearance of excavator strategies and the emergence of more coloniality species. These patterns support the notion that excavators strategies emerge by evolutionary diversification associated with selective constraints imposed by the new habitats that favor the emergence of more complex group life strategies.

S.01-13-Poster

Phylogenetic imputation of quantitative functional traits; just how reliable is it?

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Given the rapid increase of available molecular data and major advances in phylogenetic methods, phylogenetic imputation has resurged as a powerful alternative for imputing any kind of missing data. As such, understanding what are the limitations of phylogenetic modelling in predicting trait values is critical if we are to use them in subsequent analyses. Here, we used extensive simulations of quantitative trait evolution and real datasets to explore the reliability of phylogenetically-imputed values across varying scenarios of phylogenetic constraint in species resemblance. Specifically, we conducted leave-one-out cross-validation trials (i.e. sequential imputation of single values across the observed values of a trait) and estimated (i) the overall accuracy of predictions conducted for each trait (trait-level accuracy) and (ii) the variability in prediction accuracy among individual tips of the phylogeny (tip-level accuracy). We found that when phylogenetic signal is close to Brownian motion expectation (BM, $\lambda = 1$), only a narrow range of values within the distribution of tip branch-lenghts (less than 10 % of the tree height) are prone to show acceptable accuracy levels, whereas weaker phylogenetic signals (i.e. $\lambda = 0.7$) may result in predictions being no better than to simply take the observed mean value. We conclude that (i) leave-one-out cross-validation tests may not suffice to ensure success in predicting missing values, since variability in tip-level accuracy may pass unnoticed, and (ii) phylogenetic imputation as substitute for real data may be challenging, particularly for commonly-used traits in ecological research that often show weaker phylogenetic signals than BM expectation.

S.01-14-Oral

Same film, different actors: Effects of forest connectivity on Curculio spp. and Cydia spp. granivory in Quercus ilex forests

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Mediterranean forests are in expansion but little is known about how plant-animal interactions are assembling in these new habitats. Habitat connectivity might determine the colonization success of these new patches by insects with different dispersal abilities, which in turn may exert trophic pressures on plants, modulating forest dynamics. Effects of multi-scale connectivity were tested on the infestation probability of Quercus ilex acorns by two species of weevils (Curculio elephas and C. glandium) and tortricid moths (Cydia spp). A total of 6750 acorns were collected from 75 trees distributed in 15 forest patches differing in age and connectivity: old and connected forests, and recent, either connected or isolated ones. Identification of weevil larvae to the species level by means of MtDNA revealed the presence of C. elephas and C. glandium in all patches. Acorn infestation probabilities were not affected by forest connectivity; however, infestation by Curculio spp. was positively associated with old connected forests, with C. elephas being significantly more abundant in patches embedded in high-tree-density areas, according to its limited dispersal ability. The more mobile Cydia spp. moths did reach all patches equally. Ultimately, acorn predation rates were similar in all forest types although the identity of the predator changed. In view of the results, differential dispersal abilities between the three granivorous species could explain the spatial patterns of acorn infestation in the studied forests. Although poor forest connectivity does not determine a lower infestation risk of Q .ilex trees, it does affect the community composition of the granivorous guild.

S.01-15-Oral

Riparian evapotranspiration regulates stream water export in a Mediterranean headwater catchment at different spatio-temporal scales

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High water requirements by riparian trees could affect catchment water export and water availability, especially in Mediterranean regions, where water is limited. Yet, the influence of riparian evapotranspiration (ET) on both stream and catchment hydrology is still poorly understood. Here, we used both empirical and modelling approaches to investigate the relevance of riparian ET on regulating catchment water exports in a headwater subhumid Mediterranean catchment. We approached this question at different temporal scales (annual, seasonal and daily) and under present and future climate scenarios. Riparian ET (450 mm yr-1) has a small contribution to total catchment water depletion (< 4.5%) at annual scale; however, it substantially affects water exports at shorter time scales. In particular, during the vegetative period, riparian ET (0.5-2 mm d-1) can reduce the stream discharge by 15% and promote the movement of stream water towards the riparian zone during > 60% of the time. During this period, riparian ET also induces strong diel fluctuations in stream discharge (amplitude = 8-18% of mean daily discharge). Simulations of future climatic scenarios performed with the PERSiST model suggests that future warming and drying conditions would markedly increase the relative contribution of riparian ET to annual catchment water budgets and stream hydrology. Altogether, our results point out that riparian ET must be considered in catchment hydrologic models in this and other catchments that could suffer a decrease in water availability (i.e. Mediterranization process) in the next decades.

S.01-16-Poster

Effects of low and high severity prescribed fires in germination and early survival on mediterranean pine ecosystems

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Wildfires have an important influence in many different elements of the forest ecosystems. In order to reduce fire risk and occurrence, prescribed fires with low intensity have been widely used as a fuel reduction tool and silvicultural treatment in Mediterranean forest ecosystems. However, other than the fact that fire may alter microsite conditions, little is known about the impact of prescribed burning on natural regeneration or plant species renewal at the same time. Also, and after prescribed fires, some plant provenances may be more appropriated that order when ecosystem restoration is aimed. In this study, we compared the effects of prescribed burning on initial seedling recruitment of different seed provenances (P. pinaster and P. halepensis from Spanish dry and wet locations) after a low intensity prescribed fire applied using a sowing experiment in 60 plots (30 burned and 30 control) set up in the Lezuza forest (Albacete, central-eastern Spain). Also, seed predation was evaluated since this is one of the most important factors limiting seedling recruitment. Our results showed that prescribed fires do alter initial seedling recruitment dynamics. Seed coming from dryer and warmer sites perform better in burned plots whereas seed from wetter and colder sites regenerates better in control areas. Seed predation was a really important factor in both burned and control plots. Understanding and balancing seed emergence and seedling survival in Mediterranean Pinus forests should help to improve prescribed burning plans with no debilitation of pine tree vitality or plant community persistence and aiming properly plant restoration.

S.01-17-Oral

Heat resistance of the thermophilic ant Aphaenogaster iberica along an altitudinal gradient in Southern Spain

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Local adaptation is a powerful process to explain how species with wide geographic distribution tolerate contrasting environmental conditions. Hence, natural selection acting on discrete populations can promote the fixation of different adaptive traits. In ants, as in most insects, traits involved in resistance to local climatic conditions are expected to be under strong selection since important functions like development, growth and activity are temperature-dependent. Here, we present the results of a study conducted on the thermophilic ant Aphaenogaster iberica along an altitudinal gradient, from 100 to 2000 meters, in Sierra Nevada (Southern Spain). We combined behavioural, morphological, physiological and molecular analyses to determine between-populations differences in traits involved in temperature and dryness resistance. Field data show that populations located at mid-elevation, where ground surface temperature can rise up to 70ºC, have their higher daily activity at a warmer temperature than populations of low and high elevation (and cooler temperatures). In laboratory conditions, workers of mid-elevation populations survive longer when they are exposed to heat which is supported by measures of the individual activity (a proxy of the metabolic rate) as a function of temperature. In contrast, there was no difference between populations regarding resistance to cold and dryness. Measures of gene flow between populations are also conducted using 10 polymorphic microsatellite markers. Results suggest limited gene flow between populations may contribute to the above-mentioned phenotypic differences.

S.01-18-Oral

Self-incompatibility and pollen limitation in an anemophilous herb: Rumex bucephalophorus (Polygonaceae)

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Pollen limitation has been regarded as more commonly ocurring in animal rather than wind pollinated taxa. However, when anemophilous plants are self-incompatible, low density populations can suffer pollen limitation. In this work we studied the breeding and pollination system of Rumex bucephalophorus, an annual herb with hermaphrodite flowers and wind pollination that presents high levels of fruit set in high density populations. The breeding system was studied using four methods: (1) Manual self- and cross-pollinations, with observations of pollen tube growth using fluorescence microscopy with aniline blue staining; (2) Plant isolation in natural and greenhouse conditions to allow selfing and/or crossing; (3) Estimations of paternity using molecular markers in the progeny (4 seedlings) from 5 plants sampled in two natural populations; (4) Estimations of wind pollination efficiency with respect to plant density using an artificially constructed population and also pollen traps. All analyses indicate that Rumex bucephalophorus is an obligatory xenogamous species, apparently with a self-incompatibility mechanism that is likely to be of the homomorphic gametophytic type (GSI). However, this incompatibility system is broken in basal flowers when xenogamous pollen grains are not avalaible. Both fruit set and the quantity of wind-borne pollen in the experimental areas were dependent on the nearest neighbour source of pollen. Thus, relatively isolated plants showed pollen limitation effects. This is the first example to our knowledge of non-heteromorphic self-incompatibility reported in the family Polygonaceae. This self-incompatibility shown with a pollen limitation means that this species is only fully fertile in dense populations.

S.01-19-Oral

Next-generation sequencing reveals phylogeographic structure on Mediterranean firs

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The firs (genus Abies, Pinaceae) exemplify plant diversification related to long-term climatic, geological and evolutionary changes. Representing the most diverse group of the Pinaceae family and Gimnosperm, consist of 52 species and it is considered a taxonomically complex group compared with other genera within the same family. The fir trees are an important component of temperate-cool forests that characterise the boreal regions of the Northern Hemisphere. This genus has three major distribution centers: N America, E Asia and the circunmediterranean area. The circun-mediterranean firs group consists of 11 species and one recognised hybrid. Here we present the phylogeography of all the Mediterranean firs taxa using Next-generation sequencing (RADseq). The application of NGS by RADseq method in this study has provided great information for the relationship and evolution of the Abies species in the Mediterranean bassin. Multivariate analyses including PCoA, NJ analysis, and Bayesian clustering confirm species delimitations and produce a well-supported phylogenetic tree. The evolutionary history of the Mediterranean firs is also discussed in the context of the paleogeological and paleoclimatological history of the region.

S.01-20-Oral

Disentangling extreme phylogeography: long distance dispersal and niche shift in bipolar sedges

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Knowing whether climatic niches are similar in the source and founded range (niche conservatism) or different (niche shift) is important for explaining colonization process after a dispersal event. Species with disjunct distribution as result of long-distance dispersal (LDD) will display isolated populations, favouring local adaptation and hence fostering niche differentiation. Bipolar species (distributed at high latitudes in both hemispheres) in the genus Carex (Cyperaceae) have acquired their disjunct distribution by LDD. Although Northern and Southern Hemisphere populations display little to none genetic divergence, previous analyses detected ecological niche differences between them. Whether or not these differences are due to a niche shift is still unknown. Characterization of climatic niches between disjunct populations is particularly informative about species abilities to modify their ecological requirements, which is especially relevant under a global scenario of climate change. Using a Bayesian approach and six climatic variables, we studied five Carex bipolar species (872 curated data points) to address the following questions: (1) Do the climatic niche of bipolar species differ between Northern and Southern Hemisphere populations?; (2) To what extent does the climatic niche of bipolar species overlap between the two regions?; (3) Is there a trend towards wider or narrower climatic niche in the Southern Hemisphere?; (4) Are the climatic niche of species shifting towards warmer or colder conditions in the Southern Hemisphere? Our preliminary results show some degree of climatic niche shift of the studied bipolar species populations in the Northern Hemisphere towards more humid and warmer temperatures in the Southern Hemisphere.

S.01-21-Oral

Plant performance in native and invasive populations: a global study of Plantago lanceolata

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The comparative study of plant performance in native and invasive populations is crucial to understand present ecological patterns and future invasions. In this context, analysing the environmental conditions experienced by organisms in the native and invaded areas help to disentangle the factors shaping their performance. In the present work, we studied a set of vegetative and reproductive traits in the widespread Plantago lanceolata, in 33 populations in native (Europe) and invaded (N America and Australia) areas. Invasive populations showed higher plant sizes and seed production than native populations, which might have been very important for invasion success in the new environments. Invasive populations were found to be exposed to higher temperatures than native ones, and both climatic factors and local environmental variables, such as height of surrounding vegetation, helped to explain the differences in plant traits among populations. The length of flowering stems, which may enhance pollen and seed dispersal, showed instead no differences between native and invaded populations. Gathering information across multiple taxa on trait variation between native and invasive populations and its potential drivers will help us to understand the ecology and evolution of invasive plants and to manage them properly.

Session 02: Historical biogeography of Mediterranean lineages

S.02-1-Invited Lecture

Parametric approaches for inferring the biogeographic history of Mediterranean lineages

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The Mediterranean region, with its mixture of small plates, age-old and young ocean basins, and changing paleoclimate history represents a challenge for biogeographic methods. Parsimony approaches based on area cladograms were for many years the only option available for inferring the biogeographic history of Mediterranean lineages. The recent development of parametric methods based on probabilistic models of range evolution has widened the range of questions that can be addressed with phylogenetic and spatial data. Unlike parsimony, these methods allow integration of time and additional sources of evidence, such as species' ecology, the fossil record, or Earth history. Here, I review these approaches and current challenges, with an emphasis on Mediterranean studies. Maximum-likelihood methods like Dispersal-Extinction-Cladogenesis (DEC) provide detailed reconstructions of the history of lineages, including numerous types of biogeographic processes (dispersal, extinction, speciation), at the expense of computational efficiency - though recent methodological extensions offer new promise. Bayesian biogeographic methods allow joint estimation of phylogenies, divergence times, and ancestral ranges given molecular and geographic data. Based on a simpler biogeographic model, the use of MCMC techniques and a Bayesian hierarchical approach to account for taxon-specific differences make these methods powerful to test hypotheses in macroevolution and ecology using datasets of multiple lineages. New research has focused on relaxing the time homogeneity of the process, allowing dispersal rates to vary over time, and on modelling extinction. Finally, other approaches use machine-learning techniques to increase the realism of biogeographic models, but they often include many parameters and model testing/fitting can be difficult.

S.02-2-Oral

A biogeography inquiry to decipher the origin of carob populations (Ceratonia siliqua, Leguminosae)

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Despite its economic importance, the origin and long-term history of carob tree (Ceratonia siliqua L.) are still under debate. Since De Candolle, the wildness of Mediterranean carob populations has been questioned on the basis of paleo-botanical, archeological and philological evidence but, unfortunately, the scarce studies on the ecology and genetic diversity of wild populations have not thrown much light on this topic. The extremely low cold-stress tolerance of carob plants constituted the main argument against a long-term persistence of natural populations throughout Pleistocene in the Mediterranean. Under this scenario, the current carob Mediterranean range would be explained by human dissemination from Western Asia. However, a global phylogeographic study covering the entire distribution of carob is still lacking. We sequenced nuclear and plastid regions from both natural and cultivated populations covering the whole current distribution range of carob to explore its phylogeography based on coalescent methods and divergence time estimations. Here we report the first molecular evidence on the origin of Ceratonia siliqua and we try to set the hypothetical events that shaped the historical biogeography of this tertiary relict lineage.

S.02-3-Oral

Digging out the biogeographic history of European terrestrial planarians

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Climate cycles have had a major impact on the distribution and evolution of species, being Pleistocene glaciations proposed as one of the processes that led to the diversification of multiple species in the European territory. Land planarians, a group of free-living platyhelminthes that inhabit the soil of moist forests, offer an interesting opportunity to examine the relative contributions of paleoclimatic events to the phylogeny and biogeography of a genus distributed throughout the continent: Microplana. It has been postulated that many Mediterranean species differ in three major European genetic lineages due to isolation in refugia during glaciations in the three major Mediterranean peninsulas. On the other hand, some of these species apparently had Central European microrefugia. In a previous study focused on the species Microplana terrestris, we found high diversification in the western Iberian Peninsula in contrast with very similar haplotypes in the rest of Europe. Our present study includes samples from several Microplana species collected across Europe, covering the three Mediterranean peninsulas. Through phylogenies based on mtDNA genes and information from anonymous nuclear markers obtained with NGS methodologies, we will try to understand what were the processes driving the movements of these species before and after the glaciations in order to determine whether the ancestors of current populations were refugees in the peninsulas, or the origin comes from Central European microrefugia.

S.02-4-Poster

Differentiation driven by disjunctions in the Western-Central Mediterranean Basin: The evolutionary history of the Carex panormitana-C. reuteriana complex (Cyperaceae)

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Carex reuteriana and C. panormitana are two closely related species inhabiting Mediterranean creeks and rivers. They belong to the mainly circumboreal Carex section Phacocystis. Carex reuteriana is endemic to the Iberian Peninsula and North West Africa, and C. panormitana is found in Sardinia and in two single isolated populations in Sicily and Tunisia. A molecular study based on DNA sequencing and fingerprinting data was carried out to elucidate the main phylogeographic patterns and the evolutionary history in this group. Three to fourteen individuals per each of 18 populations were sampled, covering both species ranges. Phylogenetic and divergence time analyses revealed that the two species form a monophyletic group originated in the late Pliocene-early Pleistocene. A clear genetic differentiation was detected between both species, suggesting long term reproductive isolation. Moreover, the populations of each taxon formed genetic clusters according to disjunct areas indicating restricted gene flow among them and the role of geographic barriers in shaping the observed genetic variation. Sardinian populations of C. panormitana were strongly differentiated from Sicily and Tunisia, suggesting the existence of a cryptic taxon under this species. Also, genetic diversity was remarkably low in C. panormitana in comparison with C. reuteriana, especially in Sardinia, because of small effective population sizes. The specific ecology, strong phylogeographic structure, and detected levels of genetic diversity seem to point to a poor ability to respond to anthropogenic changes. It might entail the extinction of some of the most endangered populations if effective conservation measures are not applied.

S.02-5-Oral

The phylogeography of desert ants in the Iberian Peninsula and Morocco

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The Strait of Gibraltar is a major geographic barrier between the Iberian Peninsula and Morocco. After the Messinian Salinity Crisis (MSC), which closed the connection between the Altlantic ocean and the Mediterranean sea 5.9 – 5.3 Myr ago, the strait has remained open until now. Although it greatly limits gene flow for many terrestrial species of plants and animals with low dispersal capacity, many studies date the last connection between Moroccan and Iberian clades much before or after the MSC. Here, we report results on the phyleography of desert ants of the genus Cataglyphis distributed on both sides of the Strait of Gibraltar. Molecular results based on the sequencing of 1 mitochondrial and 2 nuclear genes of 130 samples from different locations suggest that the Iberian clades all come from a Moroccan ancestor. The last connection between both continents is estimated to about 6 Myr. Microsatellite data analysed with TESS and STRUCTURE partially confirm sequence data. Interestingly while the geographic distribution of the oldest Moroccan clades greatly overlaps, the Iberian clades are mostly parapatric. This pattern is consistent with a scenario of “refugee within the refuge” whereby thermophilic species were forced to take refuge in the main valleys of the Iberian Peninsula during the last glaciation, which then provoked multiple speciation events. Warming during the Holocene then allowed these species to expand their distribution ranges out of their respective refuges.

S.02-6-Poster

Niche conservatism and spread of Caulerpa taxifolia invasive lineages with different residence time in the Mediterranean Sea

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Marine algae invasions attract a lot of interest as they are altering the structure of marine ecosystems. However, niche dynamics and risk predictions of marine invasions integrating phylogeographic structure has not yet been investigated. In this study, we perform a comprehensive analysis of two invasive lineages of Caulerpa taxifolia with different residence time in the Mediterranean for a better understanding of their invasive processes. We performed lineage-based and species-based niche models to assess the risk of invasion, the spatial overlap, and the variables delimiting the distribution of the two lineages. Intraspecific models with pooled occurrences accurately found two separate regions susceptible of invasion for each invasive lineage in the Mediterranean, while species-based predictions underestimated invaded regions. Niches were not equivalent, and niche overlap and niche shift results between invaded and native ranges varied depending on the geographic extents used. We provide evidence that different invasive lineages of algae show dissimilar environmental response and invasive ranges, not detectable using species-based data. The invaded range did not show niche shift, and thus, no evidence of a post-introduction adaptation scenario was found as both lineages invaded waters similar to their Australian native locations.

S.02-7-Oral

Environmental niche divergence among Stauracanthus Link species

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The geographic distributions of species are constrained by their ecological and environmental requirements. We analysed the effects of environmental conditions, historical events and biogeographical constraints on diversification of the three species of the Mediterranean shrub genus Stauracanthus, which present parapatric distribution. To measure the response of the Stauracanthus species to the environmental gradients and map their potential distribution, we used SDM (ENFA) and GLMs. We determined the bioclimatic niche overlap between them using Schoener's index. We used GenalEx to characterize Stauracanthus species genetic differentiation. The effects of main environmental drivers on genetic distances were assessed through Mantel tests and NMS. We found that the three Stauracanthus species show remarkably similar responses to climatic conditions. This supports that this recently-diversified clade retains common adaptations to climate, thereby explaining the existence of high levels of climatic niche overlap. This contrasts with the diverse edaphic requirements of Stauracanthus species. S. genistoides-spectabilis clade grows on Miocene and Pliocene fine-textured sedimentary soils while S. boivinii, the species genetically more distant, occurs on older and more coarse-textured sedimentary substrates. These patterns of diversification are largely consistent with a stochastic process of geographic range expansion and fragmentation coupled with niche evolution in the context of spatially complex environmental ?uctuations. We concluded that the evolution and current distribution of Stauracanthus species has been shaped by edaphic and climatic requirements, as well as by historical events and biogeographical constraints.

S.02-8-Oral

Low dispersal species in expansion: genetic drift and key biological traits in the simulation of the range expansion of the spur-thighed tortoise (Testudo graeca)

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Understanding the genetic patterns caused by recent expansion processes could give us key insights about the evolutionary consequences of future range shifts caused by global change scenarios. However, such characterizations can be complex and require the combination of different approaches. Here we integrated field data with simulation experiments to explore the genetic consequences of the expansion of the spur-thighed tortoise in south-eastern Spain. The use of molecular data allowed us to date the species' arrival from North Africa in around 20,000 years ago. We simulated the first 600 years of the expansion in south-eastern Spain using a spatially explicit individual-based model which considers the survival, reproduction, dispersal and genetics of tortoises. Multiple paternity and sperm storage, key life traits of this study system, were specifically implemented. We parametrized the simulations using field and bibliographic data. Initial conditions were based on previous studies addressing the population's origin. Our results showed that an excessive dispersal of individuals difficult their reproduction and negatively impact on the viability of the population. The spermatheca was revealed as an important trait supporting, but not guarantying, the expansion at low densities. Genetic drift strongly acted promoting spatial gradients of genetic diversity from the starting point of the expansion, significant patterns of isolation by distance from STRs and clusters of mtDNA haplotyes. These signatures were previously reported in the real population and served to identify one of the first empirical examples of genetic surfing, a process dominated by genetic drift mediating the expansion of low dispersal organisms.

S.02-9-Poster

Warming trends predict trout decline 150 years later

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Bioclimatic envelope models are widely employed to forecast species ranges under future climatic scenarios, but their accuracy remains largely unknown because validation datasets will only be available within the time frame of the forecast. Historical species records offer an excellent opportunity to test the performance of distribution forecasts, by projecting past climate-distribution relationships to current climatic conditions. Here, we analyse thousands of brown trout (Salmo trutta) records from Spain in 1850 and 2000 to show that the current distribution of the species is accurately predicted based on historical records and only three temperature variables. The accuracy of the trout range forecast relies in the high temporal stability of its climate niche. Predictions and models robustly coincide in showing a suitability decline around 30% between 1850 and 2000, which will surpass 40% by 2050. We stress the huge, yet largely unexplored potential of historical species records to open a big-data pathway for long-term global change science.

S.02-10-Poster

Biodiversity and phylogeography of the taxonomic complex Sonchus asper (Prickly sow-thistle) in the Mediterranean

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Some significant morphological and reproductive variability have been recently found in Sonchus asper L. along the Mediterranean region, which involves the presence of at least four morphotypes with a clear geographical pattern of distribution. The typical morphotype, S. asper L., shows small non-attractive self-compatible florets and capitula, and the three remaining ones, i.e., S . nymanii Tineo & Guss., S. glaucescens Jord. and S. graecus Weiss, present showy capitula with large self-incompatible florets. Genealogical and genetic differentiation analysis based on nrDNA ITS/ETS region and AFLP markers supports the taxonomic segregation of these morphotypes, and reveals some additional variability in plants from North Africa. The variability in three chloroplast noncoding regions (i.e., ndhJ-TabE, atpI-atpH, and psbJ-petA) supports that perennial plants with large flowers from north western Africa and Sicily (morphotype S. nymanii s.l.) represent the ancient lineages and the oldest taxa in the complex, and suggests the presence of an old connection between both sides of the Mediterranean across Sicily. In this case, the annual S. graecus Weiss morphotype might be derived and had expanded from central to eastern Mediterranean, where some isolation process on the Balkan Peninsula took place. In turn, it seems to have given origin to the S. glaucescens morphotype as a recent ecological and local adaptation. The small flowered morphotype could be also a derived lineage that has mainly colonized western Mediterranean and, most likely, has become a common weed worldwide.

S.02-11-Oral

Isolation and speciation of the Mediterranean complex Achyrophorus laevigatus (Compositae)

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The Mediterranean Basin is considered a hotspot of plant diversity, with more than 25,000 species. This heterogeneity is the result of geologic and climatic changes, which have occurred during millions of years, shaping species distributions and promoting local expansions and extinctions (depending on the capacity of each taxa to adapt to new habitats). The most drastic factors that affected the distributional area of species in the region, in the last two million years, were the establishment of the Mediterranean climate (2.3 Ma) and the contact and isolation processes among different landmasses, due to sea-level fluctuations during the glacial and interglacial periods in the Pleistocene. We focus this study on several taxa belonging to the genus Achyrophorus (A. laevigatus, A. rutea, A. decipiens, A. hieracioides, and A. saldensis). Achyrophorus laevigatus is restricted to NW Africa (Morocco, Algeria and Tunisia), S Italy and Sicily; A. rutea is endemic to S Spain, and A. decipiens, A. hieracioides, and A. saldensis live only in Algeria. We assess the relationships among these closely related taxa and their current population structure to infer their ancestral area. For this purpose, we used AFLP molecular markers together with nuclear and chloroplast sequences from 273 individuals out of 35 populations (covering the whole distributional area of the species). The role of the main geographical barriers, which affect the phylogeographic patterns founded, is discussed.

S.02-12-Oral

Coupling ecological-niche models and phylogeography reveals demographic history and niche differentiation of the Subalpine Warblers

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The Subalpine Warbler (Sylvia cantillans) is a species complex that represents an ideal case to explore such demographic and biogeographic pattern in the Mediterranean region. Throughout its area of distribution, a broad spectrum of Mediterranean type habitats is important for the survival of more than 75% of the breeding populations of the species in the complex. Earlier studies on the phylogeography of this species complex analyzed mitochondrial DNA (mtDNA), specifically cytochrome b (cyt-b) gene, variation covering much of the distribution range of Subalpine Warblers. These studies solved for the most part the taxonomic problems within the complex, but did not delved into a detailed review on the demographic history of each species of Subalpine Warbler. Integrating distributional studies with phylogeographic analyses could offer novel opportunities to understand complex patterns of demographic history of species. As new questions are being raised concerning the ecological and evolutionary mechanisms responsible for shaping the demographic history of species, examining the distributional shifts and ecological niche differentiation of species is one of the approaches to explore reasonable answers to these new questions. Hence, in this presentation, we first aim to develop detailed distributional projections from ecological niche models, and to integrate these results with the insights from novel demographic analyses based on previously published DNA data of the species complex. Results showed that Mediterranean bird species have a different demographic history from the bird species that are now widespread in the temperate zones of Europe.

S.02-13-Oral

Phylogenetic diversity patterns under climate change: an example with the genus Nothofagus in Chile

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Climate change predictions are very heterogeneous in Chile, due to wide altitudinal and latitudinal ranges in bioclimatic local conditions. Species distributions modeling (SDM) are being used to predict spatial changes in taxon distributions due to climate change, and they can also be used to predict if and how those shifts will imply changes in the spatial patterns of phylogenetic diversity (PD). Nothofagus is a tree genus with a classical Gondwanan distribution, present in South America from Mediterranean Chile to the temperate southern forests of Chile and Argentina. We used Nothofagus as a model system to study changes in the spatial patterns of PD in a time scale, from its paleo distribution at the last glacial maximum, the present, and two climate change future scenarios. Using SDM, and sets of bioclimatic variables for the four time steps, we modeled the distribution of all the South American species in the genus for the three time periods at 1 Km resolution. We used an available molecular phylogeny and the four time steps distribution scenarios from the models to calculate PD and compared its spatial patterns in the three scenarios. Paleo and current PD patterns highlight the importance of the Mediterranean/Temperate transition zone as a center of species and PD richness and also as historical refugia for Nothofagus species. Further, changes in future PD projections highlight the importance of protection actions such as implementation of new protected areas and halting current ongoing habitat loss.

S.02-14-Poster

Phylogeography of insular polyploids: a GBS study of Macaronesian endemic Lavatera acerifolia

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By increasing dramatically the sampling of genomes, Next Generation Sequencing (NGS) techniques opened a wide avenue towards reconstructing species evolutionary histories thus representing a crucial source of information for phylogeography. However, polyploidy --a very common process among vascular plants-- is a major challenge for the NGS techniques due to difficulties in genotyping individuals resulting from the existence of multiple paralogous loci, which is even more complex in plants without a reference genome. In addition, population-base studies require a highly reliable set of homologous fragments and SNPs. Plant evolution in oceanic islands provides a suitable framework where genetic groups can be directly related to discrete geographic areas. Lavatera acerifolia (2n=44) is one of the two endemic entomophilous species of Malvaceae family occurring in the Canary Islands, sister to Lavatera maritima, also polyploid (2n=44) and distributed along the West Mediterranean basin, including SW Morocco. Our study applies GBS to reconstruct the origin and evolution of L. acerifolia in the Canary Islands. To overcome the complexity derived from the polyploid condition of this species we have done sensitivity analyses comparing different settings in critical steps of the filtering process. Our analyses group populations into 2-4 genetic groups with a clear geographic structure that supports an east-west colonization pattern following a stepping stone model with probable cases of recurrent introductions.

Session 03: Current species conservation challenges

S.03-1-Invited Lecture

Towards a process-based conservation strategy for Mediterranean endemic plants

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Endemism in the Mediterranean region is all about history. Although the diversity of endemic plants leaves one feeling that each endemic species has a singular origin, that the real singularity lies in the close links that can be established between evolutionary processes and the complex interaction and spatial heterogeneity of geological and climatic evolution since the Tertiary. Long-term ecological stability of habitats has allowed the persistence of ancient endemics and in localised Quaternary climatic refugia the diversification of neo-endemic species has occurred as a result of population isolation during range contraction and polyploidy, hybridisation and ecological differentiation during range expansion. Endemic species often occur in a distinct ecological niche in peripherally isolated populations of ancestral taxa and recent work illustrates that diversification in peripheral populations may be facilitated by ecological originality. The spatial conjunction of ancient and recent refugia and the ecological and genetic processes of persistence and diversification are of vital interest to identify future potential for evolutionary change. The conservation objective is to reduce anthropogenic processes that disenable evolutionary processes and thus cause future loss of species, habitat and population diversity. Strategies based on ecological solidarity for the conservation of diversity other than just unique species in protected areas, and the adoption of a mitigation hierarchy in which clear cut process-based priorities for how and where to avoid, minimize and offset impacts are becoming ever more essential here. As on-going climate change forces us to project conservation strategy into the future, a process-based approach will become essential.

S.03-2-Oral

What research will ensure biodiversity conservation in the Fynbos Biome?

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We canvassed the wider biodiversity community in the Fynbos Biome for ten priority research questions each which, if answered, would have a high probability of improving biodiversity conservation in the Fynbos biome. We received 341 questions from 51 respondents, primarily from research organisations, environmental NGOs or consulting groups, and government conservation departments. Questions were iteratively aggregated, arriving at 41 final questions. These clustered in seven groups: ensuring effective conservation management; detecting and understanding change; making the case that biodiversity supports critical ecosystem services; making biodiversity a shared concern; improving governance and action for effective conservation; securing sustainable funding for biodiversity conservation; and prioritising the research agenda. We tested the relevance of the aggregated questions against the IPBES conceptual framework for connecting nature and people (Diaz et al. 2015). The questions were well distributed across the framework and predominantly addressed links between categories. Our bottom-up approach to identifying research priorities reflects the IPBES aims to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. Questions were not focused on nature principally, but included institutional and governance issues, values, communication and the role of society in biodiversity conservation. Addressing the Fynbos Biome's priority questions will require collaborative efforts across disciplines, institutions and society. This poses challenges for traditional disciplinary research and emphasises the involvement of a broader range of disciplines, institutions and boundary players able to navigate disciplinary divides.

S.03-3-Oral

Big thistle eats the little thistle: rapid extinction by unidirectional introgression and demographic swamping in Onopordum hinojense

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Hybridization is known to have a creative role in plant evolution. However hybridization can also have negative effects on the parental species and it can even result in their extinction due to genetic and demographic swamping; such harmful effects may be particularly evident in the case of rare species. Onopordum L. (Asteraceae) is a Eurasian large genus with several weedy species, which frequently hybridize with congeners around the world. In the SW Iberian Peninsula, the rare O. hinojense co-occurs with the widely distributed O. nervosum, and hybrids between these two taxa have been described as O. x onubense. To determine the extinction risk in a hybrid zone, both for hybrids and parentals, we used analyses of morphological and cytogenetic traits as well as genetic markers (AFLP) and demographic models. To investigate the introgression process we used Bayesian analyses and developed a new genome scan method (R package AFLPsim). Morphology, genome size and molecular markers confirmed homoploid hybridization and also indicated unidirectional backcrossing of F1 hybrids with O. nervosum, which is likely to swamp O. hinojense, the parental with lower pollen size and a very low fruit set (8%). The introgression pattern was mostly neutral but some loci significantly deviated from neutrality in spite of our novel genome-scan method was very conservative. Our study provides strong new evidence for a scenario of rapid extinction (in less than four generations) by unidirectional introgression and demographic swamping. These results shed new light on the role of introgression in Mediterranean plants extinctions.

S.03-4-Oral

Influence of behavioral state (resident versus dispersing individuals) when identifying ecological corridors and effective distances

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Landscape connectivity in fragmented territories can be enhanced by establishing ecological corridors among suitable habitat patches. Corridors can be represented as areas where resistance to movement is minimum, with effective distances defined as the accumulated resistance along the least-cost path. Resistance surfaces are frequently obtained from the inverse of habitat suitability models or from presence data within home ranges instead of data from exploring or dispersing individuals. We assessed the extent to which corridor delineation and effective distances may vary depending of the behavioral state of individuals (resident individuals within their home range or dispersing individuals). A large dataset of GPS locations of Iberian lynx was modeled first using solely data within home ranges and then using only exploratory or dispersing data. Corridor delineation resulted akin for both models. The estimated effective distances were 42% lower in the dispersal model than in the resident model. Thus, models derived from exploratory or dispersing locations may provide higher connectivity estimates than models derived from resident locations. Assessments of the extent to which populations are isolated may differ considerably depending on the behavioral state. Although dispersal data may be difficult to obtain, they potentially provide more realistic estimates of connectivity. Also, we intended to identify the key corridors for improving landscape connectivity in case they are ameliorated by calculating their importance for contributing to connectivity when the accumulated cost is lowest. Key corridors for improving connectivity if ameliorated where those relatively close in relation to the rest of habitat patches.

S.03-5-Oral

Stand age effects on tecate cypress recruitment after the 2003 Otay fire

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Tecate cypress (Hesperocyparis forbesii) is a rare endemic species restricted to four populations in southern California and a few isolated populations in northern Baja California. This species is fire-dependent and has an estimated natural fire frequency of 50 to 100 years. Over the last century however the average interval between fires in these populations has dropped to 25 years. The aim of this study was to assess the effect of pre-fire stand age on the recruitment of Tecate cypress following the 2003 Otay Fire. Pre and post-fire densities of four cypress stands with pre-fire stand ages of 7, 24, 29, and 43 years were collected at various intervals over an 11-year period and analyzed to determine recruitment and mortality over time. Regression analyses revealed a significant positive relationship between seedling recruitment and pre-fire stand age and ANOVA results showed that sites with the youngest pre-fire stand age of seven years had significantly lower densities of cypress than sites with a pre-fire stand age of 29 and older. These findings suggest that a shortened fire-return interval in these systems has the potential to threaten the persistence of individual populations and in extreme cases can lead to the loss of entire stands.

S.03-6-Poster

Avian communities in Spartina maritima restored marshes under Mediterranean climate

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Coastal wetlands creation and restoration are essential for shorebird conservation purposes needing an environmental monitoring to assess the consecution of the proposed goals. Therefore, this work aims to assess the maturation of the shorebird community in Spartina maritima restored marshes (RM) 9 years after restoration in comparison with Spartina densiflora invaded non-restored marshes (NRM). To evaluate the progress of the shorebird communities, data were compared with previous sampling campaigns in 2008/9. Censuses were carried out after sunrise from September 2015 to June 2016 in three locations both in RM and NRM for 20 min at each sampling point (4–5 times per season) using 10_ binoculars and a 20–60_ spotting scope. Biodiversity, endangered species, maximum ecological diversity, mean species richness and mean individual number increased significantly in RM in 2015-2016 respect to 2008-2009. 17 wader species were recorded in 2015/6 in RM, two more than in 2008/9. The most relevant endangered species in RM were: the Osprey, the Audouin's gull, the Kentish plover, the European shag, the little tern, the Eurasian spoonbill and the purple heron. In autumn and winter, both in 2008/9 and 2015/6, NRM showed higher mean individual abundance than RM. Ecological diversity (H') was always higher in RM. Avian communities from RM and NRM were significantly separated in MDS analysis according with species composition and abundance both in 2008/9 and 2015/6. Our result confirms how Spartina maritima plantations address the transition toward more diverse shorebird communities in European salt marshes than in S. densiflora invaded marshes.

S.03-7-Oral

Is there a mismatch between current threat assessments and real threat status for Mediterranean biota? What´s latitude has to do with it

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Traditionally, threat assessment for red listing in the Mediterranean was based in expert opinion. However the area is under rapid and large changes in land use and land occupation trends. Besides, it is an important tourist destination; tourists doubling the local population yearly. Moreover, there are a large amount of species under risk. These facts add up uncertainties for an accurate knowledge of conservation status relying only on expert opinion. On the other hand, latitude is not only accounting for ecological gradients, but it is also related to different regional conservation strategies in a highly populated area with a long history of human intervention. There are planning differences in agriculture o livestock management following these regional approaches. Also, there is a different protected area density and quality along the latitudinal transect in the Mediterranean. In this work first, we want to address the possible mismatch between current threats assessments and red listing catalogues based in expert opinion, and real threat status based on demography plots. And secondly, we explore the role of geopolitics and latitude in the possible explanation of this mismatch. We designed a Mediterranean latitudinal sample of 117 transects of 27 population comprising 19 threatened species ranging from Canary Islands to Catalonia. We present a preliminary analysis considering some particular threat effects such as herbivory, drought and, community succession in the real status of populations.

S.03-8-Oral

Special Areas of Conservation in Portugal: assessing the relationship between area delimitations and land use dynamics

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Special Areas of Conservation (SACs) were established in Portugal under the European Union Habitats Directive (92/43/EEC) for the conservation of natural habitats and ts wild fauna and flora. More than 80% of the land in Portugal belongs to private owners which is a challenge to land use policy and nature conservation objectives. The main goal of this work was to assess the land use changes in part of the mainland territory which is inside Natura 2000 Network and evaluate the dynamics after some decades of its implementation. The analysis were made using available land use maps for the years 1950, 1990 and 2007, in the following areas: (a) within the SAC areas, (b) in the immediate surrounding buffer, (c) in the immediate surroundings, out of the conservation area influence. We assessed land use dynamics through time, the differences before and after the SACs designation (1990s), and the changes in the implicit values of land use to nature conservation. These values are related to the correspondence of each land use category to the natural habitat occurrence. Results showed no difference between the three types of areas (a, b, or c), before and after SAC designation. Along time there was a decrease of agriculture areas and an increase of unmanaged areas and shrublands. The global implicit values generally increased, inside and outside SACs.

S.03-9-Oral

Reshuffling the wintering ranges of migratory birds in the Mediterranean by climate change effects

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Migratory animals pose unique challenges for conservation biologist, the characteristics of species that undertake such movements appear to make them particularly vulnerable to detrimental impacts of climate change. We studied the effect of climate change on the distribution of two insectivorous passerines (the meadow pipit Anthus pratensis and the chiffchaff Phylloscopus collybita) in wintering grounds of the Western Mediterranean basin. In this region, precipitation and temperature can affect the distribution of these birds through direct (thermoregulation costs) or indirect effects (primary productivity). We first assessed the effects of climate and other geographical and habitat predictors on bird abundance. Multivariate analyses reported a positive effect of temperature on the present distribution of the two species, with an additional effect of precipitation on the meadow pipit. These climate variables were used with Maxent to model the occurrence probabilities of species using ring recoveries as presence data. Abundance and occupancy of the two species in the study localities adjusted to the distribution models, with more birds in sectors of high climate suitability. After validation, these models were used to forecast the distribution of climate suitability according to climate projections for the future. Results show an expansion of climatically suitable sectors into the highlands by the effect of warming on the two species, and a retreat of the meadow pipit from southern sectors related to rain reduction. Adapting conservation strategies for migrants in the light of climate change will require substantial shifts in site designation policies and flexibility of management strategies.

S.03-10-Oral

A demographically effective measure of population size for disturbance-prone environments

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Stochastic disturbances are integral to many environments. Disturbances can drive population dynamics; inducing large changes in population size and structure. Understanding how current population structure interacts with disturbance timing to influence future population size is key to making realistic estimates of population changes. Yet it is rarely considered in conservation management. Theory and methods exist to account for the influence of population structure on future population size, such as the stochastic stable equivalent ratio (SER) that accounts for small variation in vital rates. It is unclear whether existing theory applies when stochasticity is large, such as in fire-prone environments. Using a population that experiences large variation in vital rates due to fire, Callitris verrucosa, we explore the utility of the stochastic SER and evaluate a simple rule of thumb approximation to the stochastic method. We ask, can the methods: i) indicate the potential for future population growth ii) identify appropriate fire regimes and iii) estimate the abundance of seedlings that will emulate the trajectory of a reference population. Both ratios were able to accurately measure the influence of current population structure on future population size when recurrent disturbances drive population dynamics. When assessing alternative fire regimes only the stochastic SER provided information on expected variation in future population size due to stochasticity in disturbance timing. When estimating how many seedlings are required to achieve a similar future population size as a reference population, the stochastic SER has the potential to enable more effective and cost-efficient management.

S.03-11-Oral

A manifesto for collaborative development of open-source technology for ecology and conservation

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The timely convergence of accelerating engineering progress, affordable manufacturing and global data connectivity offers an unprecedented opportunity to boost research and practice in Ecology and Conservation. I argue it is time for these disciplines to go beyond their largely technology-consumer role to formally drive the interdisciplinary agenda of "Techno-ecology" or "Conservation technology". While collaborations are slowly emerging, the situation is still scattered and largely uncoordinated. We need to develop a coordinated interdisciplinary collaboration between technology developers, data modellers and end-users.

Open-source has proven a very effective way to develop software and statistical modelling solutions (e.g. the R community), and providing code is becoming a standard for publication. Ecologists are also increasingly embracing the idea of data sharing. The remaining pillar that would accelerate research and practice is to share technology developments. Open-source technology is starting to emerge in other areas within BioSciences (e.g. wet lab). This approach has potential to bring affordable technology, driven by the community of users and thus specifically designed to fulfil their needs. It could also help address inequalities between countries.

Thanks to global connectivity we currently have the means to create a platform for collaborative development which would allow tapping into the tremendous manpower and technical skills of the global community of technologists (engineers, computer scientists, programmers, electronics hobbyists, Makers…).

I will provide an overview of where we stand in this picture of open-source technology development, including researchers' attitudes towards sharing hardware design developments, and provide examples and a roadmap for implementation.

S.03-12-Oral

An integrity monitoring protocol for coastal sage scrub

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Shrublands in Mediterranean-type ecosystems support high levels of biodiversity and are threatened by multiple factors in heavily used landscapes. To be effective, management and land use decisions should be informed by up-to-date information on ecosystem quality and resilience. We present an integrity monitoring protocol based on ecosystem components readily understood by non-specialists, which is expected to enhance communication between stakeholders. Community integrity is defined by plant functional group (shrub and non-native annual grass) composition. The ability to use these simple easily observable metrics results from 1) the relatively good alignment of characteristic bird, mammal and insect communities with shrub cover, and 2) the positive feedback between annual grasses and fire, and the inhibitory effect of annual grasses on shrub seedling establishment. The protocol is designed to: 1) categorize habitats into ecosystem integrity classes, 2) forecast likely integrity class changes caused by threats (e.g. short fire interval) and environmental conditions (e.g. annual patterns in precipitation), and 3) provide a simple reporting mechanism (annual maps) that can be overlain with data on conservation status (e.g. endangered species status) and vulnerabilities (i.e. short fire interval). It incorporates streamlined updating initially using annual fire maps, which over time will be based on a more complex model of ecosystem drivers. Annual map and integrity classification system validation and refinement utilize a two tiered vegetation sampling system that employs rapid visual estimation techniques and plot-based measurements. Monitoring data is also anticipated to help identify and characterize emerging threats over time.

S.03-13-Oral

Using big-data to improve conservation outcomes in the northern jarrah forest

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Classification methods influence perception of vegetation types and ecological pattern. The use of big-data, spatially-enabled databases and modern analysis software improve the accuracy of types. The historic classification of the northern jarrah forest (3 089 vascular plant taxa - 22% of the States flora) is based on land-productivity assessment (site vegetation types). This economic-driven typology over-emphasises upland sites, with consequences for conservation. A large floristic dataset collected by Alcoa Pty Ltd (31 000 plots, 550 000 records, 525 taxa) provides big-data to reanalyse forest floristics. To ensure dataset integrity a free and open source spatially-enabled database management system (PostgreSQL and PostGIS) was developed. Data structure was then parameterised using the state's online herbarium FloraBase. A taxonomic and traits comparison (species, family, habit, life-form, mode of perennation, conservation and naturalised status and mode of nutrition) indicated species visible all year are favoured in the dataset. Floristic groups were derived and correlated to spatial moisture and topographic indices using species-to-cluster modelling in R and ArcGIS. The updated classification revealed few, dry, upland types and many, distinct, mesic-related communities. Our results question the current perception of the forest as a dryland system with few vegetation types and low conservation value, and create a foundation for testing whether moisture-related species or community types are of high conservation concern under drying.

S.03-14-Oral

Microhabitat partitioning in ancient landscapes: a case study of mygalomorph spiderling preferences for groundcover

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Conservation of highly heterogeneous landscapes in a way that enables the continued functioning of native species is fundamental in the management of ecosystems. This is especially challenging in ancient, subdued landscapes where microhabitats are complex and well established. Realisation of microhabitat requirements offers insight into optimal conditions for the survival of organisms. During dispersal, sedentary organisms have little, if any, choice in establishment of microhabitat conditions. We found mygalomorph spiderlings to be a unique case of a sedentary organism disperser capable of making an active decision for where their burrows are established. This choice may impact their chance of survival over the rest of their long (up to 40 years) lives. Three endemic mygalomorph species were used to test if spiderlings displayed active selection between particular ground cover types under controlled conditions. Idiommata blackwalli and Aganippe sp. spiderlings showed preference for Banksia leaf litter and bare ground respectively, corresponding to where adults are typically found. Unfortunately, Idiosoma sigillatum spiderlings displayed strong preference for microhabitats covered by an invasive weed species (Veldt grass), despite adults being found primarily in Allocasuarina fraseriana leaf litter. We measured ambient temperature (Ta), relative humidity (RH) and prey species assemblages (PSA) in the different ground cover types. Veldt grass showed similar variance in Ta and RH to Allocasuarina fraseriana. However, vastly different PSA jeopardises ongoing survival of I. sigillatum in Veldt grass. Reduction of Veldt grass presence is strongly recommended for urban reserves of Perth, Western Australia to conserve these vulnerable, locally endemic taxa.

S.03-15-Oral

The genetic composition of Aleppo pine at Mt. Carmel, as a basis for conservation policy

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The largest populations of the unique east Mediterranean ecotype of Pinus halepensis in Israel grow on Mt. Carmel. Adjacent are planted P. halepensis forests grown from seeds collected in other Mediterranean regions. The future of the eastern ecotype might be under threat from gene introgression from adjacent non-native planted trees. We aimed: 1. To characterize the genetic composition of the eastern ecotype and nearby planted trees. 2. To examine the presence of gene introgression from planted to natural pines. 3. To propose a science-based conservation policy for the locally unique pine ecotype. We sampled 286 trees of three size groups from 13 native and two planted stands. Genetic characterization using AFLP fingerprinting revealed 298 amplified loci; 183 were common to native and planted stands; 69 were unique to native populations, and eight were unique to the planted stand. The native populations were polymorphic (He (0.029-0.137= and genetically different from each other. A Bayesian Cluster analysis divided the populations into nine native groups, with inimitable genetic profiles. The planted stand differed genetically from all of the native populations. Individuals from different size groups within each native population showed comparable genetic profiles. The results indicate that the planted stands had only a minor impact on the genetic composition of the native P. halepensis populations on Mt. Carmel. Therefore, it's important to conserve this unique native ecotype by generating buffer zones around these populations that will considerably reduce any threat of introgression. This can be easily integrated into the fire prevention buffer zones.

S.03-16-Oral

Insights into landscape genetic structure of three short range rock outcrop endemic plant species using resistance surfaces

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Rock outcrop habitats including banded iron formations (BIF), granite inselbergs and ultramafic outcrops are found globally and are often hotspots for endemic species diversity because of their unique edaphic challenges when compared to the surrounding landscape matrix. They are frequently topographically complex and disjunct in nature and the importance of dispersal in maintaining connectivity in patchy habitats is poorly understood. Landscape features can either facilitate or act as barriers to dispersal and information on how they affect gene flow is critical to our understanding of how populations diverge and ultimately speciate. Here we examine the effect of landscape features on genetic connectivity of three narrow range plant species endemic to BIF and surrounding plains, in south-western Australia. We analysed spatial genetic patterns at nuclear microsatellite loci in three conservation priority species potentially impacted by mining activity; Acacia adinophylla, Lepidosperma bungalbin and Tetratheca aphylla subsp aphylla. Incorporating data from field surveys, we then developed resistance surfaces that were hypothesised to influence dispersal success and ask, which landscape features best explain connectivity.

S.03-17-Poster

Compensatory measures of La Breña II Reservoir. Studying the ants as bioindicators

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In the year 2005, the construction of La Breña II Reservoir (Guadiato River) started, as an extension of an older and smaller dam. It resulted in one of the biggest reservoirs in Europe, and it is located in an area with a high ecological value, being included in the Natural Park Sierra de Hornachuelos (Cordoba) and in the Natura 2000 network. Due to the consequent ecological damage, the European community demanded the development of a project of compensatory measures, designed to undertake studies and environmental interventions in the surroundings of the new reservoir. For this purpose, a mosaic of 12 close plots, with varying degrees of environmental alteration, were selected. In general, they are historically human-altered areas, mainly dedicated to livestock pastures or big-game hunting, with some few forest enclaves. In these plots, as one of the actions within the compensatory measures, a series of large herbivore exclusion fences were built, where revegetation with native flora species was carried out. Not only was intended to achieve a greater diversity of habitats but also to create biological corridors for the different emblematic species of the area. This poster shows the principal results of the long-term study of ant communities as bioindicators, inside and outside of the exclusion fences (2008-2015).

S.03-18-Oral

Is light pollution a barrier in the breeding habitat of seabirds

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Many burrow-nesting seabirds are nocturnal at their breeding colonies, i.e. visit the colonies at night. Petrel and shearwater fledglings are attracted and disorientated by artificial lights at night when they leave the nest and fly for first time towards the sea. If they are ground and not rescued, they have a high probability of perishing. In contrast, adults nesting on inland colonies have to cross over the cities or avoid the lit areas to reach their nests several times during the breeding period. How birds manage that situation may offer useful information to minimise light-induced mortality. Our aim is to study the behaviour of Cory's shearwaters Calonectris diomedea borelais during the commuting flights (adults) or dispersal (fledglings) to their breeding colonies in relation to spatial distribution of light pollution. We use GPS data-loggers to track birds from several colonies on Tenerife, Canary Islands. Nocturnal satellite imagery is employed to evaluate the spatial distribution of light polluted areas. While fledglings are attracted and grounded in the closest lights to their natal colonies, adults fly over the cities without apparently avoiding artificial lights by using the shortest distance from coastlines to their colonies. Due to high elevation of nesting colonies, return flights were longer than outgoing flights as adults glided from colony to the ocean. Artificial lights do not seem to be a problem for adult shearwaters attending their nesting colonies, but constitute an important barrier for fledglings' dispersal.

S.03-19-Poster

Setting a monitoring network of volunteers and rangers to track the dynamics of biodiversity

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Monitoring the dynamics of plant diversity to assess the “favorable” or “unfavorable” status of key species in the long run constitutes a huge task that needs the joined efforts of the Academia and the Public Administration. We have developed a network of rangers and volunteers to monitor population sizes, threats, and the trends of endangered, rare and/or endemic plants, as well as populations at the limit of distribution and indicator species of habitat and climatic change, all over a large region in NE Spain. Currently, the program involves about 200 people. They can choose to collaborate into several levels of intensity, requiring different botanical knowledge and long term compromise: from classical records presence/absence of species till individual monitoring of hundreds of plants over up to ten years following some standard and solid protocols for as many plant species as they want. As a way of assessing the efficiency of the network and the ease with which volunteers carry out the tasks we conducted a survey with questions about their previous experience, effort invested, learning and satisfaction level, interactions among participants, etc. The feedback got from surveys are helping us to optimize the monitoring network performance, and better adjust tasks for new volunteers.

S.03-20-Poster

Restoration of coastal sage scrub: mitigation or mismanagement

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California Sage Scrub, (CSS) supports about 75 rare, threatened or endangered species, and as a result is designated as critical habitat by federal and state regulating agencies. Much of CSS has been eliminated as a result of land use conversion, but air pollution, shortened fire return intervals and air pollution have contributed to further decline in the past 70 years. An estimated 15% of this plant community remains in Southern California; restoration of this community is a high priority, and is required if additional CSS is removed. However, restoration of CSS has been unevenly successful even though restoration performance standards, usually measured as percent native cover, have been achieved. Our study was conducted in adjacent areas restored as mitigation using different approaches on Puente Hills Landfill Native Habitat Authority land in southeastern Los Angeles County. We used 8-10 30 m line intercept transects to measure changes in diversity, cover and invasion in a seeded-non-irrigated area adjacent to a native (control) area yearly between 2010 and 2015. We compared water potentials and maximum stomatal conductance in control, irrigated and non-irrigated restored areas to assess resilience of different restoration approaches. Our results suggest irrigating to meet native cover required by performance standards may compromise long term resilience to drought in restored areas of CSS, and while using seeding with no irrigation may increase resilience to drought, biodiversity has eroded. We conclude that using restoration to mitigate further CSS destruction may not be an effective conservation strategy in the long term.

S.03-21-Oral

Are fire risk reduction and biodiversity conservation competing or compatible objectives in fire-prone landscapes?

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Wildfire is an important ecological process in Mediterranean ecosystems, but fire risk reduction and biodiversity conservation are often viewed as competing objectives. We explored the role of management through private land conservation and asked whether different land acquisition strategies could fulfill these mutual objectives, or whether the maximization of one comes at a detriment to the other. Using a fixed budget and number of homes, we simulated 20 years of housing growth under alternative conservation strategies in San Diego County, California, USA. We found clear differences in projected fire risk to communities and biodiversity impacts based on the way conservation lands were selected. If land acquisition was prioritized based on cost or likelihood of development, or if no lands were conserved, the projected fire risk and biodiversity impacts were much higher than if land was conserved in areas with either high fire hazard or high species richness. Thus, purchasing lands based on the prioritization of either objective resulted in nearly equivalent mutual benefits for both, in part because there is substantial overlap between high fire hazard areas and areas of high species richness. Benefits not only resulted from preventing development in sensitive areas, but they were also due to different housing patterns that occurred. Although biodiversity conflicts may still arise using other fire management strategies, mutual objectives could be attained through land use planning in this region. These results likely generalize across Mediterranean ecosystems.

Session 04: Biodiversity: species interactions, networks, communities and phylogenetics

S.04-1-Invited Lecture

Plant facilitation and phylogenetics

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The term biodiversity encapsulates several components of diversity describing the variety occurring both within and between species of organisms and their interactions. To understand the enormous complexity of biodiversity, we need to apply simple measures that could accurately describe the current patterns of biodiversity and predict the mechanisms behind them. Complex network theory has proven useful in describing the patterns of species interactions while phylogenetics provides the explanation about the evolutionary mechanisms structuring such networks. Here, I will focus on plant facilitation, an important ecological interaction shaping biodiversity at different levels across many ecosystems worldwide. Plant facilitation occurs when a species (i.e., facilitated) is benefitted from the presence of another species (i.e., nurse) without any harm for the latter. Nurses and their facilitated plants establish complex networks of interactions with cascading effects on belowground guilds, as bacteria and mycorrhizal fungi, that ultimately determine important ecosystem functions linked to biogeochemical cycles. Phylogenetics, by reconstructing the functional profiles of the organisms, can predict i) whether a species act as a nurse for other species or not, ii) the structure of the plant facilitation interaction network, iii) the outcome of the interactions of plants with belowground guilds and iv) the ecosystem functions associated to C and N cycles.

S.04-2-Poster

Bottom-up effect of an invasive prey on native predators

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Predator-prey relationships are crucial for ecosystem dynamics and are likely to change when an invasive species outcompete native preys. Not all native predators adjust their behaviour to the introduction of new potential preys. Predators may fail in recognition, capture or consumption of the new preys. Even if they get to consume them, the new preys may not be as suitable as natives and may even have negative consequences on the predators. In its introduced range, the Argentine ant (Linepithema humile) is known to displace most of the native ant species. This shift in local ant communities may have bottom-up effects on native predators such as terrestrial amphibians. Here, we test experimentally whether living in invaded areas can have negative effects on the growth and survival of two amphibian species with different degrees of specialization on ant preys. Newly metamorphosed Western spadefoot toads (Pelobates cultripes) and Natterjack toads (Bufo calamita) were reared for two months in a randomly assigned treatment: terrariums with living invasive Argentine ants or with native ants (Tapinoma cf. nigerrimum). We measured toads' growth and survival and also tested their foraging efficiency as a measure of body condition. Both toad species responded differently: thought we found no significant difference between treatments for the Western spadefoot toad, Natterjack toads feeding on the Argentine ant showed a significantly lower survival than those feeding on the native ants. The results consist in a first step towards a better understanding of the impact of Argentine ants on higher trophic levels.

S.04-3-Poster

Effect of livestock exclusion on the survival and growth of the columnar cactus Neobuxbaumia mezcalaensis

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Herbivores are a very important element in the dynamic of the vegetation. In many areas of domestic livestock it has been seen as an invading element with serious negative effects on the native flora. However, recent studies show that pressure by herbivores has been present for a long time, so that removal of livestock may have negative effects. This study analyzes the effect of the exclusion of domestic herbivores on survival and growth of the columnar cactus Neobuxbaumia mezcalaensis (Bravo) Backeb at the Biosphere Reserve of Tehuacán- Cuicatlán. Although this cactus species is highly dependent on nurse plants for its establishment, its light requirements for growth are high. We analyzed the effect of livestock exclusion on light availability as well as in survival and growth of N. mezcalaensis juveniles less than 16 cm height. We tagged 370 juveniles inside of four livestock exclusions separated 500 m approximately and 370 outside of the exclusions. Survival and growth of these plants were measured during four years. Results showed that there was a no statistically significant reduction in the availability of light inside exclusions. Survival probability was not affected by livestock exclusion but is significant related with initial height. Growth was also not affected by treatment but there were important differences among exclusions. The probability of survival and growth of juveniles of N. mezcalaensis is not affected by the presence of livestock, however it presents a great spatial variability that can respond to small environmental changes.

S.04-4-Oral

Shifts in the importance of biotic/abiotic assembly drivers in global drylands: merging biogeography and community ecology to understand assembly rules

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Understanding the relative importance of different drivers of plant community assembly is challenging because of the difficulty to separate effects of biotic interactions, abiotic filters and their relationships. We used a novel approach merging species distribution models and local plant spatial patterns to estimate the relative importance of biotic/abiotic drivers of community assembly along aridity and functional diversity gradients in global drylands. Competition was more important than facilitation for community assembly under arid conditions . Competition generated both under- and overdispersed functional trait patterns, casting doubt about the validity of such patterns to infer drivers of community assembly on their own. Facilitation was, in turn, particularly relevant for species less well adapted to local environmental conditions, especially in high arid and functionally diverse sites. The importance of environmental filters on dryland community assembly decays under high aridity levels, as remaining species are highly specialized to arid conditions. Our study contributes to better understand how communities assemble by allowing separating the effects of their biotic vs. abiotic drivers, and helps predicting the response of dryland communities to climate change.

S.04-5-Oral

Competitive dominance in the organisation of Mediterranean ant communities

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Competition by dominant species is thought to be key to structuring ant communities. However, recent findings suggest that the effect of dominant species on communities is less pronounced than previously assumed. The aim of the present study was to identify the role of dominant ants in the organisation of Mediterranean communities, particularly the role of competition in invaded and uninvaded communities. The effects on ant assemblages of two dominant ants, the invasive Argentine ant and the native ant, Tapinoma nigerrimum Nylander, were assessed. The abundances of both dominant ants were significantly correlated with a decrease in native ant richness at traps. However, only the invasive ant was associated with a reduction in diversity and abundance of other ant species at site scale. In the presence of T. nigerrimum, species co-occurrence patterns were segregated or random. Community structure in both the dominant-free and the Argentine ant sites showed random patterns of species co-occurrence. The present findings indicate that dominant ants regulate small-scale diversity by competition. However, at the broader scale of the assemblage, T. nigerrimum may only affect species distribution, having no apparent effect on community composition. Moreover, we find no evidence that inter-specific competition shapes species distribution in coastal Mediterranean communities free of dominant ants. These results show that dominant species may affect ant assemblages but that the nature and the intensity of such effects are species and scale dependent. This confirms the hypothesis that competitive dominance may be only one of a range of factors that structure ant communities.

S.04-6-Poster

Arthropod communities in Fynbos (South Africa): influences of plants and birds

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Most eukaryote species on earth are terrestrial arthropods, but the factors influencing them remain poorly known. Yet, more than 50% of insects are assumed to be herbivores, then plant community is likely to be important. Furthermore, arthropods are also an important food source for predators such as birds, then predation must also influence arthropod communities.

Here, we attempted to enlighten our understanding of the factors determining arthropod communities in Fynbos. For that purpose, we determined the relative influence of factors such as plant communities and predation by birds on arthropods using a large experimental set-up replicated in six different sites across a valley In Fynbos. In each site, birds were excluded from the vegetation with 20m x 20m cages. Plant surveys and arthropod collections were conducted in each exclusion cage and in control plots.

Then, I used a correlative approach to determine the relative strength of the associations between arthropods and plants using co-inertia analyses. Finally, bird predation effect on arthropod communities were estimated with ANOVAs and partial CCA (Constrained Correspondence Analysis) which determine the differences in arthropod communities between treatments while controlling for plant composition and site.

My results showed a strong association between arthropod and plant composition, but essentially between herbivores and plants. Birds predation affected in majority predatory arthropods (i.e. spiders) whereas there was no net effect on herbivores. However, predation pressure by spiders on herbivores were more important in absence of birds and this could have hidden the effect of birds on herbivores.

S.04-7-Oral

Relative relevance of environmental, spatial, and historical factors in shaping community structure: endorheic Mediterranean shallow lakes as model ecosystems

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Community structure can be determined, among others, by environmental (i.e. species sorting), spatial (i.e. dispersal limitation, mass effects) and historical (i.e. priority effects) factors. In this multi-scale metacommunity spatial analysis we selected a set of shallow endorheic lakes located in the Biosphere Reserve of La Mancha Humeda (Central Spain) to study the relative importance of such factors in shaping the biological communities. We specifically focused on the crustacean (ostracoda) and the bacterial taxocoenosis, both differing in their dispersal capacity and ecological versatility, to evaluate the relative importance of the aforementioned factors, especially on the relative relevance of pure environmental vs pure spatial effects and their variance partitioning, using Moran Eigenvector Maps. Both species sorting and dispersal processes structure the metacommunity of the ostracod and bacterial assemblages, although the overall variance coverage and the relative contribution of spatial effects was higher in the ostracod assemblages as having less dispersal capacity than bacteria. Additionally, we used paleoecological approaches to compare the ostracod taphocoenoses-biocoenoses structuring mechanisms, whose relative importance differed. Environment dominated over space in explaining the biocoenoses, whereas in taphocoenoses space dominated over environment. Additionally, pure historical effects were also noticeable, suggesting a significant major role of earlier habitat occupation in these ecosystems. Our study stresses the importance of considering historical processes as well as the differences in the dispersal capacity and ecological versatility of each taxocoenosis in metacommunity structuring.

S.04-8-Poster

Can Hawks and Orchids be ecologically linked? Ecological network found in Albufera de Mallorca (Balearic Islands)

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Anacamptis robusta (T.Stephenson) R.M.Bateman is a rare terrestrial orchid that can be found in west mediterranean basin. Albufera de Mallorca Natural Park (Mallorca Island) is the only area of Europe where this species is present. Its pollination system has been an enigma as no pollinator action have been reported. The coexistence with A. coriophora (L.) R.M.Bateman, Pridgeon & M.W.Chase have developed the origin of a particular hybrid among them: A. x albuferensis R.M. Bateman. This finding reveal the existence of a pollinator which visits both orchids. In order to study who is the pollinator actor and the frequency of visits to A. robusta and A. coriophora, five plots were made in the field and information about pollinator behavior were registered, repeating experiment in different days. Visits of insects were very scarce in A. robusta and more frequent in A. coriophora and activity was done mainly between 10:00h and 13:00h. While different species of insects were visiting A. coriophora flowers, only Megascolia bidens individuals visited A. robusta. Our results relate both orchids reproductive biology with the fact that M. bidens is needed to parasitize Polyphylla fullo L. larvae in order to survive. Also, P. fullo is predated by the hawk Falco eleonorae Gene during the month of June at the Natural Park. In this scenario, P. fullo is stablished as a key species in the ecological network of Albufera de Alcudia relating F. eleonorae diet, M. bidens eggs deposition, A. robusta and A. coriophora reproductive biology and A. x albuferensis existence.

S.04-9-Poster

Water mites as parasites of Hemiptera. What is their role in the interactions between native and alien Corixidae?

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The invasive species Trichocorixa verticalis verticalis (TVV) is originally from North America and has become the dominant Corixidae species in saline wetlands in the south-western Iberian Peninsula. We report on field studies and laboratory experiments which compare infection levels, prevalence and PO (Phenoloxidasa) activity of parasitic water mites between TVV and native Hemipterans in Doñana, and consider the implications for the success of the invasion by TVV. We conducted a laboratory experiment to infect different hemipteran species including TVV with the mite Eylais infundibulifera at 5 and 10 g/l salinity. We quantified Phenoloxidase (PO) activity, a key immune response in insects. PO and prevalence of mites were also quantified in field samples collected from Doñana. The effects of parasitism on the immune response of species studied (Sigara lateralis; S. scripta; S. stagnalis; Corixa affinis and TVV) as indicated by a decrease of PO activity were significant but varied between species. Field data show corixids were much more affected by water mites than other aquatic insects in Doñana ponds., and that TVV suffers higher infection levels by mites than native corixidae. These data are supported by higher infection rates for TVV in laboratory experiments. In contrast to “enemy release”, our results suggest that the invasion success of TVV in natural wetlands of low salinity may be limited owing to a higher susceptibility to parasitic mites compared with native species. TVV is highly dominant in wetlands too saline for mites.

S.04-10-Oral

Evidences for a stochastic geometry of biodiversity in a Mediterranean shrubland: the effects of species abundances, richness and intraspecific clustering

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Most ecological theories seeking to explain coexistence in megadiverse communities share a set of three rules describing a stochastic geometry of biodiversity: (1) individuals show intraspecific clustering; (2) species abundances vary following a log-normal distribution; (3) the spatial arrangement between species is independent. The first two rules have received strong empirical support, however the third one remains highly unexplored. To fill this gap, we evaluated the independent species arrangement rule in a species-rich shrubland, and its potential drivers: the levels of species richness and intraspecific clustering experienced by a given species at different scales and the relative abundance of such species in the community. Here we show that interspecific associations were rare and that independence was positively related to species richness and intraspecific clustering, and negatively related to relative species abundances. Our results concur with the independent species arrangement rule and provide empirical support to a stochastic geometry of biodiversity. In a context of species-rich plant communities, the likelihood of two species to encounter become really small. However, what our study reveals as a novelty in this context, is that both, intraspecific clustering and the relative species abundances are playing a fundamental role determining the probability of two species to encounter and interact, especially at very fine spatial scales.

S.04-11-Poster

Niche variation in mountain tree shrews (Tupaia montana) by means stable isotopes along an altitudinal gradient on two mountains in Borneo

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Altitudinal gradients represent a good opportunity for evolutionary ecology studies because they offer changes in selective pressures, changing both the composition of communities and their trophic structure. We analyse the trophic ecology of a small mammal, the mountain tree shrew Tupaia montana, by means stable isotope analysis (carbon [d13C] and nitrogen [d15N]) along an elevational gradient (from 900 to 3200 masl) on two of the tallest mountains of Borneo, Mount Tambuyukon and Mount Kinabalu. We use these data to test if: 1) there is a different trophic niche depending on altitude, 2) there is a different trophic niche between sexes, and 3) which kind of trophic generalist is that species? Trophic generalist may be due to all individuals having a wide range of food types (Type A generalization) or individuals are specialized in a narrow range of food types (Type B generalization). To answer the two first questions we analyze hair from 121 individuals, and we compare if there is difference in their isotopic signature depending on altitude or sex. In order to know which kind of generalist is Tupaia montana, we use different tissues with different turnover through time (hair, muscle and liver), and we test if there is more variance within individuals than between individuals. The isotopic signature of a tissue reflects the temporal window in which it has been synthesized and it incorporates the d13C and d15N values during that time. We use liver as short-time integrator, muscle as mid-time integrator, and hair as long-time integrator.

S.04-12-Poster

Impacts of urban sprawl on biodiversity at broad spatial scales. An overview of a comprehensive evaluation project in Switzerland

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Urban growth seriously threatens biodiversity worldwide. We present the results of an exhaustive analysis of the impacts of urban sprawl on biodiversity along a broad urbanization gradient in Central Switzerland that suffers a strong growth of urban areas. We investigated the relative contributions of distinct components of urban sprawl (e.g., urban area, dispersion degree or land use intensity) to impacts on biodiversity for several taxonomic and ecological groups classified according to species characteristics and functional traits that were expected to be sensitive to urbanization (e.g., mobility or habitat and resource specialisation). We also investigated how functional structure of biological communities respond to urbanization. Urban sprawl mostly related to the proliferation of non-native and ruderal plant species, as well as to the replacement of specialist birds with more common and generalist species, and thus to the homogenisation of species assemblages. Urban area showed the strongest impacts, but the intensity of urban land use and the degree of dispersion of urban areas significantly contributed to these impacts too. Responses to urbanisation were greatly affected by species mobility, specialization degree and their interaction. Urbanization modified community assembly patterns and caused marked trait-dependent compositional changes in plant and bird assemblages. Contrasting trait assembly patterns were found for plants and birds as result of distinct underlying processes and 'organism-specific' or 'scaled' environmental perceptions. Our results also indicate a potential homogenization of species assemblages, as well as low functional redundancy and diversity levels, especially for birds, and thus low buffering capacity against further environmental changes.

S.04-13-Poster

Seedling establishment of two contrasted Quercus species in Mediterranean grazed areas with very poor soils: the role of native shrub Cytisus multiflorus as suitable microsites

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Traditionally, the shrub was considered as a harmful element for the restoration of plant species, but recent studies showed the facilitating role of shrub in Mediterranean forest restoration. Nevertheless, the effects generated can vary depending on the environment and shrub species involved. In this study, we evaluated if shrubs (Cytisus multiflorus) and large herbivores exclusion can facilitate seedling survival and growth of marcescent and sclerophyllous oaks (Quercus pyrenaica vs Q. ilex subsp. ballota) in open oak woodlands of central-western Spain. A two-year field experiment was conducted planting 200 seedlings of each Quercus species under four different treatments combining the influence of nurse shrubs and herbivory, together with soil characterization under each treatment. Among the main results obtained, emphasize that C. multiflorus enhanced the very low Quercus seedling survival, particularly during the first dry season. The improvement in soil organic matter and clay content registered under shrub canopy can contribute to this positive effect. Instead, seedling herbivory did not seem to be a survival limitation. In addition, seedling growth of both Quercus species was also very low and no growth was registered two years after plantation without shrubs. Seedling herbivory was a seedling growth limitation in areas without shrubs, mainly for Q. pyrenaica. Therefore, we can conclude that in Mediterranean grazed areas with important summer water shortage and extremely sandy soils, shrubby plants of Cytisus multiflorus have a clear facilitative effect on seedlings of ecologically-contrasted Quercus species, but in a different degree depending on the species considered and the variable measured.

S.04-14-Poster

Functional ecology of soil microbial communities along a glacier forefield in Tierra del Fuego

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A previously established chronosequence from Pia Glacier forefield in Tierra del Fuego (Chile) containing soils of different age (from bare soils to forest ones) differing in community structure of bacterial, fungal and algal communities is used as framework to postulate that microbial successional development would be accompanied by changes in functionality. To test this, the GeoChip functional microarray was used to identify diversity of genes involved in microbial carbon and nitrogen metabolism, as well as other genes related to microbial stress response and biotic interactions. Changes in putative functionality generally reflected succession-related taxonomic composition of soil microbiota. Major shifts in carbon fixation and catabolism were observed, as well as major changes in nitrogen metabolism. At initial microbial dominated succession stages, microorganisms could be mainly involved in pathways that help to increase nutrient availability, while more complex microbial transformations such as denitrification and methanogenesis, and later degradation of complex organic substrates, could play more important roles at vegetated successional states. Shifts in virus populations broadly reflected changes in microbial diversity. Conversely, stress response pathways appeared relatively well conserved for communities along the entire chronosequence. We conclude nutrient utilization is likely the major driver of microbial succession in these soils.

S.04-15-Poster

Looking for a needle in a haystack: a study on carnivore populations in the Sahara desert using poop samples

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Djebel Ouarkziz and Draa River areas in Southern Morocco have long been attracting the attention of numerous naturalists and biologists, such as J. A. Valverde who organized a well-known expedition in 1954. The diverse carnivore community in this remote region is of special interest by including felids (Caracal caracal, Felis margarita, F. sylvestris lybica), canids (Canis aureus/C. Anthus, Vulpes vulpes, V. rueppelli, V. zerda), mustelids and hyaenas, and there are recent evidences for the occurrence of cheetahs (Acinonyx jubatus hecki). Faecal analyses seem to be the most feasible tool to study such cryptic carnivores spread over vast regions. These noninvasive sampling techniques have largely proved their utility in terms of species identification and population studies as well as to understand dispersal and dietary patterns. Using already well-settled genotyping protocols we aim to elucidate by means of a molecular approach the local carnivore community makeup in collaboration with the Harmusch “Asociación de Estudio y Conservación de Fauna”.

S.04-16-Poster

How complementary are the taxonomic, functional and phylogenetic diversity facets in the European-Mediterranean woody plant assemblages?

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Past conservation strategies have commonly focused on species richness and taxonomic diversity, but more recent approaches stress on the importance of maintaining also species functional and evolutionary processes in order to better estimate ecosystems resilience to disturbances and propose effective conservation strategies for ecosystems persistence at different scales. The Woodiv project aims to explore how the taxonomic, functional and phylogenetic diversity of Mediterranean tree assemblages are spatially distributed, and to which extent hotspots overlap among the three diversity facets. It also aims to identify key environmental factors that drive diversity patterns within the European Mediterranean forest and shrubs biome (from Cyprus to Portugal). Preliminary results from a pilot study concerning only the French Mediterranean zone showed that the three diversity facets do not spatially overlap, which indicates that they are potentially complementary for conservation issues. It also revealed a high functional redundancy, especially when considering regeneration traits. Finally, strong spatial autocorrelation patterns were revealed for less than 50 km distances, so broader scale analyses should be conducted at a 30-50km resolution, in order to adequately study the spatial structure of tree species assemblages. We discuss the implications of these results for conservation and the ecosystems resilience to disturbance pressures, such as fire frequency and land-use changes.

S.04-17-Oral

Effects of landscape characteristics and mosquito and vertebrate communities on the phylogenetic diversity of avian malaria parasites in Southern Spain

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The dynamic transmission of vector-borne pathogens under natural conditions requires an integrative approach combining the study of parasite,mosquito and host populations.Mosquito and vertebrate community composition may affect pathogen amplification through factors such as abundance, species distribution and diversity.Moreover, landscape characteristics may also affect pathogen communities, due to the impact of environmental factors on both vectors and hosts. In this respect, we investigated the relationships between the diversity of avian malaria paraites and i)mosquito community composition, ii)vertebrate community composition and iii)landscape use. 2,588 house sparrows were sampled in 45 localities grouped in triplets (15 urban,15 rural and 15 natural areas) from Spain. In addition, the mosquito and vertebrate community composition in these areas was estimated.Overall, twelve different Plasmodium lineages were identified infecting birds. Per locality, the mean Plasmodium lineage diversity was 0.41 (range 0–0.74), being significantly higher in rural and urban than in natural areas. Plasmodium diversity was positively associated with the abundance of ornithophilic mosquito species and negatively with mosquito diversity. Moreover, it decreased with bird abundance and mammal richness, and increased with bird richness. Finally, the Plasmodium lineages diversity showed a positive association with the distance to the coast and water reservoirs.The variance in parasite diversity was mostly explained by vertebrate community. Overall, we provide the first integrative study of an avian malaria community infecting wild birds together with information regarding insect vectors, vertebrate hosts and landscape. Our results allow a better understanding of those factors contributing to the frequently observed geographic variation of Plasmodium lineages infecting birds.

S.04-18-Poster

Spatial distribution analysis of the diploids, triploids and tetraploids involved in the Centaurea aspera L. polyploid complex

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Hybridization between Centaurea aspera subsp. stenophylla (2x) and C. seridis subsp. maritima (4x, allotetraploid) is a common process in anthropically disturbed coastal sand dunes along the Eastern Iberian Peninsula. This hybridization produces a sterile hybrid: C. x subdecurrens nothosubsp. subdecurrens (3x) with intermediate morphological characteristics, but with a notorious hybrid vigor that makes hybrid plants compete and even may kill the nearest parentals. In this study the spatial pattern of each taxa and the relationships among them are analyzed in large sampling plots (>3 ha) and different locations in order to understand the effect that the different driving forces have on their spatial distribution. The observed point patterns distributions are clearly related with the reproductive behavior of the involved taxa. The asymmetry of the hybridization process (hybrids are only produced in one direction, with pollen of C. seridis over ovules of C. aspera), the strict allogamy of C. aspera, and the autogamy behavior of C. seridis, could be interpreted as adaptive traits to escape from the minority cytotype exclusion effect.

S.04-19-Oral

Coupling coexistence theory to field experiments reveals a complex matching between the species' differences modulating diversity and functioning

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Ecologists have argued for decades that exist a parallelism between the mechanisms determining species diversity and those driving functioning in a community: stabilizing niche differences underlies the positive complementary effects of diversity on community function, and differences in species' fitness are related to differences in species' selection effects. However, recent theoretical advances suggest that this parallelism does not occur, instead, complementarity effects results from the interaction of niche and fitness differences and the same is true for selection effects. We empirically tested these novel predictions by coupling a competition experiment to a diversity-multifunctioning experiment with ten annual plant species. We additionally included an extreme drought treatment to explore how abiotic conditions changes these relationships. We clearly found that more diverse communities produced more biomass, litter was decomposed faster, and soil nutrients were more abundant. Moreover, drought reduced this overall functioning as well as niche and fitness differences between species. Could we then establish that this reduction in multifunctionality was caused by lower niche and fitness differences between species? The answer is no as results revealed a diverse range of relationships. For biomass and soil nutrients, complementarity effects between species pairs were explained only by niche differences and differences in selection effects only by fitness differences, supporting the classical parallelism. For litter decomposition, only complementarity effects were explained by the interaction of niche and fitness differences, partly supporting the novel predictions. Our results suggest that common linkages between the species' differences modulating diversity and functioning across multiple functions do not occur.

S.04-20-Oral

Estimating species richness with hierarchical occupancy-detection models: what to expect

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Species richness is a fundamental measure that underlies many ecological models and conservation strategies. Since detection is often imperfect in wildlife surveys, studies of richness patterns that are based on metrics obtained from raw "presence-absence" data risk that real patterns are masked or spurious patterns falsely identified. Recognition of this problem has led to the development of several statistical methods for inferring the number of unobserved species at a site or incorporating information on species detectability in community analyses. In this presentation, we focus on a promising community-modelling framework, applicable to spatially- and temporally-replicated samples (Dorazio et al 2006, Ecology). Its philosophy is that species richness and other attributes of community structure are best described using models of individual species occurrence that explicitly account for imperfect detection during sample collection, i.e., combining single-species occupancy-detection models. By linking individual models in a hierarchical fashion, the method also provides inference about the number of species that completely eluded detection. This modelling framework has been used in a limited but growing number of studies and, given its apparent power and relative ease of implementation, is expected to attract increasing attention from community ecologists. However, its potential and limitations are not yet well understood. In this presentation, we first provide an intuitive explanation of the method, and clarify what its estimates represent. We then assess estimation performance under a range of plausible scenarios, including the impact of model assumption violations. Our results will guide community ecologists wanting to apply this method to their studies.

S.04-21-Poster

Interactions between hosts, parasites and vectors in Mediterranean ecosystems: physiological consequences of avian malaria parasites for mosquito vectors

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Host-parasite interactions represent one of the most important and widespread biological relationships, with parasites having a major impact on the ecology and evolution of hosts' populations. In Mediterranean ecosystems, avian malaria parasites are commonly found infecting birds, but they require mosquitoes to be transmitted between individuals. However, in spite of the high diversity and abundance of both birds and mosquitoes in areas of Southern Spain, factors affecting parasite transmission, especially those related with mosquitoes, are poorly studied. Here, we investigated the competence of the common mosquito Culex pipiens to transmit two avian malaria parasites of genus Plasmodium and Haemoproteus infecting house sparrows (Passer domesticus) and the physiological consequences (survival probability) of these parasites in mosquitoes. First, birds infected with Haemoproteus and co-infected by Haemoproteus-Plasmodium were exposed to mosquitoes to test their competence for pathogen amplification using molecular tools. Second, mosquito survival after blood feeding on Plasmodium infected birds (two treatments, high and low infected birds through medication manipulation of the parasite load) was monitored. Our results support the competence of Cx. pipiens to transmit Plasmodium but not Haemoproteus infecting birds. In addition, we found that Plasmodium parasites have deleterious consequences in their vectors, significantly reducing their survival. These results are valuable to understand the interactions between birds, parasites and vectors in Mediterranean ecosystems, which may have important consequences for biodiversity conservation.

S.04-22-Poster

Ecology of fungal communities after fire in Mediterranean systems dominated by Cistus ladanifer L.

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Wildfires are the most significant disturbance in Mediterranean ecosystems. Fire produces direct effects on fungal communities by destroying belowground organisms and indirect effects due to the changes in soil properties and vegetation composition. Thus, fires can affect the subsequent structure of fungal communities following succession patterns mainly driven by the dynamics of post-fire plant communities. The aim of this study is to analyse post-fire fungal ecology in a Mediterranean ecosystem dominated by Cistus ladanifer in northwestern Spain. Sporocarps were collected and identified on a weekly basis during the autumn season 2003-2006 in 100m2 plots located in recently burned areas and mature stands. 146 fungal taxa were found during the four-year sampling. There was a shift in the taxa composition of fungal community during C. ladanifer succession, from pioneer species (e.g. Coprinus spp. or Pholiota carbonaria) found after fire, to late stage taxa (e.g. Lepista spp. or Conocybe spp.) that fruited in the last years of succession. Cistus-specific taxa such as Entoloma cistophilum, Hebeloma cistophilum and Lactarius cistophilus were classified as multi-stage taxa being able to fruit in both early and late stages. Furthermore, several mycorrhizal taxa, usually associated with mature forest tree stands, were able to fruit much earlier in C. ladanifer scrublands. These ecosystems, traditionally considered ecologically and economically unproductive, seem to exhibit significant levels of fungal richness and can play an important role in diversity conservation as well as acting as a bridge for mycorrhizal inoculum in the recovery of forest stands after fire.

S.04-23-Oral

Effects of fragmentation of beech forests under contrasting environmental conditions on the phylogenetic, functional and taxonomic diversity of epiphytic communities

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Despite habitat fragmentation constitutes one of the major threats for biodiversity, the knowledge about its effects on the different diversity dimensions of epiphytic communities is scarce. Here, we assessed the effects of forest fragmentation on the taxonomic, phylogenetic and functional diversity of epiphytic communities at forest-patch and plot scales. We studied fragmented beech forests in the north and southern limit of Fagus sylvatica in Spain. We hypothesized that forest fragmentation decreases taxonomic, phylogenetic and functional diversity of epiphytic communities, with a stronger effect in the southernmost beech forests where climate is characterized by a strong summer drought. We selected two beech forest landscapes (47 patches, 238 plots) in the Atlantic and Mediterranean regions, where we recorded the presence and abundance of lichens and bryophytes (taxonomic diversity) in a total of 952 trees and ca. 4000 inventories. We also studied selected functional traits and analyzed the phylogenetic diversity. In order to assess the relationship of these diversity dimensions with climate, environmental and forest structure variables linked to habitat fragmentation we used structural equation modeling (SEM). Our results evidence a decrease in the taxonomic, phylogenetic and functional diversity of epiphytic communities with a stronger effect in the Mediterranean region. Our results also suggest that environmental filtering affects both taxonomic and phylogenetic diversity through its effect on the functional diversity.

S.04-24-Poster

Sown biodiverse pastures: quantifying the contribution of functional groups to productivity

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In Portugal, the concept of sown biodiverse pastures (SBP) in agro-silvo-pastoral systems, as a strategy to boost productivity and soil fertility has increasingly gained popularity, with SBP now occupying an area >4% of the agricultural land. The rationale behind this system is the introduction of species specific to semi-arid regions, with the aim of establishing a functioning ecosystem with complementary ecological niches. Compared to semi-natural pastures (SNP), studies have shown that SBP provides higher yields of better quality forage. However, robust quantitative data, validating the affirmation of increasing plant diversity in SBP, is lacking. Our objective is to fill this knowledge gap, by determination of plant biodiversity in SBP and SNP through field-based experimental studies, and disentangle the impact of soil, climate and management on the success of the agricultural practice of SBP. We selected nine farms, differing in climate and soil characteristics. In each of these nine farms, we selected sown and semi-natural pastures, with SBP installed in the period 2003-2014 and SNP acting as a baseline comparison. Data collection began in May 2015, to be continued for an additional four years. In all pastures, the line intercept method was employed at 1-m intervals along four 100m transects, with subsequent calculation of diversity and similarity indices. In addition, we assessed soil parameters and aboveground productivity. Detailed results will be presented, combining data collected in spring 2015 and 2016. Ultimately, our time-series will elucidate whether SBP will promote ecosystem functionality and stability.

S.04-25-Oral

Is inter-annual variability in biomass production by Mediterranean herbaceous vegetation caused by variation in number of species, species plant mass or plant density?

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Primary biomass production (productivity) is one of the fundamental processes of ecosystem functioning. In Mediterranean ecosystems ephemeral herbaceous species are a major source of annual biomass production. Productivity in this annual vegetation is the sum of the biomass produced by individual plants of co-occurring species. Therefore, inter-annual variability in productivity is the direct result of variability in number of species, combined with variability in plant density and plant mass of the different species. In order to assess the relative importance of these components for inter-annual variation in productivity, we analyzed data collected during 10 years in two contrasting Semi-arid and Mediterranean sites (300 and 540 mm/year rainfall) protected from grazing. Annual species were the largest contributors to biomass production (80-85%) compared to geophytes and herbaceous perennials. Even though 166 and 241 herbaceous species co-exist in the Semi-arid and Mediterranean sites, 85% of the biomass was produced by just 9 and 17 species, respectively. We found large inter-specific differences in average plant mass, but variability within species in plant mass across years was independent of species plant mass. Variability in species plant density was the main source of inter-annual variation in productivity of the herbaceous vegetation, not variability in species plant mass.

S.04-26-Oral

Scaling up interactions: plant associations drive pollination network functioning

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There is growing interest in understanding how species coexist and influence one another. However, cascading effects of co-occurring plant species on other ecosystem components are still poorly understood. In this study we aimed at investigating the effects of plant species associations on plant–pollinator networks. An experimental study was performed in the Sierra Nevada mountains (south-east Spain) at 3200 m a.s.l. in a patchy alpine vegetation dominated by two foundation species: the cushion forming species Arenaria tetraquetra ssp. amabilis and the dwarf shrub Hormathophylla spinosa. Plant–pollinator interactions were observed in plots containing either the foundation species alone, flowering herbs alone or the foundation species together with associated flowering herbs. The two foundation species differentially affected the pollinator community when harboring associated flowering herbs. Arenaria increased pollinator diversity and abundance for associated flowering herbs, and showed itself higher visitation rates when harboring associated herbs. In contrast, Hormathophylla had no positive effect on visitation rates of associated flowering herbs and was itself less visited when harboring other plant species. Consequently, even though plant associations increased network complexity and interaction diversity for both foundation species, only for the cushion plant Arenaria the plant association was net positive for pollination. Our research provides indication of a new network-based mechanism for community assembly by looking at how plant diversity scales up to other trophic levels and their ecosystem services.

S.04-27-Poster

Long-distance dispersal explains the bipolar disjunction in Carex macloviana (sect. Ovales, Cyperaceae)

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Bipolar disjunction, shown by about 30 vascular plant species, constitutes one of the most fascinating distribution pattern. This distribution could be explained by four main hypotheses: long-distance dispersal (either by mountain hopping or by direct dispersal), vicariance, convergent or parallel evolution and anthropogenic introduction from one hemisphere to another. Genus Carex includes six species with such distribution, which makes it the genus with the highest number of bipolar species. In order to test these hypotheses in Carex macloviana, phylogenetic and phylogeographic analyses were carried out based on two nuclear ribosomal regions (ETS and ITS), one nuclear low-copy gene (CATP) and three plastid DNA regions (rps16, 5´trnK and psbA-trnH introns), using Bayesian inference, maximum likelihood and statistical parsimony. Bioclimatic data were used to identify possible differences among the ecological niche of C. macloviana populations from both hemispheres. The results show that C. macloviana constitutes a paraphyletic species, dated back to the Pleistocene (0.62 Mya, 95% HPD: 0.29–1.00). Populations from both hemispheres present well-supported genetic differences, as well as two lineages in each hemisphere. This species displays genetic structure in the Southern Hemisphere, in which there is an on-going process of divergence among several populations, while lineages within Northern Hemisphere present limited genetic differentiation. The proximity to Northern Hemisphere lineages of an intermediate lineage of the Southern Hemisphere could be pointing to a south-to-north long-distance dispersal between hemispheres. Also, Southern Hemisphere populations show a trend towards an extreme in the range of ecological regimes with regards to the Northern Hemisphere populations.

S.04-28-Poster

Diversity of fungal communities after a wildfire in Mediterranean pine forest is linked to vegetation replacement

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Mediterranean forests have been affected by wildfires since ancient times, altering vegetation and its fungal communities. Despite the great amount of researches conducted in order to study the plant communities affected by forest fires, our knowledge on the interactions between fire occurrence and development of fungal communities is still scarce. The aim of this work was to assess the changes in sporocarp production linked to vegetation succession under a Pinus nigra artificial stand in Northern Spain. Sporocarps were collected and identified from a set of three 100 m2 transects at each one and five year old burned areas and an unburned adjacent area. Then, fungal species richness, biomass production and species composition was analysed as dependent on time after fire, and also considering aspects as edibility and fungal life form. Sporocarp production and mycorrhizal and edible species richness were strongly affected just after fire, but a prompt recovery was noted since few differences respect to unburned areas were evidenced only five years after the disturbance. Also, specific fungal communities composition was correlated with successive stages after fire. This was likely because of the different vegetation composition found at different stages, with species typically connected to Pinus, Quercus and Cistus in the areas where each one of them predominated. Promoting a mixture of host species just following fire by leaving the pioneer species during the implantation of new forest stands, could result in a prompt recovery of the associated fungal community, adding extra ecological value to these forests.

S.04-29-Oral

Lithological heterogeneity shapes functional structure of Mediterranean plant communities through environmental filtering and facilitative interactions

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Community assembly theory is complex and comprises multifold processes. In recent years, many studies have interpreted non-random patterns of community structure as an evidence for different forces governing their assemblage. However, community assembly processes usually act antagonistically, and may cancel each other's signatures on community structure. For example, environmental filtering can reduce the spectrum of functional strategies suitable to local conditions, whereas facilitative interactions may increase functional divergence within communities. Therefore, making inferences on the underlying mechanisms from the sole use of community-scale patterns may lead to misleading conclusions. Here, we analyze patterns of abundance-weighed mean trait values (i.e. specific leaf area; SLA) at either community and guild scales (i.e. individuals sampled in understorey, overstorey and open-ground conditions), in order to disentangle the jointly effect of environmental filtering and facilitative interactions on the functional structure of Mediterranean plant communities along a marked gradient of lithological conditions. Our results suggest that harsh lithological conditions (i.e. dolomite outcrops) act as an effective filter selecting stress-tolerant species from the regional pool (i.e. low SLA), whilst communities on milder habitats tend to harbour species less tolerant to edaphic stress (i.e. high SLA). Further, communities on dolomite habitats seem to experience a high degree of functional divergence between understorey and overstorey and open-ground individuals, whereas communities on milder habitats show non-significant divergence. These results suggest that either environmental filtering and facilitative interactions may be at stake under harsh lithological conditions, and both contribute to the maintenance of functional diversity at various spatial and ecological scales.

S.04-30-Poster

Can nursery plants affect Tetraclinis articulata recruitment under overgrazing conditions? Experience under a LIFE Project framework

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Tetraclinis articulata is an endangered plant species in Europe, protected from regional to european levels. Its only native populations on mainland are located in southeastern Spain, in some coastal mountains under semiarid conditions. Several perturbation sources as fires and overgrazing threaten these isolated populations. Very different effects can be originated by cattle grazing on native vegetation, depending on the stock density and the grazing intensity. Preliminary studies indicate both individual and population damages in Tetraclinis articulata in overgrazed areas because of changes in recruitment and development. Moreover, microhabitat components as nursery plants and substrate type can modulate cattle effects on recruitment and juvenile development stages. The LIFE-TETRACLINIS-EUROPA proyect (LIFE13 NAT/ES/000436), aimed at improving the species conservation status, offers an exceptional framework to study those ecological relationships. Data obtained from monitoring conservation actions can complete our previous studies and improve the comprehension of cattle and microhabitat effects on Tetraclinis articulata at both, the individual and the population levels.

S.04-31-Oral

New vegetation classification system for the Mediterranean Biome of Europe: syntaxonomy serving nature conservation and management

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Vegetation classification schemes are indispensable tools of nature conservation and management. European Nature Information System (EUNIS) EUNIS curates the EUNIS habitat classification and the EU Habitats Directive Annex I habitat types, two databases strongly based (or influenced) by knowledge of the diversity of vegetation, especially in terrestrial habitats and ecosystems. In the not so distant past, one of the caveats diminishing the usefulness of these databases was the lack of unified vegetation classification system for Europe. The recently published EuroVegChecklist (Mucina et al. 2016, Appl. Veg. Sci.) has filled this historic gap as it offer a universal classification system able to calibrate the habitat classification systems across all Mediterranean Europe. This talk introduces basic features of the new syntaxonomic (floristic) vegetation classification of the Mediterranean vegetation. The EuroVegChecklist summarises 100+ years of vegetation classification research in Europe. It features the Mediterranean vegetation as the most diverse (in terms of vegetation units) component of the European vegetation, being composed of 58 classes, 108 orders and 363 alliances (of 109 classes, 300 orders, and 1104 alliances for the entire Europe+). Great deal of the Mediterranean vegetation is composed of zonal vegetation units, however, the intrazonal, azonal and anthropogenic vegetation contributes considerably to vegetation diversity too. The major drivers of the vegetation diversity are briefly analysed, and outstanding challenges and new developments of the contemporary syntaxonomy are discussed. The update of the Mediterranean EUNIS habitat types using the new vegetation classification is underway.

S.04-32-Oral

The population genetics and phylogenetics of Sporothrix splendens (Ascomycetes: Ophiostomatales) hosted by Protea repens L. in the Core Cape Subregion of South Africa

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The genus Sporothrix has been recently redefined to include the peculiar Protea-associated Ophiostoma species (now Sporothrix. This newly discovered system comprises of 9 described species. There have been no associated adverse impacts inflicted by these ophiostomatoid fungi on their hosts. Their ecology is relatively well studied. They form symbiotic relationships with the Protea pollinators which also serve as short and long distance dispersers of the fungal propagules. Their evolutionary trajectory, phylogenetics and population genetics are not as well understood. The study presented here looked at the dispersal genetics of the species in the Sporothrix splendens complex which show signs of undergoing rapid evolution within the Protea niche. This study forms part of a bigger study looking at the population genetics of the whole clade (five species), and the phylogenetics of all the 10 known species (including one undescribed species). The population genetics of S. splendens suggests a short history in the Protea niche with roots in the Northern Hemisphere- relations to known pathogenic Ophiostoma species.

S.04-33-Poster

The role of long distance dispersal syndromes in distribution and diversification of large ancient angiosperms groups: a case of study in Boraginaceae and two Mediterranean lineages (Omphalodeae and Cynoglosseae)

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Long distance dispersal syndromes (LDD), especially endozoochory, have been hypothesized to facilitate plant colonization boosting diversification. However, few studies have analyzed the influence of epizoochorous fruits in diversification rates and biogeography. We evaluate the effect of epizoochory in the diversification patterns of cosmopolitan Boraginaceae (Cynoglossoideae). Phylogenetic reconstructions of 57 genera (227 spp.) and estimates of divergence times are used to infer evolutionary pathways. We employed Bayesian method for estimates of diversification rates (BAMM), latest redefine trait-dependent diversification analysis (HiSSE) and a biogeographic reconstruction approach (Lagrange). Differentiation of Cynoglossoideae lineages in the Paleocene reveals an origin in western Asia and that epizoochorous traits (glochids) have been long-term maintained through different groups from an ancestral condition. Two events of diversification rate increases occurred in two major epizoochorous lineages at approximately the same place (western Asia) and same time (17-36 myr). However, there are four epizoochorous lineages with an unexpected lower diversification rate, which is revealing a hidden effect. Mediterranean lineages within Cynoglossoideae are widely distributed within the major groups of the tribe. Two of these lineages showed contrasting evolutionary patterns. Omphalodeae (29 spp), distributed in three Mediterranean regions (Mediterranean Basin, Chile and Mexico), displays a great variety of fruit traits but has a moderate diversification rate (0.11). In contrast, Cynoglosseae (ca. 100 spp), largely confined to the Western Palaeartic, is essentially epizoochorous and shows the highest diversification rate within Cynoglossoideae. Our study stresses the idea that complex traits are not necessarily derived and do not necessarily imply the endpoint of fruit differentiation.

S.04-34-Poster

Evaluation of supplementary feeding of ungulates as a management strategy to avoid human-wildlife conflicts

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Supplementary feeding of ungulates is a common practice in wildlife management for avoiding crop damage. We addressed how these inputs affect the aoudad (Ammotragus lervia) movements and homerange and the indirect effects on other non-target vertebrate species in Sierra Espuña Natural Park in Murcia, where supplementary feeding is used to avoid crop damage. We marked 9 aoudads with GPS/GSM transmitters for monitoring their movements during spring and summer. Besides, 8 camera traps were placed collocated at feeding stations. We use GLM to evaluate if there are differences between periods with and without to register their use by vertebrates. Our results showed that there were not significant effects of supplementary feeding on aoudad home-range and movements. The non-target species that most frequently used the feeding stations was the wild boar a competitor for food resources of the aoudad tha. Supplementary feeding stations failed to fulfill their main objetive of regulating aoudad movements. Moreover wild boar benefit from the avialable biomass despite being the species which might cause major crop damage. Therefore supplementary feeding for ungulates should be carefully assesed to evaluate its effectiveness and the potential negative effects.

S.04-35-Oral

Rhizobacterial strains and nitrogen concentration as drivers of root-cluster production among Mediterranean plants

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Many plants in mediterranean Australia, South Africa and Europe are known to produce root clusters, bunches of hairy rootlets, described for >1800 species in nine families so far. After 40 years of controversy, the involvement of micro-organisms in root-cluster formation has only recently been proven (Lamont, Pérez-Fernández and Rodríguez-Sánchez 2015). Even so, much remains to be understood about the role of rhizobacteria in the overall growth of root-cluster-bearing species. Our present study evaluated the effect of rhizobacteria on total plant size and relative cluster production by Leucadendron salicifolium (from South Africa), Viminaria juncea (Australia) and Lupinus albus (Europe), and related outcomes to their indole-3-acetic acid (IAA)-producing ability as a possible explanation of past conflicting results. We grew plants in gnotobiotic, hydroponic culture for 13 weeks at two nitrogen levels and inoculated them with seven bacterial strains. While root-cluster formation could often be induced simply by introducing rhizobacteria to aseptic culture, the same bacteria sometimes inhibited plant growth and cluster production. All nine possible combinations (positive, negative, neutral) of resource (plant size) and morphogenetic (relative cluster production) effects were observed, especially positive synergism (larger plants with a greater density of clusters). Thus, the growth-promoting properties of apparently bene?cial bacteria on general growth and root-cluster production are best described as facultative, as their promotory effects depend on host species, growing conditions and index of plant response used. There was no clear relationship with apparent IAA-production, although low IAA strains of Pseudomonas putida and Bacillus magetarium were associated with greatest root cluster production.

S.04-36-Oral

Network analysis of collision fatalities in wind farms: is the Griffon vulture a good indicator species?

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Wind farms have had adverse impacts on wildlife including threatened species. The effects of wind-farms on species of conservation concern should be carefully monitored to reconcile renewable energy production with biodiversity conservation. The application of network analysis to study the effects of infrastructure impacts allows optimizing the selection of indicator species and improving the knowledge of mortality patterns. Spain is the world's third largest wind-power producer and, holds the largest populations of endangered raptors in the European Union. In this study we present the results of a long-term monitoring of wind turbines in two areas of Southern and Eastern Spain. We analysed wildlife collision fatality patterns and identified potential species indicator of mortality in wind-farms by means of network analysis. From December 1993 to March 2016 a total of 10,135 fatalities of 163 species (including birds and bats) were recorded. In both areas wildlife mortality showed a significant nested pattern. Griffon vulture was the most affected species with 2,520 collision fatalities that represent 20.2% and 66.5% of the total mortality in the Southern and Eastern areas respectively. Moreover it showed the highest co-occurrence in both areas with the rest of wildlife species collided. This confirms the high sensitivity of this scavenger to the impact of wind farms and therefore it could be a good candidate to be indicator species of mortality in wind-farms. Our results could help to environmental managers and wind-farm planners to identify risk areas and to implement effective conservation actions to reduce wind-farm negative impacts.

S.04-37-Oral

Fire recurrence impacts the functioning and phylogenetic structure of fungal communities in Mediterranean pine forests

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Fire is a major disturbance of Mediterranean forests. Predicted wildfire frequency increases associated with global change may alter soil fungal communities with important consequences for the functioning of forest ecosystems. Forests with low/high fire recurrence regimes of two representative Mediterranean pines, Pinus pinaster and Pinus halepensis, were monitored. Combining high-throughput sequencing with phylogenetic methods and soil enzymatic tests, we evaluated whether fire recurrence affected the structure and functioning of soil fungal communities. For P. halepensis, high fire recurrence increased activities related with carbon, nitrogen and phosphorous cycles, while P. pinaster soils barely responded. Concerning the phylogenetic structure of fungal communities, recurrent fire induced a clustering of the fungal community of P. halepensis marked by an overrepresentation of Basidiomycetes. For P. pinaster, only when representative fungal guilds (i.e. ectomycorrhizal, saprotrophic) were separately analyzed this fire-related clustering was detected. Compared with common diversity metrics, fungal phylodiversity of P. halepensis better explained key soil activities implicated in the mobilization of nitrogen and phosphorous. Our results reveal that fire can filter certain fungal groups and affect relevant ecosystem functions, changes that can be of main importance for the resilience of Mediterranean forest ecosystems.

S.04-38-Poster

Secondary vegetation in the olistostromic complex of La Puebla de Cazalla (Sevilla, Spain)

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Secondary vegetation in the olistostromic complex or undifferentiated subbetic complex of La Puebla de Cazalla (Sevilla Spain) is studied. This territory is included between the termomediterranean and mesomediterrranean belt, mainly in the first. Biogeographycal range of the territory are Mediterranean region (Western Mediterranean subregion), Betic province and Hispalense sector. The main plant communities inventoried correspond to serial climax forest communities, a termophylus and basophylus Holm oak forest. The thorny schrubland (with Rhamnus, Chamaerops and Asparagus), rosemary schurbland (Rosmarinus officinalis), brooms (Retama sphaerocarpa), open thyme schrubland (Thymbra-Thymus) and arid meadows (Machrocloa tenacissima) are the best types of vegetation represented.

S.04-39-Poster

Endophytes bacterias from phyllosphere of Arthrocnemum macrostachyum seem to play an important role in the tolerance to stressing concentrations of NaCl

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We hypothesized that bacteria from the halophyte Arthrocnemum macrostachyum play a key role in its high tolerance to excessive salinity. Endophytic bacteria were isolated from phyllosphere of the halophyte. The presence of plant-growth-promoting properties and tolerance towards NaCl was determined. Effects of inoculation on sedes germination and adult plant growth under experimental NaCl treatments (0, 510 and 1030mM NaCl) were studied. Total shoot and root dry mass showed an optimum at 510mM NaCl, and did not show differences between inoculation treatments in both salinity levels. Furthermore both parameters decreased considerably in plants grown at 1030mM NaCl external salinity, however, this reduction was mitigated in plants inoculated with the bacterial consortium. Similar trends were reported in mean relative growth rate (RGR), with 45% and 72% of reduction in plants grown at 1030mM NaCl with and without bacterial inoculation, respectively. About the kinetics of germination,both velocity and the number of germinated seeds were greater in inoculated seeds than in non-inoculated control seeds. We emphasize how the concentrations of Na+ in the tissues of A.macrostachym increased markedly in inoculated plants grown at 1030mM NaCl which showed a significant increment of shoots Na+ concentration up to 103 mg*g-1.

S.04-40-Oral

Patterns of plant spatial association networks in global drylands

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The use of network analysis has helped ecologists to unveil the complex structure of the interactions within ecological communities. Networks have been mostly used to study few ecological communities, such as predator-prey, host-parasitoid, or plant-pollinator systems; but in recent times the development of appropriate datasets has permitted the characterization of new types of communities on a global scale. In this communication we describe the structure of 109 plant-plant networks from drylands worldwide, and analyze the effect that several abiotic and biotic factors have in their organization. We built networks using the local spatial association between all the perennial species present in the communities. We found that plant networks presented higher density of links than expected, and these links were particularly representative of competitive interactions. Furthermore, network structure was not random, but species associated in groups of species which presented the same connectivity patterns. On the other hand, species richness and aridity seemed to have a significant effect on some indicators of the robustness of the networks. We discuss some of the mechanisms behind the organization of plant communities and possible applications of networks for the study of vegetation in terrestrial environments.

S.04-41-Poster

Past, present and future in an old-growth forest: dynamics and biodiversity

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Old-growth forests are important sources of biological and genetic diversity in terrestrial ecosystems, significant global carbon sinks, and provide many ecosystem services with important value for society. However, old-growth forests are continually changing due to their relations intra and interspecific (competence, biotic factors…) or their relations with the environment (climate, perturbations…). Therefore, nowadays is necessary to determine the dynamics and responses from these forests to the new climatic conditions and how these changes could affect the biodiversity. We installed two permanent plots in an old-growth and well-preserved forest in the "Ordesa y Monte Perdido" National Park, where we determined the position and characteristic from all living and dead trees. We also considered and characterized the dead wood on the floor. We studied the forest dynamic at long temporal scales using the tree-ring information from woody species. Additionally, we made specific samplings of biodiversity considering different elements of the ecosystem: coleopteran, birds, bats, plants, lichens and mosses, butterflies… Finally, we applied the newest technologies realizing 2D and 3D photogrammetric models at different scales (forest, plot, subplot). It is expected repeat the complete sampling each 5 years. Our initials results from the ongoing project confirm the intense forest dynamic since the end of land uses and the establishment of the park in 1918. We observe a primary colonization of Pinus sylvestris, followed afterwards by other species like Abies alba or Fagus sylvatica. These empirical results are specially useful to determine the past, present and future of old-growth forests in Mediterranean ecosystems.

S.04-42-Poster

Non-linear relationship between altitude and seed harvesting by ants in Mediterranean grasslands

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Seed harvesting by ants is one of the main processes regulating ecosystem functioning and community composition in Mediterranean grasslands. Previous observations suggest that seed removal rates are higher in warmer environments, suggesting that global warming will drive an increase of granivory by ants in these systems. However, little is known about the shape of the relationship between temperature and harvester ant activity, making difficult to predict whether we face a simple and linear increase in seed removal rates, or the response will be more complex. In this study we used a marked altitudinal gradient (650m-2.350m) in Guadarrama Mountains (Central Spain) to approximate to the effect of temperature on seed harvesting by ants. We measured seed removal rates, ant community composition, harvester-ant-guild abundance and composition, and used 6 to 18 localities depending on the variable. Inter-annual and seasonal variability was taken into account, as well as seed size and seed aggregation. Other ecological factors like slope, orientation, grassland structure and grazing pressure were fixed. We observed that seed removal rates decreased with altitude in a non-linear way, with a marked threshold at about 1400 m. Below this altitude, granivory was generalized and very intense, while in higher altitudes it abruptly declined and concentrated on small seeds. These results suggest that seed banks in communities at intermediate altitudes can dramatically change their ecological functioning in response to a slight shift in temperature, while higher and lower altitude communities can be more resistant to temperature increase.

S.04-43-Poster

The role of regional processes on the structure of Mediterranean mammal assemblages in a protected area

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Protected areas are expected to preserve mammal communities that represent the regional species pool. Species richness and diversity inside functional natural reserves usually are higher than in surrounding unprotected areas. However, reserves tend to be increasingly isolated from other areas with high biodiversity because of the expansion and intensification of human activity in the intervening land. Therefore, regional effects may shape local assemblages within reserves. We characterize the structure of terrestrial mammal assemblages in two Mediterranean forests: an unprotected region of Sierra Morena (SM) and the protected area of Doñana (DO), about 40 km apart in southwestern Spain. We also examine whether geographic distance (dispersal constraints) and functional distance (landscape connectivity) contribute to explain similarity in these metacommunities. SM and DO were more dissimilar than expected from a null model, and species richness was significantly higher in SM than in DO. We also observed a nested pattern, with DO assemblages being subsets of SM assemblages. Geographic and functional distances were collinear. The occurrence and relative abundance of the species located in SM, but not in DO, showed a negative relation with geographic distance. Geographic distance was also correlated with environmental distance. Results suggest that protection fails to fully preserve regional biodiversity in our system. Relaxation and isolation by physical and functional distance could help to explain differences in metacommunity structure. Unexplored local processes may also contribute to explain the observed pattern.

S.04-44-Poster

Changes in beta diversity in a post-fire ephemeral plant community suggest predominance of short-distance seed dispersal regardless of dispersal strategy

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Post-fire Mediterranean environments are rich in plant species and provide opportunities for community change and reassembly. Since many of these species are short-lived, rapid changes in community composition are expected during the first years post-fire, leading to potential changes in beta diversity. Here we studied the changes in beta diversity of the annual and biannual plants during three years after a wildfire using Whittaker's beta diversity index and analyzing the spatial structure of species turnover with PCNM (Principal Coordinates of Neighbor Matrices). Different seed dispersal strategies (anemochory, zoochory, barochory) and seed sizes (small, medium, large) were considered. Beta diversity index decreased markedly from the first to the second year post-fire, and it decreased more in species with anemochory and zoochory than in those without a specific seed dispersal strategy (barochory), regardless of seed size. Spatial structure of species turnover increased with time after fire, mostly due to differences in composition at long (10-180 m) distances while the spatial pattern of species turnover at short distances (<10 m) decreased. Spatial structure of community composition showed no clear pattern related to seed dispersal strategy. These results suggest homogenization of the plant community mediated by seed dispersal at a very local scale, and that dispersal occurs probably at short distances regardless of seed dispersal strategy or size, while long-distance dispersal plays a poor role. Thus, compositional differences are maintained rather than blurred during early post-fire succession in ephemeral plant communities.

S.04-45-Poster

What is the effect of the time after abandonment of cultivation on the plant community succession? A case of study in the marshland of the Doñana National Park

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One of the most ambitious actions of the Doñana 2005 Project seeks to restore 2668 ha of the Caracoles estate, a transformed and cultivated marshland for 30 years inside Doñana National Park. In 2004, apart from the land expropriation, a number of restoration actions were undertaken for the recovery of its hydrology, which would permit a natural revegetation process on agricultural plots that had been abandoned. This work addresses the changes undergone by the plant communities through spontaneous succession after land abandonment and restoration actions, linking them with environmental changes. In this sense, the considerable variety of agricultural plots with different times of abandonment during the last years of the farming activity provided a great opportunity in order to analyse the role of this crucial factor in the ecological succession. The changes in the structure and composition of the vegetation resemble the early stages of secondary succession after the abandonment of crops in places under Mediterranean climate, starting with higher values of richness and diversity associated with the dominance of annuals or biennials (mainly ruderal or weeds) that, over time, were gradually replaced by grass or herbaceous perennials, and eventually, by native shrubs and other woody plants (more characteristic of wet grasslands, marshes and brackish soils). Despite the fact that the original populations of perennial vegetation still represented a low occupancy for the whole estate after several years, the secondary succession was more evident in places that had been abandoned for a longer period.

Session 05: Evolutionary and ecological drivers of MTEs as biodiversity hotspots

S.05-1-Invited Lecture

Climate and the past and future of Mediterranean-ecosystem plant diversity: a Californian view

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The five regions with Mediterranean-type climates are the world's only major 'hotspots' of plant endemism that are not in the tropics, and the only ones that are not similarly rich in animal endemism. Therefore, climate and its effects on plants must be at the center of any ultimate explanation for the high botanical endemism of these regions, even though rugged topography, unusual soils, geographic barriers, and other factors play supporting roles. Using mainly Californian examples, I will review a range of ideas relating neoendemism and paleoendemism to the current climate and to historical climatic stability, and will consider the implications of these ideas for the future of endemic plant diversity in a rapidly changing climate.

S.05-2-Oral

Coenology of Laurus nobilis L. in Italian forests

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Laurus nobilis L. is considered one of the extant relic species of the late Tertiary Eurasian lauriphyllous forest belt, persisting in the Mediterranean vegetation. Understanding its current ecology is fundamental for conservation and monitoring issues and to clarify biogeographical aspects. The recent availability of large vegetation databases can elucidate some of these aspects using coenological records. We investigated the ecology of L. nobilis in Italian forests, taking into account a selection of climatic factors extracted from Bioclim. We analysed a national dataset of 804 phytosociological relevés in stands with L. nobilis in order to assess the coenology of the species along geographical and topographical gradients in Italy. Selected clustering and ordination techniques were used in order to obtain a robust classification. Indicator values according to Ellenberg's approach, modified for Italy, combined with climatic data were applied to the classification to gain deeper insight into the ecology of Laurus. Our results show that L. nobilis occurs in a wide range of distinct plant communities. It is present in zonal evergreen forests, extrazonal mesophilous forests, and azonal riparian forests. The major contribution to this pattern is given by the minimum temperature of the coldest month and by the precipitation regime. This pattern suggests that its relict status is driven more by micro-topographical environmental factors rather than by the current macro-climatic envelope.

S.05-3-Oral

Dissecting the drivers that shape vascular plant richness patterns of Mediterranean riparian forests at local and regional scales

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The community species richness depends on factors interacting at different scales from local to regional. The across scales relationships can arise from bottom-up processes where local scale factors are preeminent and their effects are upscaled to regions or top-down processes where the opposite occurs. Riparian forests are characterized as azonal vegetation, i.e. relatively independent of regional factors, that implies a bottom-up framework. However, few studies simultaneously evaluate the relative importance of each biotic and abiotic factor at different spatial scales. We aim to reveal the key factors and their interrelationships that shape the number of vascular plant species of Mediterranean riparian forests. We have designed an a priori model summarizing the knowledge on the relationships between biotic and abiotic variables (plus disturbances) at two spatial scales, local and regional. Then, we have analyzed the richness of vascular plants of riparian forests (n > 650) from the southern half of Spain (SW Europe) by using structural equation modeling. The local scale richness of vascular plants of Mediterranean riparian forests depends on local lithology and sediment textures of the riverbanks whereas the climate plus the lithology and water regime emerge as the main drivers at regional scale. Local richness is also significantly driven by the regional richness. Unexpectedly, regional richness is also affected by several local factors. Thus, the richness of a riverbank forest at the local scale and of the one at the regional scale are determined by different factors acting within a framework that includes top-down and bottom-up relationships.

S.05-4-Oral

Floral nectar spurs as a key innovation in the Mediterranean flora: a multi-scale analysis of snapdragons and relatives

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Factors influencing species diversification in Mediterranean hotspots are currently being investigated using novel statistical methods that allow us to estimate the effect of particular traits on speciation and extinction rates. Of particular interest are those traits, known as 'key innovations', whose recurrent evolution has consistently resulted in bursts of diversification. One of the traits that has been hypothesized as a key innovation in flowering plants is the floral nectar spur, a tubular outgrowth containing nectar that may promote pollinator specialization, thus potentially mediating reproductive isolation. Snapdragons and relatives (tribe Antirrhineae), a lineage with its highest species diversity in the Mediterranean region, constitutes an ideal study system to test the key innovation hypothesis for nectar spurs at multiple evolutionary scales. It is formed by c. 30 genera of varying species diversity, including spurless and spurred ones. A comprehensive, time-calibrated phylogeny confirmed the recurrent acquisition of nectar spurs in the course of Antirrhineae diversification, and allowed us to test the key innovation hypothesis using state-of-the-art methods (HiSSE, BAMM). To understand the mechanisms underlying spur evolution at shallower evolutionary scales, we are investigating the role of spur length variation in speciation within a recently-diversified Western Mediterranean clade of the genus Linaria using an eco-evo-devo approach. Phylogenetic relationships were resolved using coalescent analyses of genome-wide sequence data generated by genotyping-by-sequencing. A sister relationship between two species with extreme spur lengths was obtained. Ecological and developmental mechanisms underlying this evolutionary change in spur length potentially involved in a recent speciation event are being evaluated.

S.05-5-Oral

Scale dependent relations of diversity and climate: a case study with Mediterranean riparian forests

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The strength of the relations among local richness, regional richness and climate are known to change with spatial scale in a complex way. Regional richness and climate are expected to have stronger effects on local richness at intermediate scales where local effects are less important and the extent is not too large to include different regional pools. However, few empirical tests analyze which is the scale at which the regional processes turn important. We investigate the regional determinants of local diversity in order to find out the turning point where they become relevant to explain local richness. To do so, we used a large database comprising ca.660 riparian forests from the southern half of Spain. First, we used three different methods to calculate the regional diversity: circular buffers, hydrographical basins and cost buffers. Using these three criteria we calculated 8 units of increasing extent. Second, we correlated the obtained regional diversity values at the different scales with the climate and local richness. Finally, we analyzed changes in beta diversity across scales to aid the interpretation of the results. As expected, we observed major changes in the strength of the relation between local richness and regional factors but also with the method used to define the regional pool. The strongest relations occurred at small and intermediate scales. Among the used methods hydrographical basins arise as a simple and effective definition of regional richness for riparian forests.

S.05-6-Poster

Assessment of the old oak forests in Portugal using land use and forest wildfires data

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Ecosystem services provided by old forests have been studied in many different countries. This type of forest is important because it provides a diverse wildlife habitat which increases the biodiversity of the forested ecosystem. Identification and localization of these forests are important tasks for the implementation of strategies to protect forest biodiversity and the conservation of their habitats. Yet, the relevant information on these subjects is still scarce and scattered. This study aims to identify oak forest stands 60 to 80 years old across mainland Portugal, in 1950-2007. Land Use and Land Cover (LULC) data for Portugal are now available for the period 1950/60. In order to identify oak forests established at least since 1950, we used LULC maps with a scale of 1,25000 for the years 1950, 1970, 1990 and 2007. Potential oak stands that still remained in 2007 were also identified. Data from forest wildfires for the same time periods were analysed to understand if the lack of oak stands were due to fires. Changes happened on stand composition along time, but many oak stands still remain in 2007 and several of them are located in the Special Areas of Conservation. Assessment of these forests is crucial but it is a challenge in Portugal due to the dynamics and fragmentation of land use. National forest inventories are insufficient tools to provide the necessary information. Our methodology proves to be useful to detect potential old oak forests, dynamics on land use due to fires and species introductions.

S.05-7-Oral

Fire vs Climate: what is more important shaping hardseededness in Mediterranean Basin species?

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Traditionally, hardseededness in Mediterranean basin species has been considered a trait selected in response to fire. It allows seeds to persist high temperatures during fires, confers a physical dormancy that is broken by fire and allows germination in conditions of high resources availability. However, it has been suggested that the Mediterranean climate could also have driven the selection of this trait by itself. After perturbations and vegetation removal, daily soil temperature fluctuations can break seed physical dormancy, and thus can regulate germination timing. For example, germination will only occur after the dry period of summer and just during the first wet period of autumn. This gives the advantage that seedlings have all year to develop before the next dry period of summer. In this work, first, we present a field-based experiment where we introduced seeds just before and after an experimental fire. We aimed to ascertain which factor (fire vs summer temperatures) was the most determinant in determining seed dormancy breakage. Secondly, we present an study analyzing phylogenetic clustering at community level of species that present hardseededness along crossed gradients of fire frequency and aridity. Results indicate that climate and summer temperatures may have a more decisive role than previously though in selecting the hardseededness trait in the Mediterranean basin vegetation.

S.05-8-Oral

Revealing drivers of understory plant diversity under variable overstory cover in Mediterranean forests

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Mediterranean forests are increasingly managed for enhanced biodiversity and complexity. We studied patterns and mechanisms through which understory plant diversity is influenced by overstory cover in Mediterranean pine forests assessed by LAI (leaf area index).We asked: is the effect of overstory cover on understory species richness dependent on spatial scale? We approached this question experimentally by measuring understory species richness at variable spatial scales, throughout a range of overstory cover levels. The study was performed in the Kedoshim Long Term Ecological Research site located on the Jerusalem Mountains of Israel. Sixteen experimental plots (0.5 ha) thinned to variable overstory cover levels (LAI= 0 to 4 m2 m-2) were monitored for five years using hierarchical, nested sampling approach (0.01-400 m2). Understory richness increased linearly with overstory openness throughout the entire LAI range. This relationship became stronger with increasing spatial scale up to 100 m2, but moderated towards 400 m2. Understory composition varied among overstory openness levels, and this variation was most pronounced at the measurement scale of 10 m2. Higher contribution of vine and shrub species was linked to higher LAI, while contribution of annual species was more associated with lower LAI. Observed LAI-richness patterns pointed towards resource availability (light, water) rather than resource heterogeneity, as the main driver of understory diversity. Furthermore, spatial patterns pointed towards environmental filtering rather than plant density as the main mechanism through which higher resource availability encouraged diversity.

Session 06: Ecophysiology and functional traits

S.06-1-Invited Lecture

Space, time and traits: understanding climate change responses in relation to environmental gradients

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Plant distributions are shaped by environmental gradients from local to global scales, reflecting the interactions of climate and soils, plant traits, niche requirements, and biotic interactions. Climate change will alter local conditions, resulting in species dying out in some locations and potentially find newly suitable conditions outside their current range. In this talk, I will explore how these changes in local suitability may result in distributions shifts along a spectrum of environmental gradients, including latitude, elevation, maritime-continental climate, topography, and contrasting soils. Distribution shifts may compensate for climate change directly (e.g., moving to cooler locations in response to a warmer climate), or indirectly as factors interact to impact plant performance (e.g., higher moisture locations can offset warming). Teasing apart the mechanisms underlying responses is difficult due to the multiple dimensions of the environment and the plant niche, and uncertainties about the 'dark niche' (species tolerances under non-analog conditions that are not observable in the present-day). A synthesis of functional ecology and distribution modeling is needed to understand the shape of species niches along multiple environmental axes. This understanding, together with a improved mapping of environmental factors at multiple scales, will allow enhanced predictions of how a changing climate will impact distributions from local to regional scales. (PS I think I have indicated the right session - I have been invited as the plenary speaker)

S.06-2-Poster

Adaptive mechanisms of wheat landraces in Jordan to climate change

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Wheat is most important food grain source for humans. With the growing demands on wheat production and consumption, along with the increasing challenging environmental conditions such as global warming and decreasing water resources worldwide (specifically in Jordan), improving wheat growth and yield has become a serious issue. The aim of this study was to assess the effect of drought and heat stress simultaneously on Triticum durum landraces collected from Jordan. Plants were grown either under control condition for 10 days, or grown under control conditions for 5 days then under drought and heat stress for another 5 days. In general, drought and heat stresses reduced significantly most of the studied growth parameters (germination percentage, shoot length, root length and root number). However these abiotic stresses significantly increased proline, LPO and the transcript levels of stress responsive genes (DHN15.1, 3H9, HSP101 and HSP17.6) of all landraces with significant differences between landraces. Results show that the best adapted landrace to drought and heat stress is Wastayah. With minimum effect on shoot length, root length, roots number and MDA (91%, 87%, 105%, 129%, respectively relative to its control). Furthermore, Wastayah landrace showed the highest Proline accumulation rate (725% relative to its control), HSP101 (505% relative to its control) and HSP17.6 (3732% relative to its control) expression level. In conclusion, results indicate that one of the studied landraces (Wastayah) show adaptive mechanisms to drought and heat stress which could be used as a gene donor for wheat breeding programs to cope climate change consequences.

S.06-3-Poster

Contrasting ecophysiological responses of plant functional types to groundwater lowering in Mediterranean coastal ecosystems

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Groundwater lowering affects systems sensitive to water limitation as coastal dune ecosystems. It can produce dramatic changes on physiological performance or survival of plant species. The impact of drought due to climate change and groundwater extraction on coastal ecosystems has become of increasing concern, with uncertainties about how vegetation will respond over the short and long term. We aim to evaluate, in meso and thermo-Mediterranean coastal ecosystems under anthropogenic groundwater changes, the ecophysiological responses of different plant functional types. We hypothesize that climatic conditions and functional traits such as plant form, root system and water preferences will determine how plants respond to the groundwater gradient. We used an isotopic approach and reflectance indices to assess water sources used and plant physiological performance. Our study showed that functional types present different physiological patterns depending on climatic (mesic and xeric) conditions and we found that community responses to groundwater depth during dry season were influenced by functional traits, being water requirement an important attribute determining the ability to cope with atypical water limitation. Additionally, we showed that seasonal physiological variation is an important functional feature and can translate the capacity of plants to tune their physiology to changing conditions.

S.06-4-Oral

Combining multiple anatomical traits to identify cambial climatic constraints along Pinus pinaster climatic range

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Climate variability drives changes in the pace and intensity of cambial activity patterns that are registered in xylem anatomical traits. We explored how climate constrains cambial activity at different spatio-temporal scales by analyzing the effect of climatic factors through multiple anatomical proxies of cambial activity; earlywood width (EW), adjusted latewood width (LWadj), minimum and maximum wood density (Dmin, Dmax) and intra-annual wood density fluctuations (IADF) in Pinus pinaster Ait. along a 300 km gradient of increasing continentality, representing its climatic range, from warm and humid oceanic climate conditions at the Spanish Cantabrian Coast to continental climate at the Central Iberian Range. Cambial activity was very plastic with a high frequency of IADF (reaching 55% of the rings in coastal site). Although, there were differences in the timing of the climatic response of each anatomical trait along the gradient, the effect of trait type wiped out site effect in determining chronologies similarity with EW and density related chronology being discriminated from LWadj and IADF chronologies. Multiscalar SPEI analysis revealed the temporal complementarities in the signals of EW and LWadj; as well as the mostly short-term climatic signal of IADF. Dmax and Dmin had extremely high climatic signal (reaching nearly 50% for Dmin) showing a strong dendrochronological potential. This study reveals the ability of P. pinaster to grow under contrasting climatic conditions and the potential of combining multiple parameters to improve our understanding of cambial activity. Moreover, this work highlights the usefulness of Dmin as a climatic proxy in water-limited Mediterranean climates.

S.06-5-Poster

Phenotypic space of tree species responds to the canopy species richness

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Functional diversity, quantified by species functional traits, is often considered as a mean value for each species. However, traits are measured at the individual level and they are rarely fixed within a species. In fact, the distribution of their intraspecific variability (ITV), the functional space occupied, can be considered a proxy of its (realized) niche, and may give new insights into questions linked to the species coexistence, community assembly or their responses to global change. Here, we measured architectural traits in 1957 adult trees and leaf traits in 699 of four dominant tree species, Quercus ilex, Quercus faginea, Pinus sylvestris and Pinus nigra, in a Continental-Mediterranean forest in Alto Tajo Natural Park (Spain). The surveyed individuals were in forest patches at different levels of canopy diversity, going from monocultures to four-species mixtures. The aim of this study was to find out whether ITV of these species is related to the species richness reflecting the current level of species coexistence in the canopy. We used a multivariate approach generating hypervolumes (n-dimensional functional space) of the target species in monocultures vs mixed stands, using the least correlated traits. The results showed different responsiveness among species to the species richness, and shifts in the species phenotypic space suggesting that intraspecific variability may promote species coexistence by allowing individuals to adjust their traits in response to neighbours, and therefore, avoiding niche overlaps.

S.06-6-Poster

Drought and shrub invasion reduce transpiration and resilience of a Quercus suber ecosystem

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Shrub invasion is increasing in many regions worldwide and extreme events such as droughts are projected to increase in frequency and intensity, namely in the Mediterranean region. Nevertheless, little is known about how these drivers may interact and affect ecosystem functioning and resilience Using a manipulative shrub (Cistus ladanifer L.) removal experiment in a Mediterranean Quercus suber woodland, we show that the combination of native shrub invasion and extreme drought reduced ecosystem transpiration and the resilience of the key-stone oak tree species. We established six 25 x 25 m paired plots in a shrub encroached Mediterranean cork-oak woodland and measured sapflow and pre-dawn leaf water potential of trees and shrubs and soil water content in all plots during five years. Ecosystem transpiration was dominated by the water use of the invasive shrub, which further increased after the extreme drought year. Tree transpiration in invaded plots declined more sharply (67 ± 13 %) than in plots cleared from shrubs (31 ± 11%) relative to the pre-drought year (2011). Trees in invaded plots were not able to recover in the following wetter year showing lower resilience to the extreme drought event. Our results imply that in Mediterranean-type of climates invasion by water spending species coupled with extreme droughts events may cause critical drought tolerance thresholds of trees to be overcome, thus increasing the probability of tree mortality.

S.06-7-Poster

Near infrared spectroscopy and functional traits: its potential to unveil complex ecological questions in European forests

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Trait-based approaches are particularly useful to quantify and describe species niches by tracking plant functional traits related to individual performance. Approximately 25% of the total trait variation within plant communities worldwide is found within species (intraspecific trait variability, ITV). Quantifying ITV at large scales and determining the spatial structure of ITV would allow the identification of functional complementarity among individuals of the same species and the ways in which this variation affects coexistence. To assess complex questions such as the species-level niche differentiation we will use near infrared spectroscopy (NIR) for simultaneous determination at large scales of some key functional traits, like tree height, trunk diameter, wood density, sapwood, age, growth, bark thickness, specific leaf area, and many biochemical features. To calibrate NIR, we collected 100 samples from individuals of Pinus sylvestris growing in two populations at contrasting elevational sites in Sierra de Guadarrama (Spain). The functional traits were measured by traditional protocols in the field and in the laboratory and their spectral absorbance in the range of NIR recorded. We found that both parameters were correlated by regressing partial least squares (PLSR) to generate independent models for each of these traits. NIR provided rapid, cheap and non-destructive measurements of key functional traits, increasing the potential of trait-based studies. We are currently scaling up these calibrations to quantify ITV at population scale in a spatially explicit experimental design. Results will be also combined with extensive genotypic analyses to quantify the genetic signal of the observed phenotypic variability.

S.06-8-Poster

Priming effects on seed germination tolerance to water stress of eight Cistus species

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Mediterranean environments are water-controlled ecosystems and thus, timing of germination is mainly regulated by water availability. Buried seeds in soil are subjected to cycles of hydration-dehydration before germination finally occurs, usually, under water stress conditions. Overall, the term “priming” is used to describe the process by which organisms exposed to stress prepare and develop resistance for improving their response against future stress. In particular, seed priming consists in exposing the seeds to hydration-dehydration cycles, which can improve germination and stress-tolerance by two strategies. First, seed priming may promote the pre-germination metabolic processes. Second, seed priming may generate a moderate abiotic stress during both hydration and dehydration periods, which allow the seeds to cope with environmental stresses. In this work, we analyzed the response of eight Cistus species, to water stress conditions as well as to two priming treatments. Previous to priming treatments, seeds were exposed to a heat-shock for breaking seed physical dormancy. Then, seeds were hydrated-dehydrated for two periods, 24 and 48 hours. Finally, seeds were germinated under five different water stress conditions (0, -0.2, -0.4, -0.6 and -0.8 MPa). Germination of all species decreased with water stress but germination sensitivity was different for each species. Additionally, hydration-dehydration cycles improved germination and/or germination tolerance to water stress in five out of eight Cistus species. Although hydration-dehydration almost has not been studied for wild species, it seems to play an important role in facing drought and ensuring their viability under warmer future conditions projected by climate change in Mediterranean area.

S.06-9-Oral

How does the hemiparasitic scrub Osyris lanceolata obtain water from its hosts?

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Authors have described a set of convergent adaptations to water scarcity in Mediterranean plants: to escape, tolerate or avoid drought. A fourth strategy is to steal water from a host species. Hemiparasitic species form a haustorius embracing the root of the host species, from where they can obtain water and minerals, maintaining their photosynthetic activity. Osyris lanceolata is a hemiparasitic, dioecious scrub species. Its biogeographical area extends over the Mediterranean basin. Birds usually eat the fruits and through a perching effect deposit the seeds under a tree canopy. The aims of this study were: How do Osyris plants manage to obtain water from the host plant? Is there any negative physiological effect from this hemiparasitic relationship on the host plant? To perform these objectives we selected two study areas in the Asperillo stabilised dunes (SW Spain), one dominated by Pinus pinea and the other by Juniperus phoenicea in which O. lanceolata was well represented. In each site we marked 30 plants, 10 Osyris plants with their respective hosts and 10 free trees. Measurements (gas exchange, photochemical efficiency, pigments and proline content) were performed in spring and summer. The results showed that water potentials of O. lanceolata plants were always three times more negative that those of the host plants and they showed high accumulation of proline. Through this gradient the hemiparasitic plant is able to absorb water from the host. However, there were no significant differences in the physiological performance of the parasite face to the free plants.

S.06-10-Oral

Do Mediterranean legumes regulate N2 fixation?

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Dinitrogen (N2) fixation is a source of new nitrogen in ecosystems thus sustaining carbon storage, and shaping ecosystem biogeochemistry. Mediterranean ecosystems are home to an incredible diversity of annual and perennial legumes. Most of these legumes potentially fix N2 (in symbiosis with root bacteria). However, fixation patterns and strategies, and the environmental consequences of fixation in Mediterranean legumes are largely unresolved. Therefore, we studied: 1) Whether Mediterranean species differ in N2-fixation intensity and regulation as a function of soil nitrogen availability?, and 2) Are growth and fixation of Mediterranean N2-fixers constrained by phosphorus? We tested the effects of nitrogen and phosphorus availability on fixation rate, biomass production and biomass partitioning between shoot, root and nodules, in a controlled experiment, with four annual and five perennial legume species. All studied species fixed nitrogen, but differed in fixation rate and strategy. Perennial species down-regulated fixation in response to soil nitrogen availability, presenting a facultative strategy, while the annual species presented a diversity of fixation strategies, including obligatory. Regulation of fixation involved reduction in both nodulation and fixation rate within nodules, in most cases simultaneously. We found no clear effect of phosphorus on perennial species fixation. We conclude that the high physiological cost of fixation imposes the need to regulate fixation in perennial legumes in seasonal dry Mediterranean conditions, whilst annual legumes, growing only in the wet season, do not necessarily regulate their fixation effort. Apart of the direct effect on plant economy, N2 fixation strategies influence succession and function in Mediterranean ecosystems.

S.06-11-Poster

Is photosynthetic plasticity affected in current soybean genotypes relative to older ones or wild ancestors under drought?

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The “green revolution” resulted in an increase in world food production, at the expense of a significant loss of biodiversity. The world population in 2050 is estimated at 9000 million people. Moreover, the impact of stressful growth conditions, such as water stress represents a major challenge for current and near future crop developments. In this context, it is clear that food for the population should be guaranteed, but with the need to ensure proper conservation of agricultural biodiversity in order to ensure environmental sustainability. Therefore, the aim of this work is to study the photosynthetic plasticity of current high yielding soybean varieties (tolerant and sensitive to water stress) relative to older ones or to wild ancestors, in order to elucidate if breeding efforts focused in crop productivity, had a significant effect in the loss of plasticity in soybean plants exposed to mild drought (and thus loss of ability to cope with environmental conditions). The study was performed with nine different soybean genotypes (2 old, 5 current and 2 wild ancestors) that were subjected to mild drought stress. In addition to growth parameters, performance of photosynthetic apparatus and fluorescence parameters were analyzed. The results indicated that soybean was tolerant to drought but with significant differences between genotypes. Indeed, the observed decrease in photosynthetic parameters was due to stomata limitation. In this work, early markers of response to changing of the environmental conditions, as drought in soybean plants will be obtained in order to remark the value of conservating agricultural biodiversity.

S.06-12-Oral

Reading on the rays: Amount of tocopherol in ray parenchyma in tree rings shows a link to environmental factors

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While, traditionaly, most dendrocronological studies had focused on the hydraulic architecture of the xylem in the past, there is an increasing recognition of parenchyma’s relevance in xylem function. Recently, quantitative analyses of tocopherol concentration in parenchyma rays in combination with dendrochronological techniques has suggested its potential as a biomarker molecule to track past environmental stress (Fleta-Soriano et al. 2014). Our aim was to explore the changes in parenchymatic tocopherol in response to environmental stimuli. Specifically we aim to evaluate (i) the relationship between secondary growth and tocopherol concentration in the xylem and (ii) to assess the potential use of parenchymatic tocopherol as indicator of biotic stresses. We have detected alpha-tocopherol in all the 25 species from 22 different families analysed including angiosperms and conifers, trees, shrubs and climbers and proved the relationship between tocopherol content and abiotic factors (i.e. heavy rain episodes) in Populus. Additionally, we present preliminary data where chronologies and tocopherol contents in non-defoliated vs strongly defoliated cohabiting Pinus nigra trees (affected by the insect Thaumetopea pityocampa) are compared.

S.06-13-Poster

Distribution of pines in Europe is determined by differences in foliage frost tolerance but not in the xylem embolism vulnerability

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Drought and frost limit the function and distribution of plants. The objectives of this study were: 1) to analyze whether the distribution of six pine species in Europe is related to differences in seedling frost tolerance, 2) in case of frost tolerance differences, determine its physiological basis and 3) assess if the frost tolerance is affected by the water status of the plants. The frost temperature al which seedlings showed 50% mortality was lower in Pinus sylvestris, Pinus uncinata and Pinus nigra, than the typical Mediterranean pines (Pinus halepensis, Pinus pinea and Pinus pinaster). Similarly, pines that inhabit cold winter sites had less foliage damage (measured by electrolyte leakage) than the Mediterranean pines. In contrast, embolism caused by -15 ºC frosts was very low with no differences among species. Foliage frost damage depended on seedling water potential. Drought enhanced foliage frost damage in P. uncinata and P. pinaster. Conversely, drought reduced frost damage in P. pinea and P. sylvestris while drought had neutral effects on foliage frost tolerance in P. halepensis and P. nigra. Results indicate that intraspecific differences in foliage frost tolerance and not vulnerability to frost embolism could limit the distribution of Mediterranean pines at higher latitude and altitude in Europe.

S.06-14-Poster

Fragmentation in holm oak forests attenuates water stress even under extreme drought

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Fragmentation and summer drought are two of the main threats to Mediterranean forests. More frequent extreme droughts over the last decades have challenged plant tolerance to severe water stress and have increased alteration of natural habitats which are further compromising plant performance and survival. We hypothesized that trees at fragmented Mediterranean forests are suffering higher water stress during summer drought because they are more exposed to high radiation and temperatures due to edge effects that would prompt higher water losses by evapotranspiration. However, forest edges reduce intraspecific competition, allowing higher water availability, and tempering water stress. To test the alternative hypothesis that fragmentation may not exacerbate water stress under extreme drought in Mediterranean tree forests we monitored ecophysiological variables during two years in two holm oak (Quercus Ilex) forests archipelagos of the Iberian Peninsula. Water stress was highest in trees at forest interiors in both study forests. Trees at small forest fragments showed the highest predawn water potential, stomatal conductance and photochemical efficiency of photosystem II. During the intense summer drought those patterns were also observed and water stress was exacerbated much more at the forest interiors. Our results rejected our hypothesis and demonstrated that fragmentation attenuated water stress even under extreme drought. This study highlight the relevance of addressing at a local scale the interaction of extreme drought events with other driving forces of global change to elucidate the real tree tolerance to severe water stress and therefore, the potential evolution of Mediterranean forests in future.

S.06-15-Poster

Variation in leaf structural and chemical traits among 98 Mediterranean woody plant species

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Leaf structural and chemical traits are key attributes of plant growth ability, resource use efficiency and nutrient cycling. On this respect, the variation of foliar structure and chemical composition can be determined by different factors such as habitat type, growth form and evolutionary history. In this study, we evaluated how habitat association, leaf habit and phylogeny affected foliar structure and nutrient concentrations in 98 Mediterranean woody species growing in five types of forests and shrublands from South Spain. Our aim is to provide key aspects of leaf structure and nutrient composition in a highly diverse pool of woody plants on Mediterranean ecosystems, based on field data set. To this end, w We explored the spectrum of variation of one important leaf trait (leaf mass per area “LMA”) and its relationships with twelve leaf nutrients (N, C, P, B, Ca, Cu, Fe, K, Mg, Mn, S, Zn), and the stoichiometry of N:nutrient. Our results provided solid evidences that the overall foliar elemental composition and structure was conditioned by forest type, leaf habit and phylogeny. The results supported the existence of a leaf biochemical niche; originated by species specialization and evolutionary processes leading to adaptations to environmental conditions. Leaf trait distribution supported the general existence of the “leaf economic spectrum” in Mediterranean woody species for a broad number of leaf chemical and structural traits. In addition, our analyses showed that these leaf traits were highly coordinated, supporting thus the fundamental convergence in leaf formation and functioning

S.06-16-Poster

On the relationship between water potential regulation, stomatal behaviour and water transport in plants

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In this review we address the relationship between stomatal behaviour, water potential regulation and hydraulic transport in plants, focusing on the implications for the iso/anisohidric classification of plant drought responses at seasonal timescales. We first revise the history of the isohydry concept and its possible definitions. Then, we use published data to answer two main questions: (1) is greater stomatal control in response to decreasing water availability associated with a tighter regulation of leaf water potential (?L) across species? And (2) is there an association between tighter ?L regulation under drought (~isohydric behaviour) and lower leaf conductance over time? These two questions are addressed at two levels: across species growing in different sites and comparing only species coexisting at a given site. Our analyses show that, across species, a tight regulation of ?L is not necessarily associated with greater stomatal control or with more constrained assimilation during drought. Therefore, iso/anisohydry defined in terms of ?L regulation cannot be used as an indicator of a specific mechanism of drought-induced mortality or as a proxy for overall plant vulnerability to drought.

S.06-17-Poster

Intraspecific sensitivity to oxidative stress: physiological and morphological response to ozone across the latitudinal gradient of the evergreen oak Quercus ilex

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Tree species subjected to Mediterranean climate undergo high levels of oxidative stress, derived from high sun-light radiation, extreme temperatures, water shortage or air pollution. Despite recent insights on the species response to these oxidative stressors, the intra-specific variability in plant sensitivity to air pollution (such as tropospheric ozone) is still poorly understood. However, under a global change scenario, where species are likely to become more vulnerable to air pollutants, this knowledge is mandatory in order to assess whether populations within a given species hold enough adaptive capacity to cope with this stressor. In this communication we discuss the results of the intraspecific sensitivity to ozone of some key functional traits in Holm oak (Quercus ilex L.), the dominant evergreen tree species in the Mediterranean Basin landscapes. For this purpose, we gathered acorns from 12 Q. ilex populations covering the species latitudinal range (from South France to South Morocco). Seedlings grown from acorns were fumigated (80 ppb ozone in air) during three months under controlled (growth chamber) conditions. Ozone treatment decreased both photosynthetic rate (39%) and actual quantum yield of PSII photochemistry (50%); and increased non-photochemical quenching (98%). Q. ilex populations showed high heterogeneity on the sensitivity to ozone stress, with those native to the range edges displaying the lowest reduction of the photosynthetic performance. The higher tolerance of bordering populations seems to be related to their inherent lower stomatal conductance, as well as putative higher constitutive defensive endowments.

S.06-18-Poster

Chlorophyllous spores, is “die or dry” a dilemma?

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Fern spores can be classified in two main groups depending on whether they contain or not chlorophyll. Chlorophyllous spores have the advantage of being ready for germination, but is assumed that this occurs at expenses of a higher sensitivity to desiccation, which greatly limits its dispersal capacity. In the present study we aim to establish which are the limits of desiccation tolerance for the chlorophyllous spores of Osmunda regalis. In the sporangium, at the time of maturation, spore water content (WC) was 0.26 g water g-1DW, a WC equivalent to that obtained in equilibrium with an atmosphere of 80%RH. This WC is well above the physical limit of molecular mobility, the so-called glassy state (estimated by DMTA in approximately 0.12 g water g-1DW at 25 °C). When the spores were equilibrated at different RH, no loss of germination or decrease on photochemical efficiency (Fv/Fm) was observed, even under the driest conditions (8% RH). RHs below 50%, which are not uncommon in the study area, resulted on WCs within the range of the glassy state. However, when the spores were wetted with liquid water, the capacity to tolerate a new desiccation cycle was reduced after the driest treatments. Interestingly, once the germination started, the capacity to tolerate desiccation in the gametophyte was complete lost, as occurred in the sporophyte. These results demonstrate that Osmunda spores are fully desiccation tolerant, but also have important implications for the protocols of spore conservation in germplasm banks.

S.06-19-Poster

Xylem anatomy along a rainfall gradient reflects common responses at multi-species level

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Environment either filters particular phenotypes from a species or species from the regional pool. Thus, some tree species modify their hydraulic system to cope with varying spatio-temporal climatic constraints. Understanding how trees adapt along their distribution ranges is critical to develop vegetation models able to predict shifts on species distribution areas due to climate change. We explored variations in xylem anatomy, a critical component of the tree hydraulic system, along an abrupt rainfall gradient in the Chilean Patagonia (from 2500 mm to 600 mm of annual precipitation), in order to determine general trends in xylem adjustments. We selected three study areas and four sampling sites per area. Two generalist and two specialist species were sampled in each study area (eight species in total). We evaluated xylem anatomy in permanent histological preparations of branch sections to obtain information on vessel size and position that allowed estimating vessel density, grouping and hydraulic conductivity. A consistent regional trend associated to rainfall appeared: when rainfall decreased, mean vessel size decreased but vessel density and grouping increased. In contrast, neither percentage of conductive area, nor hydraulic conductivity per area varied along the gradient. These results suggest the existence of common responses to water availability beyond the generalist–specialist character of woody species; the environment selects similar traits at the within and across–species level. Apparently, increases in hydraulic safety of xylem anatomy were not linked to a decrease in conductivity, suggesting a poor trade-off between both components of hydraulic system functionality at this scale.

S.06-20-Oral

The unexpected contribution of bryophytes to the global COS budget

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Carbonyl sulphide serves a tracer of gross primary productivity (photosynthesis) and nocturnal stomatal aperture, provided that COS flux is unidirectional and that carbonic anhydrase (CA, responsible for COS uptake) is light independent. These assumptions cannot be tested in plants where stomata close at night, but in astomatous bryophytes gas exchange is only limited by diffusion through capillary water or by hydration. In bryophytes, net COS fluxes in the light and in the dark should mimic those of CO2 in the light as (1) stomata cannot limit COS uptake, (2) CA is light independent and (3) COS flux into the vegetation is assumed unidirectional. We measured COS, H2O and CO2 fluxes in bryophytes in the light and in the dark, through complete desiccation and with decreasing [COS]. In the light, as capillary water evaporated, CO2 and COS uptake increased to a maximum and as dehydration continued CO2 uptake decreased towards 0, whereas net COS flux went from uptake to emission. In the dark, net COS uptake was greater than in the light and little or no net COS emission was observed near dehydration. COS uptake increased with [COS] at a similar rate in the light and in the dark, but COS emission at minimal [COS] (0±5 ppt) was greater in the light. We show that bryophytes have an expected contribution to COS cycling: they act as sinks at night and sources in the light. We suggest that GPP from COS uptake could be overestimated in areas where biological crusts dominate biogeocycles

S.06-21-Poster

Coexisting oak species show higher adaptive responses to new environmental conditions in xeric than in mesic forests

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The ability of individual tree species to cope with climate change is a pivotal feature of forest ecosystems to evaluate their current and future threats. We compared xylem traits of Quercus robur and Quercus pyrenaica coexisting in a mesic and a xeric forest in north Spain to study their adaptive responses to the environment and adjustments to climate variability. We further tested whether growth was related to xylem anatomy and possible links with stomatal conductance (gs) and photosynthetic rates (A), both inferred from the dual-isotope approach (i.e. using carbon isotope discrimination and oxygen isotopic composition: ?13C and d18O, respectively). Annual time series (1960-2008) of ring width, earlywood anatomical traits, latewood ?13C and d18O were built. Both sites experienced lower water availability in recent years. Q. robur showed the highest growth in the mesic forest explained by higher A and equal gs than those of Q. pyrenaica. The study species had similar growth and physiological functioning at the xeric forest. Trees decreased gs in recent years, which coupled to lower (xeric) and constant (mesic) ?13C point to stable A in the xeric forest but decreasing in the mesic one. A lack of connection between xylem anatomy and physiological performance was generally found except for Q. pyrenaica in the mesic forest. Both species show adaptive responses to contrasting environments. However, trees from the mesic forest seem to be more sensitive to lower water availability in recent years, whereas trees from the xeric site seem to show better adjustments to increasingly drier conditions.

S.06-22-Oral

Functional trait diversity maximizes ecosystem multifunctionality in global drylands

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Global threats to biodiversity make it important to understand the relationship between biodiversity and ecosystem functioning. A key hypothesis is that differences in functional traits — any measurable morphological or physiological attributes of a species — determine species coexistence and ecosystems ability to maintain multiple functions simultaneously (multifunctionality). Yet, how trait differences scales to ecosystem functioning have never been assess at a global scale. In a global survey of 124 dryland plant communities spread over all continents except Antarctica, we found a unique scaling relationship between functional trait diversity and multifunctionality. At the biome scale, we identified a strong relationship between the skewness and the kurtosis of the abundance distribution of two key functional trait, specific leaf area and maximum plant height. The observed skewness-kurtosis relationships predicted a strikingly high trait diversity to occur within dryland plant communities which was associated with a local maximization of ecosystem multifunctionality. Any departure from the biome-scale distribution led to a sharp decline in multifunctionality. Trait diversity had a much stronger impact on ecosystem functions than did plant species richness, abiotic factors such as aridity, and other variables hypothesized to affect multifunctionality. We uncovered a general scaling relationship that quantifies how much plant diversity is required to maximize multifunctionality in global drylands. The scaling relationship identified here may therefore provide goals and guidelines to anticipate and mitigate the functional consequences of biodiversity loss in terrestrial ecosystems.

S.06-23-Poster

Focusing on individual species reveals the specific nature of assembly mechanisms in a tropical dry-forest

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Focusing on "how do individual species respond to" and "what effects do they exert on" the diversity structure of the community at an ample range of spatial scales could provide definitive insights into community assembly processes. We employ the framework of individual diversity-area relationship functions to analyze the relationships of individual species of the dry tropical forest with three aspects of community structure, taxonomic (TD), functional (FD) and phylogenetic (PD) diversities along spatial scales. These functions could information provide about the incidence of neutral or niche processes in community assembly. We found that although when considering just any arbitrary spatial scale most species appeared as independent (i.e., neutral) with respect to TD, FD and TD. But when considering the whole range of spatial scales, most species either accumulated or repelled diversity more than expected by the null models of species distributions. Within the non-neutral species, 35% of them had higher TD and FD than expected in their fine-scale neighborhoods, which suggests the existence of rich species clumped spots, which are consequence of competitive and not facilitative processes. The existence of some species surrounded by low TD and FD suggest that environmental filtering effects are also ruling community assembly in this forest. We found also a contrasting pattern for non-neutral species, with species that accumulate FD in their neighborhoods being surrounded by less PD than expected. This result suggests that the distribution of values for the studied functional traits is the consequence of a divergent evolution in response to competitive processes.

S.06-24-Oral

Linking hyperspectral imaging and ecophysiological traits for detecting oak forest decline at an early stage

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Processes of widespread oak mortality have been described in recent years, being mainly attributed to complex interactions of abiotic and biotic factors such as extreme rainfall events, severe droughts, affections of the fungus Phytophthora cinnamomi, and overexploitation of the agroforestry ecosystems dehesas. Long-term stressed trees combined with high temperatures and levels of radiation causes a depression of photosynthesis and efficiency of photosystem II, which is not easily reversible even in resistant species such as Mediterranean oaks. Some authors have shown that the stress level is related to transpirational and biochemical alterations of trees, undergoing an early stomatal closure and a widespread degradation of basic pigment concentration. We propose an innovative methodology based on high-resolution hyperspectral sensors and ecophysiological data for parameterization of forest health status. Early detection of processes leading to forest decline will be performed based on the quantification of the main biochemical variables regulating forest physiological condition using hyperspectral image information. Thus, this study has required physiological field measurements, biochemical analysis of leaves and high-resolution airborne hyperspectral images acquired by airborne remote sensing platforms. Our results showed water potentials, photosynthetic rates and VAZ pigment concentrations were related to hyperspectral indices and thermal data, depending on crown exposure, time of the day and season. These results open new possibilities on the early detection of dieback process, which will be a major technological advance in systems management of the natural environment.

S.06-25-Poster

Assessment of key physiological traits determining diffusional limitations of photosynthesis through stomatal conductance regulation under future climate change conditions

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Future climate changes are expected to include increases in temperature, CO2 and aridity in the Mediterranean area. Photosynthesis, and hence plant function and growth, are expected to be seriously limited under those conditions and, even, to compromise plant survival. Although intense modelling efforts have been conducted on assessing the effect of climate change on photosynthesis considering biochemical factors, like Rubisco kinetics, the main limiting factors under drought conditions have been proven to be diffusional, but they have not been so thoroughly evaluated yet. Diffusional restrictions involve both stomatal and mesophyll conductance, but only the latter one has drawn most of the attention in recent simulations. One of the reasons for this lack of analysis of the effect of climate change in stomatal conductance was the absence of a mechanistic model of stomata response to environmental conditions. Our objective was to use a recently published mechanistic model of stomatal conductance to identify the major physiological traits that determine the regulation of stomatal conductance and their sensitivity to warmer and more arid conditions in olive and grapevine, two species with different hydraulic characteristics. Our results show that species with a high hydraulic capacity would cope better with an increase in temperature and air vapour pressure deficit than those with a low one. However, olive would be less affected than grapevine by water availability. The trade-off between hydraulic capacity and vulnerability to cavitation poses a limit in the capacity of species with high hydraulic capacity for osmotic adjustment in response to water stress.

S.06-26-Poster

Föhn effects in the Andes shape assemblages of lizards

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Tropical easterlies in South America bring humidity to the Andean ecosystems. When air masses meet the rising terrain, different climatic conditions appear in the divide, the windward and the leeward sides. This is known as the Föhn effect. We expected this climatic heterogeneity to be reflected in the species composition of assemblages of ectotherms. Lizards were surveyed at different elevations (3600–4300m), slopes and aspects in the leeward (western) side of Cordillera de Sama, southern Bolivia. Operative temperature time series were recorded in models attached to dataloggers. Preferred temperatures were measured with some lizards in thermal gradients in laboratory. Different exposure to clouds and fogs in the complex topography of the Cordillera de Sama, created a strong thermal heterogeneity in a reduced spatial scale. We found four species of the genus Liolaemus, from the most the less thermophilous: L. ornatus, L. puna, L. aff. pantherinus and L. orientalis. The highest densities of the three most thermophilous were observed in the lowest sites; while lower densities of L. puna, L. ornatus and L. orientalis were found in intermediate and higher sites. Particularly L. orientalis was only observed in the coldest sites, which were those more exposed to fogs. L. aff. pantherinus was restricted to habitats only found in lowlands, while L. puna and L. ornatus were spread along the elevation gradient in most of the habitats. Both hydric and thermal physiology and habitat preferences are key parameters to understand the distribution of reptiles at small scales.

S.06-27-Poster

Deciphering the ecophysiological traits involved during water stress acclimation and recovery of the threatened wild carnation, Dianthus inoxianus

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Dianthus inoxianus is an endangered species endemic from a small littoral area in the SW Spain, with an unusual flowering season under the adverse conditions of dry Mediterranean summer. A greenhouse experiment was designed to assess the physiological traits involved in drought acclimation and recovery of 3-month-old plants. The evolution of plant water status, leaf gas exchange, chlorophyll fluorescence, photosynthetic pigments concentrations and a quantitative analysis of photosynthesis limitations were followed during water stress and re-watering. Our results indicated that plant water status values only decreased at the end of the drought period, together with the net photosynthetic rate. Photosynthetic impair was mainly caused by diffusional limitations of CO2, as indicated the joint and marked decrease of stomatal and mesophyll conductance and intercellular CO2 concentration during drought period, while the maximum carboxylation efficiency of Rubisco did not vary. After rewatering, leaf water status recovered faster than photosynthetic one, reaching control values on day 1 after recovery instead on day 7. Additionally, stomatal conductance showed the slowest recovery taking 15 days, but the decrease was enough to keep plant water status variables at constant values throughout the experiment. Results suggest a high tolerance and recovery of D. inoxianus from severe drought periods. This drought tolerance was also reflected in the stability of its photochemical apparatus (actual and maximum photochemical efficiency of PSII) and pigments concentrations, as indicated the constant values showed through the whole experiment. Conservation management of this endangered species is discussed in the context of future global climate change.

S.06-28-Oral

Plasticity in plant hydraulic traits: do we know what is going on?

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In addition to rapid evolution and to dispersal mechanisms, plasticity is often mentioned in the scientific literature as one of the few main processes available to plants in order to respond to climate change. Although the concept of plasticity goes back several decades, significant understanding of its ecological significance has occurred only in the past two decades. This is especially true for plant hydraulics. We contend a globally-wide perspective of the patterns regulating plasticity in plant hydraulic traits is currently missing. We identify the main constraints that limited available generalisations regarding plasticity and acclimation in plant hydraulics and argue that this knowledge gap needs to be urgently filled to help improve our basic understanding of plant functioning and help respond to pressing questions related to our ability to predict terrestrial ecosystem responses to global change-related challenges. Basic questions to be addressed relate to the following areas: the relationship between hydraulic traits showing substantial plasticity versus those showing substantial invariance; the measurement and significance of acclimation in plant hydraulic traits; the balance between physiological and structural acclimation; the significance of plasticity at scales varying from microscopic changes in wood and cellular properties to whole-plant changes in functional balance; the relationship between phenotypic plasticity and individual- and population-level genetic variability. Preliminary results from a global meta-analysis of plasticity in plant hydraulic traits will be presented, with an emphasis on trends specific to Mediterranean ecosystems. Further ways in which these analyses may be developed will also be discussed.

S.06-29-Poster

The profitability of leaves, an economic analogy

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We follow an economic approach of the leaves considering it as a process of economic investment with a construction cost (the leaf mass per area, LMA, g m-2) and maintenance costs, both of which have to be covered by production, to generate profits or economic returns. These costs should be offset by gains by photosynthesis, and must produce some additional benefits to ensure the survival and growth of the rest of the plant. Kikuzawa (1991) proposed a theoretical model to determine the leaf longevity by the balance of construction cost, gains and losses. Following this approach and using data from the Leaf Economic Spectrum (LES, Wright et al. 2004), we determined the leaf economic profitability by estimating the rate of return of the investment process (TIR) of a leaf. TIR is the percentage of investment in construction of the leaf obtained daily as surpluses and therefore it can be allocated to manufacture other leaves or other plant parts. Our results show that leaf of deciduous species have higher TIR values (6%) than those of evergreen species (2%). The results show that profitability is negatively related to the construction costs (LMA) and positively related to gains by photosynthesis, as proposed by Kikuzawa. However, variation in TIR was not explained by differences in respiratory cost, which is contrary to the Kikuzawa model. The results are compared with TIR data of Spanish companies, and the similarities between the patterns of leaves and companies are discussed

S.06-30-Poster

Effects of myxoma virus and rabbit hemorrhagic disease virus' immunity on wild European rabbits oxidative stress status

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The wild European rabbit (Oryctolagus cuniculus) is one of the most important vertebrate species in the Mediterranean ecosystem. In the recent decades, the arrival of two important viral diseases, myxomatosis and rabbit hemorrhagic disease (RHD), have led wild rabbit populations to a dramatic decline in the Iberian Peninsula. Although at present these diseases have become endemic, periodic outbreaks still occur with substantial impact on wild populations. Physiologically, infections with myxoma virus (MV) and rabbit hemorrhagic disease virus (RHDV) encompass diverse effects on their hosts derived from aerobic metabolism. To fight off these viruses, rabbits activate the immune system. But production of immune defense generates reactive oxygen species (ROS) involved in killing pathogens that as a negative side effect can also damage host tissues(immuno-pathology). This extensive oxidative damage increases consequently oxidative stress status. Based on the hypothesis that immune response increases oxidative stress, we aimed to test if rabbits infected naturally with MV and RHDV that develop immunity have high oxidative stress. Thus, we carried out seven live-trapping sessions in three wild rabbit populations over a two-year period. Blood samples were collected to measure anti-MV and anti-RHDV antibody concentrations and to measure oxidative stress markers related to antioxidant system and proteins and lipids damage. Definitely, this is an important study about oxidative stress as a currency for quantifying physiological costs these viral diseases impinge on wild rabbits. Further research disentangling consequences of oxidative damage for the health and for the biological fitness is pivotal to ensure the viability of natural populations.

S.06-31-Poster

Influence of vapour pressure deficit in leaf turgor pressure measured in olive shoots with and without fruits

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The Mediterranean Basin is one of the hot-spot of biodiversity and climate in the world where the climate change constitutes a threat for agro-ecosystems such as the olive orchards. The actual tendency of increasing plant density in these orchards requires increasing water amounts for irrigation. According to predictions of the Intergovernmental Panel of Climate Change (IPCC, 2015), increasing atmospheric demand and decreasing rainfall are expected. In this human-driven scenario, studies on the physiological response of olives under irrigation to harsh environmental conditions are welcome for a rational use of water. Leaf turgor related measurements can now be easily made under field conditions thanks to the recently developed LPCP probe. Previous years findings showed that the maximum daily turgor of the leaves decreased along the dry season, even in trees under non-limiting soil water conditions. Our aim was to explore the reasons behind of this dynamic of turgor. Two hypotheses were tested: 1) a direct effect of the seasonal maximum daily VPD (VPDmax); 2) the presence of nearby fruits. Our results showed that the seasonal evolution of maximum leaf turgor was related to both factors VPD and fruits. The different stages of fruit growth and oil synthesis imposed a moderate stress in the plant, even under well-watered conditions, highlighting the sensitivity of LPCP probes to water status of the plant.

S.06-32-Poster

Growth and physiological responses of the halophyte Salicornia ramosissima to CO2 enrichment and salinity

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Climate change emerges as one of the biggest challenges for sustaining global food security so it is crucial to research about alternative crops; species capable of growing in hostile environments (salinity and water deficit). In this respect halophyte plants, like Salicornia ramosissima, may be considered because they possess morphological and physiological traits that allow them to survive against rough conditions. A glasshouse experiment was design to study the growth and physiological response of the halophyte Salicornia ramosissima, selected for its commercial interests as practical crop, in synergistic conditions of elevated CO2 (400 and 700 ppm) and salinity (0, 171, 510 mM NaCl). Gas exchange, efficiency of PSII, photosynthetic pigments profiles, carbon isotopic discrimination and antioxidant enzymatic activity were measure to follow the physiological state of the plants. Our results revealed that S. ramosissima was able to maintain its growth even at salinities of 510 mM NaCl or 700 ppm of CO2, since there was no significant difference between any treatments in the relative growth rate, RGR, although it was lower at 0 mM NaCl. Also, our preliminary results showed a positive effect on S. ramosissima development at 700 ppm CO2, in terms of enhancement of chlorophyll a and b concentrations and modulation of its antioxidant enzymatic activity which was showed by the superoxide dismutase.

S.06-33-Oral

A global test of the environmental filtering concept for the functional trait diversity in drylands

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The environmental filtering hypothesis refers to the effect of abiotic environment in sorting species with a similar set of trait values to establish, grow and persist in a community. We tested this hypothesis by assessing the effect of multiple climatic and edaphic gradients, and their interactions on the functional diversity of 124 dryland communities spread over the globe. We identified the particular set of conditions under which the environmental filtering hypothesis operates at global scale in drylands. Even under prevailing environmental filtering, our study also revealed that species with functionally contrasting strategies can still co-occur locally. Interactions between sources of environmental stress should be therefore included in global trait-based studies, as this will help to further anticipate where the effects of environmental filtering will impact plant trait diversity under climate change.

S.06-34-Oral

SAPFLUXNET, the first global database of sap flow measurements: how well are Mediterranean-type ecosystems represented?

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Plant transpiration is the main evaporative flux from terrestrial ecosystems, it controls land surface energy balance, determines catchment hydrology and influences regional and global climate. Transpiration regulation by plants underlies vegetation drought responses and land evap_orative fluxes, two processes that may be significantly altered by global change. Increases in climatic aridity and in the occurrence of drought events have been predicted for many Mediterranean-Type Ecosystems (MTEs). Myriad studies have applied thermometric sap flow measurements to analyse temporal patterns (from diurnal to seasonal and interannual) and environmental regulation of transpiration all over the world, but syntheses of sap flow data at regional to global scales are still lacking. We are compiling the first global database of sap flow measurements in individual plants (SAPFLUXNET), with a potential coverage of hundreds of species and sites. Here we report the geographic and climatic distribution of the datasets contributed thus far, highlighting the coverage of MTEs compared to other terrestrial biomes. While the number of datasets from MTEs is good overall, some geographical gaps have been identified. We also present the distribution of datasets according to measurement method, species, functional groups and plant size attributes, both globally and within MTEs. For MTEs, we show examples of seasonal patterns of transpiration and of water use traits extracted from the response of sap flow to fluctuations in water supply and demand. SAPFLUXNET is thus a promising resource to investigate the physiological and environmental controls on transpiration by whole plants and stands.

S.06-35-Oral

Intraspecific variation in seasonally-dry climates: a comparison of drought response strategies of oaks (Quercus) in Mediterranean and seasonally dry Neotropical regions

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Mediterranean and dry tropical ecosystems are characterized by a marked seasonality in rainfall, with a period in which precipitation is lower than potential evapotranspiration. Despite similar patterns of rainfall, these ecosystems differ in winter temperatures, which can limit carbon assimilation in Mediterreanean-type climates during this period. Based on a literature review plus analyses of new unpublished data on oak species from the Mediterranean Basin and Mesoamerican dry tropics, this study synthesizes the patterns of intraspecific variation in leaf traits across precipitation and temperature gradients in these ecosystems. Overall, we find high intraspecific variation in functional traits in both Mediterranean and tropical oaks. Mediterranean species from xeric environments tend to have small sclerophyllous leaves with increased osmotic adjustment, consistent with a drought tolerance strategy. Neotropical species exhibit the opposite pattern, with populations from climates characterized by long, severe dry seasons exhibiting large mesophyllous leaves (low leaf thickness and high specific leaf area) and high growth rates in the wet season. Interestingly, these populations respond to drought by increasing leaf shedding and reducing leaf surface area and transpiration rather than increasing drought tolerance via osmotic adjustment. Together our results suggest that xeric populations from Mediterranean species have evolved towards drought tolerant strategies whereas populations of dry tropical oak species from particularly severe dry seasons tend to reduce photosynthetic activity during the dry season but increase growth during the wet season. Such responses associated with differences among climatic regimes may be a consequence of selection under contrasting temperatures during the wet season.

S.06-36-Poster

Increased water deficit decreases Douglas-fir growth throughout western US forests

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Changes in tree growth rates can affect tree mortality and forest feedbacks to the global carbon cycle. As air temperature increases, evaporative demand also increases, increasing effective drought in forest ecosystems. Using a spatially comprehensive network of Douglas-fir (Pseudotsuga menziesii) chronologies from 122 locations that represent distinct climate environments in the western United States (US), we show that increased temperature decreases growth via vapor pressure deficit (VPD) across all latitudes. Using an ensemble of global circulation models, we project an increase in both the mean VPD associated with the lowest growth extremes and the probability of exceeding these VPD values. As temperature continues to increase in future decades, we can expect deficit-related stress to increase and consequently Douglas-fir growth to decrease throughout its US range.

S.06-37-Poster

Ecophysiological impact of arbuscular mycorrhiza inoculation on Arundo donax, a promising biomass crop

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The interest of biofuels has increased in the last decade as an alternative to non-renewable energy sources. However, biofuels presented several social, economic and ecological costs, like competitiveness with food crops and high water and fertilizer needs. The second-generation biofuels based on perennial grasses such as Arundo donax (giant reed) are non-food plant species that should be able to produce large amounts of biomass with low inputs and presented high adaptability to marginal lands. Giant reed is able to adapt to different soil conditions and presents high biomass production under low fertility conditions in Mediterranean areas. However, one of the handicaps of giant reed may be is its sensitivity to lack of water and nutrients during the early stages of growth. Arbuscular mycorrhizal fungi (AM) symbiosis has been demonstrated to increase resistance to biotic and abiotic soil stresses in a variety of host plants. In this scenario, the aim of this study was to obtain a global picture of the impact of AM colonization on giant reed plantlets in early stages under drought stress (salinity and water stress) and lower nutrient inputs. Plant responses were evaluated through the study of the photosynthesis and respiration in vivo and on the levels of primary metabolites, nutritional status and biomass accumulation. AM inoculation represent a valuable tool to increase the successful implementation and increase crop biomass of giant reed on marginal lands, increasing plant performance under salt stress and water deficit conditions.

S.06-38-Oral

Integrating hydraulic traits into functional traits framework to predict drought vulnerability at the global scale

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Drought-induced tree mortality is emerging as a global concern. Because more frequent and intense droughts are predicted, particularly in the Mediterranean basin, it is essential to identify the traits determining drought resistance. A worldwide spectrum of correlated leaf traits has been identified defining plant strategies and affecting global patterns of nutrient cycling and primary productivity. Plant hydraulic traits, however, are not considered within this spectrum, although they determine the capacity of plants to transport water from the soil to the leaves, their water use efficiency and, ultimately, their growth and survival. We have compiled a global dataset containing ~2000 species and integrating key hydraulic traits (vulnerability to xylem embolism, leaf water potential at the turgor loss point, minimum leaf water potential and hydraulic conductivity) with more standard functional traits (specific leaf area, wood density, nitrogen concentration, Huber value and maximum plant height) to assess trait variability, relations and trade-offs. Water use efficiency, a key integrative measure of multiple water- and carbon-related tradeoffs was also included. Our results suggest that a negative correlation between specific leaf area and Huber value plays a key role in linking traits related to xylem safety with those related to xylem efficiency, reflecting an overall trade-off between fast growth and resistance to stress. This new framework will contribute to the development of more realistic dynamic global vegetation models capable of predicting changes in vegetation composition and dynamics under changing climate conditions. The role of Mediterranean vegetation will be highlighted using examples from this new global database.

S.06-39-Poster

Phenotypic plasticity to ENSO and Non-ENSO rainfall regimes in Prosopis pallida populations of North Peru

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The North Peruvian dry forests suffer a high climatic variability marked by extreme rain events during El Niño–Southern Oscillation (ENSO) and long dry periods with very low annual precipitation. Prosopis pallida, the most representative tree species in these ecosystems, should have plastic traits to grow and survive under these two contrasting conditions. We studied phenotypic plasticity at two levels of water availability, simulating ENSO and Non-ENSO rainfall, in a greenhouse experiment using seven P. pallida populations from a climatic gradient. Total biomass, biomass allocation, morphological traits and water related traits were measured and compared between populations using a phenotypic plasticity index (RDPI). Phenotypic plasticity was significantly different between populations and traits, suggesting that each population have different response to water availability. Phenotypic plasticity was highly correlated to plant performance. Root ratio RDPI was positively correlated to shoot/root ratio under high water availability, and negatively correlated to shoot/root ratio under low water availability, suggesting that root ratio RDPI regulates plant metabolism and energy conservation according to water availability. WUE under low water availability was positively correlated to WUE in field conditions under Non-ENSO conditions, both of which were highly correlated to mean annual temperature of the origin of populations. We conclude that phenotypic plasticity to water availability explains how P. pallida strategies deal with rainfall variation during the ENSO, enhancing water conservation strategies under detrimental periods, while increasing aboveground biomass under high water availability.

S.06-40-Oral

The winter is coming: plant freezing resistance as a key functional trait for the assembly of annual Mediterranean communities

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Since Mediterranean annual plants need to survive winter freezing temperatures to become better ranked at the beginning of the spring growing season, it is surprising that the effect of freezing events as an abiotic determinant of these communities has not been assessed yet. Here, we recorded during three years the abundance of annual species in 120 plots located in a semiarid Mediterranean steppe (Spain). The response of community functional structure related to the Lethal Temperature causing 50% frost damage (LT50 trait) was summarized as CWM-LT50 and FD-LT50 and assessed against rabbit density, influence of perennial species (Stipa tenacissima) and three spring irrigation treatments. Most of annual species studied had LT50 values around the absolute minimum temperature for the 3-years studied. Functional attributes varied significantly among years and high rabbit densities led to lower CWM-LT50 and higher FD-LT50 values. Stipa influence and irrigation treatments had no effect on any attribute but plots under the influence of Stipa showed higher CWM-LT50 for one year. Our outcomes denote the markedly high freezing resistance of winter annual species and suggest the presence of an historic environmental filtering linked to winter freezing events. In turn, changing environmental conditions, presence of rabbits and Stipa tussocks modulate the functional structure related to freezing resistance suggesting that: i) assembly of these communities responds to inter-annual variation in environmental conditions; ii) plant traits that allow to thrive herbivory may also promote freezing resistance; iii) tussocks can act as nurses by producing a microclimatic amelioration in winter.

S.06-41-Oral

Climatic events inducing die-off in Mediterranean shrublands: variation in functional traits related to defoliacion?

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Extreme weather episodes associated to climate change often result in profound alterations of ecosystems and, particularly, vegetation die-off. Species' functional traits are able to explain biological responses to environmental alterations. Here we explored how both inter and intra-specific variability in functional traits are related to changes in remaining green cover after a prolonged drought in the Mediterranean shrubland of Monegros (Ebro Central Valley, Spain). We sampled ten individuals with different levels of canopy loss (die-off) in twenty coexisting species and measured the following traits: specific leaf area, leaf dry matter and nutrient contents (N, C, P), non-structural carbohydrates (NSCs) in shoots and roots, wood density, and specific root length. We also measured the overall pattern of affectation by die-off in the area for most of these species. We found that die-off responses are associated to some functional traits. Particularly, NSCs differ between species according to functional traits related to growth and leaf phenology/ longevity. NSC stocks were not as high in fast-growing, low wood density species as in slow-growing ones. Thus, suggesting that they do not rely on underground organs in an environmental context involving higher aridity and climatic variability.

S.06-42-Oral

Testing the fast-slow economic spectrum hypothesis in plant communities of the Atacama Desert located along a rainfall gradient: above- and below-ground functional trait diversity

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The study of root traits and their relationship with aboveground traits can be particularly important for understanding how different species persist in arid environments, and ultimately how plant communities are organized. It has been hypothesized that strong selection along trait and life-history trade-off axes results in convergence for any taxon on a uniformly fast, medium or slow strategy for resource acquisition among all organs. Moreover, along resource gradients, it is expected that species having fast traits (i.e., 'fast' taxa) should be more prevalent towards in high-resource environments, whereas the opposite pattern should be observed for slow taxa, because resource conservation enhances survival in resource limited environments. The main objective of this study is to test the generality of the fast-slow economic spectrum hypothesis within and between plant communities of the Atacama Desert located along a rainfall gradient. We characterized different above- and below-ground functional traits of 10 to 15 dominant shrub species naturally growing in each of four localities along a precipitation gradient (from 14 to 80 mm, 30 years mean). Data revealed that shrub communities have more superficial and extensive root systems toward the most arid environments, as well as greater root / shoot ratio and, lower specific leaf area and specific root length. However, there were only few changes in drought-tolerance stem traits along the gradient. Our results do not provide strong evidence that support the predictions of the Fast-Slow Economy Spectrum Theory. Projects FONDECYT 1151020, ICM P05-002, CONICYT PFB 23, CONICYT Doctoral Fellowships 21140050 & 21150334.

S.06-43-Oral

Resprouting ability encapsulates the most functional variability in the Mediterranean Basin flora

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Growth form is considered among the most important traits in plants. We hypothesized that in Mediterranean ecosystems; the ability to resprout is as important or even more than growth form in explaining the functional variation of plants. We evaluated this hypothesis using the BROT database of functional traits for the Mediterranean Basin flora and considering three general growth form classifications: (1) herb, woody; (2) annual herb, perennial herb, woody; and, (3) annual herb, perennial herb, scrub, shrub, tree. For each of these classifications, we compared the variability of eight functional traits (seed mass, height, leaf size, specific leaf area, mass-based leaf nitrogen content, root depth, shoot:root ratio, and stem density) before and after considering the resprouting ability of the woody species. Comparisons were made using linear mixed-effect models with growth form and resprouting ability as the fixed effect and species within genus and family as random factors. The results showed that for most traits, resprouting ability accounts for a significant variability after considering growth form. For all Mediterranean plants, resprouting explains more functional variability than woodiness (herb/woody); and for woody plants, resprouting had more explanatory power than growth form (scrub/shrub/tree). Overall the results suggest that despite resprouting is a simple binary trait, it is a key trait in the Mediterranean flora and encapsulates a very large portion of plant functional variability.

S.06-44-Poster

Pine thinning modulates the architectural response of Pinus halepensis to climate variability in dense post-fire Mediterranean forest

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We aimed to determine the effect of thinning pattern on the response of tree-architecture to climate variability in dense young post-fire pine communities. In 2010, we stablished three experimental thinning sites in SE Spain, which resulted in three types of pine stands on each site: 600 trees/ha, regular pattern (600R); 600 trees/ha, aggregated pattern (pines were left in clumps of 20 trees) (600A); and control areas with no thinning. Most of the architectural traits assessed appeared to be highly sensitive to competition and climate variability. Pre-thinning shoot length, branching rate, and pine needle number showed a decreasing trend with pine aging. Both thinning treatments (600A and 600R) reverted this trend, leading to much higher values in thinned than in control pines, which reflected the constrains imposed in the development of pine canopies by tree competition. Secondary branching was the trait responding earlier to thinning. We found no major overall differences in architectural traits between thinning spatial patterns, yet old and medium-age branches performed better under regular thinning pattern, while young branches performed better under aggregated thinning pattern. Pine architecture in thinned areas clearly responded to the inter-annual climatic variation, with growth dynamics that matched the variation in the ratio between annual precipitation and temperature. Our results provide insights on the interaction effect of competition and climate variation on the development of pine canopies, and therefore on the potential productivity of Mediterranean pine stands in response to climate change and management.

S.06-45-Poster

Within-crown light seasonality in a non-seasonal light environment

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Solar radiation and crown architecture together shape within-crown light environments. Describing those environments is important to improve our understanding of individual-level light capture and its potential effects on key life processes such as photosynthesis, phototropism and photoperiodism in multi-layered crowns. Large efforts have been devoted to the study of spatial variation in light across tree crowns and canopies, while diurnal and seasonal variation have been unheeded. We quantified photosynthetically active radiation (PAR) above and within crowns under clear sky conditions in eight wild populations of a broadly distributed evergreen tree species (Olea europaea) across a global latitudinal gradient (10,000 Km), from Central Spain to Reunion Island. We estimated diurnal (hourly) and seasonal variation in PAR for a whole year. Preliminary results showed a marked diurnal variation in PAR within the crown in all latitudes. This variation was similar to that measured above the crown (i.e., a bell-shaped curve peaking at noon). Above the crown, PAR seasonality (the difference between summer and winter diurnal PAR curves) fell from mid-latitudes to the Equator, where PAR seasonality was negligible. Within the crown, PAR seasonality was lower than above the crown, except for the Equator. While in non-equatorial populations crowns seem to play a buffering role on PAR seasonality; in equatorial populations within crown PAR showed marked oscillations that cannot be explained by above-crown PAR alone. We suggest that the emergence of within-crown PAR seasonality in equatorial populations may be related to seasonality in solar direction of incidence typical of the Equator.

S.06-46-Oral

The underlying anatomical causes of the leaf economic spectrum

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The leaf economic spectrum (LES, Wright et al. 2004) describes how a single variable as the leaf mass per area (LMA) can explain many functional aspects of the species, as carbon assimilation, water efficiency, resistance to stress (herbivory, etc.) and nutrient economy. These patterns are very general including many different species and biomes. Therefore, it is interesting to understand which are the underlying causes of the variation in LMA. Variation in LMA can be due to variation in leaf thickness and/or leaf density, which are due to variation in leaf anatomical structure. However, there is not a clear picture of how leaf anatomy explains LMA. We create a database comprising 450 species from different biomes and we explore how the variation in leaf anatomical structure is the basis to understand the leaf economic spectrum.

S.06-47-Poster

Strategies, function and vulnerability of key Mediterranean woodland species under drought

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Increasing temperatures and lower precipitation are predicted in the Mediterranean basin as part of climate-change, likely resulting in increased frequency and severity of droughts. The central role of water availability in determining the structure and function of vegetation systems within the Mediterranean makes them especially vulnerable to climate change. Drought resistance mechanisms vary highly even among species of the same functional group and coexisting in the same habitat. This can result in differential responses, including mortality, among species. This study was set out to investigate the response of key woody species of eastern Mediterranean woodlands (Quercus calliprinos, Phillyrea latifolia, Pistacia lentiscus) to increasing drought stress for a better understanding of the mechanisms of drought resistance. Results from extensive field measurements show significant variation in plant water status with time of day, season and species. Leaf gas exchange follows the seasonal and diurnal changes in water potential in all species. The function of Q. calliprinos and P. lentiscus in terms of water relations, xylem hydraulics, and leaf gas exchange is very similar, indicating that these species have adapted the same drought resistance strategy. P. latifolia exhibited higher resistance to embolism, lower water potential levels and less stomatal control than the two other species. The different drought resistance mechanisms adapted by species were not related to the actual drought resistance observed in the field. These results indicate that the species-specific differences in plant function may give rise to major changes in vegetation composition in Mediterranean woodlands under future climate conditions.

Session 07: Ecosystem functioning and services: challenges and risks in a changing world

S.07-1-Invited Lecture

The importance of facilitative interactions on the diversity of alpine plant communities

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Alpine habitats are expected to be prone to facilitative interactions among species. Although the consequences of facilitation at individual and population levels are well known, the community-level consequences of these processes have received much less attention. Using a dataset spanning 78 sites and 5 continents, including alpine areas located in Mediterranean-type ecosystems (MTE) we assessed the relative importance of biotic interactions in determining plant diversity in alpine ecosystems. We focused on alpine plant communities dominated by cushion plants, a particular growth form that act as nurse plant for other species. Samples from cushions and open areas were combined in a single matrix accounting for the difference in cover between both microhabitat, and through rarefaction curves we assessed how many more species are added to the community due to the presence of cushions. In general, the presence of cushions consistently increased species richness at the entire community level. The magnitude of these increases in species richness varied with habitat severity where cushion species enhanced species richness more in systems with harsher environments and hence inherently impoverished in local diversity. This is particularly evident in alpine sites located in MTE where both low and high elevation zones are environmentally severe due to drought and low temperatures, respectively. Nurse species appear to act as a "safety net" sustaining diversity under harsh conditions, demonstrating the importance of positive interactions among species in determining the diversity of alpine habitats in general and those of MTE in particular. Funded by F ICM P05-002, CONICYT PFB-023.

S.07-2-Poster

Is there a substitution of Pinaceae by Fagaceae in temperate forests at the global scale?

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Reports on forest declines, shifts in species composition and forest distribution in response to changing climate and land use are increasing around the world. Two families of trees (Pinaceae and Fagaceae) dominate most temperate forests around the World. These two families present contrasted functional properties and are favored by different combinations of environmental conditions. Several local and regional assessments, particularly in Europe, have concluded that Fagaceae species (mostly oaks) are taking over Pinaceae (mostly pines) in some areas. The aim of this synthesis study is to analyze the dynamics of temperate forests worldwide focusing on the relative dynamics of Pinaceae and Fagaceae species. Our specific objectives are: (1) to establish whether there is a consistent directional replacement of Pinaceae by Fagaceae worldwide; and (2) to determine whether these directional changes are associated to specific climatic conditions or certain geographic regions, reflecting differences in historical forest management and land use. We conducted a literature review and found 41 papers fulfilling our search criteria, including a total of 103 instances in which the relative dynamics of Pinaceae and Fagaceae had been assessed. Our results show that in 81% of these instances Fagaceae had increased more than Pinaceae over recent decades, this pattern being significant in all continents except North America. These relative changes, however, have not (yet) lead to a generalized change in dominance from Pinaceae to Fagaceae in these forests.

S.07-3-Poster

LIFE ADAPTAMED: adaptive management for the protection of ecosystem services in a climate change scenario

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Climate change constitutes the most important challenge that our society is currently facing. Nowadays, there is a general consensus on the magnitude of the changes in our planet due to the impact caused by human activities. The services that can be provided by natural ecosystems are currently being negatively affected by Climate Change and, on the basis of current data, this affection is expected to increase in the future. Life Adaptamed aims to mitigate the negative effect of Climate Change on key ecosystem services provided by three representative Mediterranean Natural Protected Areas (Cabo de Gata-Níjar Natural Park, Doñana National and Natural Park and Sierra Nevada and Natural Park) to local inhabitants and their socioeconomic sector. To achieve this objective Life Adaptamed's central actions will follow an adaptive management framework tested in a pilot scale, aimed to improve resilience of the targeted socioecosystems. Communication and dissemination actions will ensure that the project results are effectively spread and fit the objectives established for the transferability of the project. A temporal and spatial multiscale indicator system will be implemented through monitoring the impact of the project actions. Life Adaptamed (LIFE14 CCA/ES/000612) is funded by the European Commission through the Life Program. The project is guided by the Regional Government of Andalusia and several scientific, dissemination and conservationist institutions are also involved. It is considered as basis for the implementation of the Andalusian Global Change Observatories Network, and constitutes a demonstrative initiative to incorporate the ecosystem functioning and services dimension into the adaptive management.

S.07-4-Oral

Monitoring the effect of management actions on ecosystem functioning and services in Protected Areas through remote sensing: the ADAPTAMED project

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In the Anthropocene era, conservation practice faces the challenge of protecting biodiversity while promoting human welfare. Thus, managers need indicators validated from scientific knowledge to monitor the effects of global change on ecosystem functioning and services. Remote sensing is an adequate approach for this challenge, since it is cost-effective, and provides repeated and synoptic information about the matter and energy exchanges between the biota and atmosphere, which are the support of services provision. Here we present the application of satellite tools to the Life ADAPTAMED project, an enterprise that focuses on the role of adaptive management ensuring the provision of ecosystem services. ADAPTAMED is being implemented in Mediterranean-type ecosystems facing climate change, located in 3 protected areas of Andalusia of high environmental heterogeneity (Sierra Nevada National Park, Doñana National Park and Cabo de Gata-Níjar Natural Park). We aim to monitor the effects of management actions on ecosystem functions and services related to carbon and energy balance, and with water cycle, through a set of spectral indices such as NDVI, EVI, NDWI, LWSI, albedo and Surface Temperature. To do so, we are working with Landsat 8, Sentinel 2A and MODIS data at experimental plot and ecosystem level. Methods to derived indicators from satellite information include time series analysis, spatial experimental design and in situ radiometric information validation. This experience constitute a demonstration of the work between scientists and managers to incorporate the ecosystem functioning and services into conservation practice through remote sensing.

S.07-5-Poster

Role of magpie (Pica pica) as a mobile link species for tree regeneration in Mediterranean agroecosystems

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Anthropogenic landscapes such as agroecosystems are characterised by a reduced tree cover, often forming isolated patches where seed dispersal by animals is highly reduced. This is relevant for the regeneration of the main tree species that form temperate broadleaf forests, such as Fagaceae or Juglandacea species with large size nuts that rely on animals for dispersal. Corvids are major vectors for the dispersal of these nuts and provide a crucial ecosystem service for forest regeneration and expansion into disturbed areas. In this study we analyzed for the first time the role of magpie, a common corvid that inhabits agroecosystems and open landscapes throughout the Palearctic, as a potential effective nut disperser of broadleaf trees. We used radio-tracking of inserted small transmitters into the nuts and conducted field work in two sites (central and south Spain) and with two genera (Quercus and Juglans). After dispersal, cached nuts were located and replaced by another intact nut, whose fate was monitored until seedling emergence. Magpies dispersed nuts of both species up to distances of 150 m. A portion of the cached nuts survived until the seedling emergence period, providing therefore opportunity for seedling recruitment. Our results demonstrate that magpies are effective nut dispersers and may be relevant for forest densification and expansion in Mediterranean agroecosystems and agroforestry systems, a habitat where other important nut-dispersing corvids such as European jays are absent. Magpies can provide therefore a key ecosystem service to maintain biodiversity in highly humanized landscapes.

S.07-6-Oral

What Ecosystem Functional Types bring to Earth Observation Systems? Insight in biogeography and conservation as essential biodiversity variables

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Satellite remote sensing provide multiple descriptors of ecosystem function, but their relevance to explain biogeographical patterns and usefulness as essential biodiversity variables that effectively guide conservation actions need to be assessed. Actually, satellite-derived descriptors of the dynamics of carbon, radiation, heat and water exchanges have been used to identify Ecosystem Functional Types (EFTs), i.e., groups of ecosystems with similar dynamics of matter and energy exchanges between the biota and the physical environment. Popular EFTs use three ecosystem functional attributes (EFAs) of the seasonal dynamics of carbon gains from spectral vegetation indices (e.g. EVI-MODIS): annual mean (a surrogate of primary production, an essential and integrative indicator of ecosystem functioning), seasonal coefficient of variation (descriptor of seasonality), and date of maximum (indicator of phenology). Here, we assessed the capacity of EFT mapping to 1) characterize patterns of ecosystem functioning across biogeographical regions in Europe, and 2) set geographic priorities in the protected area network of Baja California. For the first, we identify functional attributes at ecosystem level and the EFTs composition of each biogeographical region of Europe; and for the second, we obtain regional patterns of EFTs richness, rarity and level protection and then we achieved geographic priorities to conserve functioning. Our results looked promising for the use of EFTs and EFAs as essential biodiversity variables related to ecosystem function. EFTs based on the carbon gains dynamics captured essential functional biogeographical patterns in Europe and identified gaps in the representation of ecosystem functional diversity in the protected area network of Baja California.

S.07-7-Poster

Richer tree canopies do not increase recruitment richness nor abundance in five mature European forests

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Increasing evidence supports the notion that biodiversity favors forest multifunctionality and thereby guarantee the provision of ecosystem services for human well-being. Natural regeneration thus becomes a key forest function due to its key role for the maintenance of forest dynamic and for the conservation of local diversity. Whereas the influence of species richness on forest functions such as productivity or nutrient cycling has been widely explored, there is little information on its influence on natural regeneration. Here, using an innovative and exclusive large-scaled European exploratory platform (5 forests, 173 plots, 5 levels of canopy richness), we explored whether richer tree canopies lead to an increase in recruitment abundance and richness by two non-exclusive ways: 1) by seed supply (quantity and richness) and 2) by inducing environmental heterogeneity. Our results indicate that recruitment abundance and richness do not increase with canopy richness either by seed supply or environmental heterogeneity since no significant effect was found. Results from statistical power analyzes showed that our experimental design was statistically robust to be certain about no relationship between recruitment-canopy richnesses, although it was not as clear for abundance of recruitment, for which at least 12 plots per forest and richness level would have been required to explore this relationship. Our findings show natural regeneration as a process highly complex and variable, where its success depends on the interaction of many factors. Results point up to huge experimental designs to study the diversity-regeneration relationship.

S.07-8-Oral

Recovery of forest functioning and complexity from abandoned croplands in central Spain

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Field abandonment is leading to forest expansion due to secondary succession (passive restoration) and afforestation programs. During the XX century, the main aim of afforestation programs in Spain was preventing erosion, but since the 1980s the EU Common Agricultural Policy has aided new tree plantations to promote multiple forest functions. However, the achievement of multiple forest functions by these new forests is largely unknown. Our aim is to understand forest recovery through passive and active restoration in comparison to their reference ecosystems, and the underlying drivers (i.e. abiotic, structural and legacy drivers) that explain the differences found. We study a 61-year chronosequence using three consecutive National Forest Inventories (1990, 2000 and 2012) in central Spain and four possible reference forests in the study area. We identified previous land use and field abandonment age using aerial photographs and land use maps, starting in 1933. We fitted mixed models to estimate the level of recovery by analyzing plant diversity and ecosystem functioning (i.e. growth, biomass, regeneration). Diversity, biomass and regeneration had a wide range of responses for each forest type. Similarities with the reference system increased with time, being generally greater in the passive than in the active restoration areas. We also identified under which abiotic, structural and legacy conditions the similarity between restored vs. reference systems reached their maximum.

S.07-9-Poster

Soil contamination and the provision of ecosystem services in Mediterranean lands: implications for livestock and bionergy uses

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Soils provide a wide range of ecosystem services that are essential to human societies. The provision of these services is currently threatened by different drivers of soil degradation, from which soil erosion, contamination, salinization and loss of organic matter are highly relevant to the Mediterranean Region. Here, we present a summary of our experiences at evaluating the implications of soil contamination for the provision of two natural resources: pastures for livestock and lignocellulosic material for biofuel production. These experiences have been gathered during the monitoring of a trace-element contaminated area in SW Spain, affected by a mining accident in 1998. Soil contamination appeared to have a limited effect of pasture biomass production, but the accumulation of potentially toxic elements into aboveground biomass during the autumnal season might led to restrictions for grazing use during this season. The potential of certain native Mediterranean species for bionergy production in the contaminated lands was evaluated in field and mesocosm studies, which showed that some herbaceous species have a potential as energy crops, given their hability to colonize highly contaminated soils and to produce a high biomass with appreciable calorific value. The combination of controlled low-intensity grazing and bionergy crops could thus contribute to the re-valorisation of such degraded lands, where agricultural production for food purposes is often not allowed.

S.07-10-Poster

Effects of increasing aridity on above- and belowground ecosystem functioning: mechanistic processes and biological feedbacks with climate change

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Scientific evidence overwhelmingly projects climate change-driven aridity increases in many areas of the planet in coming decades. However, it is still a major scientific challenge to understand the effects of increased aridity on multiple ecosystem functions and services. We aimed to understand, under natural conditions, how changes in aridity drive changes in (i) plant cover, diversity and functional traits; (ii) soil diversity and function; and (iii) the biological feedbacks with climate change represented by the exchange of greenhouse gases between soil and atmosphere. To do this, we selected 25 plots along an aridity gradient in the Iberian Peninsula, and intensively collected information and samples of vegetation and soil. To minimize the confounding effects derived from using different soils, and to better understand the mechanistic processes behind the observed results, we restricted our sampling areas to a single soil type: soils from stabilized dunes. The collected samples are being analyzed to estimate the above- and belowground nutritional status and diversity, a myriad of key soil-based ecosystem processes, including the exchange of greenhouse gases between the soil and atmosphere. During this congress we will present some of the preliminary results of this study.

S.07-11-Oral

Herbivore activity as a driver of ecosystem structure and function

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Grazing by domestic livestock is one of the most extensive land uses on the planet, providing a range of ecosystem services and sustaining millions of people and their cultures. Although Australia's woodlands have been grazed by livestock for less than two centuries, anecdotal evidence suggests that grazing has had substantial negative impacts on woodland functions. We used a continental analysis of the effects of grazing on structure, function and composition, and a regional study of the impacts of livestock and feral and native herbivores, to determine whether grazing effects are consistent across Australia's semiarid woodlands. Using the continental analysis, we detected substantial declines in structure, function and composition, and reductions in plant litter, cover and abundance, but neutral effects on plant richness and soil functions associated with the cycling of carbon and nitrogen. Our study of regional woodland communities in NSW showed substantial herbivore-specific reductions in soil health, changes in plant richness and community composition, and changes in soil function mediated by soil microbial communities. Overall, our work suggests that grazing by livestock and rabbits is associated with declining ecosystem functions whereas kangaroo effects are relatively benign. The results provide insights into how grazing can be managed in the semi-arid woodlands, and indicate that herbivore type is an important consideration when developing strategies to manage total grazing pressure.

S.07-12-Poster

Natural regeneration and expansion capacity of forestry species: Pinus pinaster and Eucalyptus globulus

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The tree species used in planted forests are highly productive and have an important role in countries economy but the expansion of these trees into habitats outside plantations is a concern for managers and conservationists. Our study aimed to identify the recruitment spatial patterns of Pinus pinaster and Eucalyptus globulus into habitats surrounding plantations in Portugal and to determine the factors that influence recruitment. We observed that the recruitment of P. pinaster and E. globulus decreased exponentially from the plantation edge. However, the higher P. pinaster seedling recruitment, the smallest decline in seedlings density with distance from plantation boundary, and the longer distance of seedling establishment, demonstrate clearly that P. pinaster is more successful colonizing the habitats near plantations than E. globulus. E. globulus can growth seedlings within the planted stands suggesting that the species is becoming naturalized. However, localized recruitment and lower levels of establishment of E. globulus, suggested that this species did not demonstrate an invasive behavior. Site characteristics were the most important group of variables influencing these species natural recruitment in comparison to climate or propagule pressure variables. Forest and grassland were the most resistant habitats to tree colonization while highly disturbed areas can be considered hubs for tree density. The high importance of site characteristics reflects that most of the variability in eucalypt establishment occurs at small spatial scales. Thus, monitoring and management efforts should focus on those sites with higher establishment probability (i.e. open areas) trying to promote native vegetation and reduce disturbance levels.

S.07-13-Poster

Semi-quantitative approach to evaluate the impact of wildfire on the ecosystem service provisioning capacity in Pinus pinaster ecosystems

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In Mediterranean systems fire constitutes a major ecological factor causing ecosystem degradation and disrupting the provision of ecosystem services (ES) with important ecological implications and socio-economic consequences for human well-being. Thus, the development of tools for ES assessment that will help to evaluate the impact of fires on ES provision appears as a key issue in effective post-fire management strategies. This study aimed to evaluate the applicability of the semi-quantitative approach reported by Stoll et al. (2015) to assess fire impact on ES provisioning capacity (ESPC) in fire-prone Pinus pinaster Aiton systems, using Sierra del Teleno (NW Spain) as a case study. The land cover classes used for analysis were developed from the SIOSE database and translated to CORINE Land Cover (CLC) classes. We assessed the ESPC of ES including provisioning, regulating and cultural services by using a matrix which related the 44 classes of CLC with their potential ESPC. This matrix included 39 ES accounting for ecological integrity, provisioning, regulating and cultural services, being ecological integrity services discarded in this study. This study offers a useful framework to integrate ES in post-fire environmental planning and management implementation. The study was financed by the GESFIRE (AGL2013-48189- C2-1- R) and the FIRECYL (LE033U14) research projects.

S.07-14-Oral

Climate change impacts on forest functioning through the alteration of tree physiology and change in species composition

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Climate change affects forest ecosystem functioning directly through effects on tree physiology, and indirectly by changing the composition of communities through local extinctions and colonisations. We investigated how climate change may alter the total biomass, the net productivity and the temporal stability of the productivity of 11 central European forests, by forecasting their potential tree species communities by the end of the century and simulating species succession after that moment. We first built these potential forest communities for the year 2100 with basis on the probability of presence of each species in each location. We used for that task an ensemble (BIOMOD) of 7 Species Distribution Models, which use the relationship between the distribution of species and some aspects of the environment to estimate their potential distributions. We then simulated forest succession in these communities over time with a Forest Succession Model (FORCLIM), which uses the ecophysiological response of each species to abiotic and biotic factors to simulate forest dynamics. We observed that, on average and in comparison with a baseline scenario that used stable climate data, climate change decreased the total biomass and the stability of productivity (mostly when using the ICHEC-EC-EARTH global climate model), and increased productivity (specially for the greenhouse gas concentration trajectory RCP4.5). Our results suggest that these changes are mostly caused by the direct effect of climate change on tree physiology because alternative simulations, in which this direct effect was not included, showed no appreciable change in comparison to the baseline.

S.07-15-Oral

Choice of assessment methods affects ecosystem services trend interpretation

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Trends of ecosystem services are being assessed through a multitude of assessment methods and indicators. With many scientists being involved in the global and regional IPBES reports, there is a strong focus on identifying indicators to fill data gaps for reporting purposes. Ideally indicators capture the impact of global change on ecosystems and their related services, but through the choice of approaches and concepts used, a selective inclusion of global change pressures and impacts takes place. In this presentation, I will compare for three different assessments which aspects of ecosystem services can be identified and how these approaches can lead to different interpretations of trends in ecosystem services. These three assessments include: 1. an assessment relating species richness data to the resilience in ecological functioning using the planetary biodiversity safety boundaries; 2. an analysis of trends in land cover change translated to changes in ecosystem services supply using expert based estimates; 3. a comparison of ecosystem services supply and demand trends, using essential ecosystem services variables. The comparison of these three approaches highlights the impact of the considered scale (from local case studies such as Mediterranean wetlands to the scale of the Mediterranean Basin), and the focus of the study (from ecological capacity to ecosystem services flows) on the interpretation of ecosystem services trends. To inform decisions on ecosystem services management, assessment methods may currently be missing that capture the spatial and temporal scale required to identify the governance and management effects of interventions on ecological functioning and ecosystem services.

S.07-16-Oral

Disentangling the influence of anthropogenic and environmental drivers of wildfires in central Chile

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Wildfires have strong ecological and socio-economic impacts worldwide. Fire activity is related to climate, fuel, topography, and human pressure. However, the relative importance of these factors and how they interplay in promoting/preventing fire remains unclear. This information is crucial for formulating sustainable management and fire prevention policies. In this study, we performed structural equation modeling to evaluate the relative importance of human impact, drought severity, aridity, topography and land use (native forest, plantations and croplands) on fire occurrence (i.e. number of fires) and damage (i.e. burned surface area) in central Chile. Human impact, drought severity and forest plantations showed the strongest positive effects on the number of fires. In contrast, native forest is a factor that inhibited fire occurrence. Aridity, drought and croplands had the strongest positive effects on the burned surface (damage). Our results suggest that the drivers that control the probability of ignition (human impact and the relative cover of native forest and plantations) are different to those that control the ultimate fire damage (aridity and croplands). Drought is a common driver controlling both the ignition and damage. Based on our results, we propose to restore actively the native forest along the watersheds and to revise the current policy for land-use ordination, in order to reduce fires and drought in central Chile, a highly vulnerable region to climate change. Altogether, our results provide new insights into the applied ecology of fire, and reveal the potential role of native forest as an ecosystem service of fire protection. CONICYT-FONDAP-15110009.

S.07-17-Oral

Fire regimes and environmental gradients shape vertebrate and plant distributions in temperate eucalypt forests

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Fire is a global driver of ecosystem structure, function and change. Problems common to fire scientists and managers worldwide include a limited knowledge of how multiple taxonomic groups within a given ecosystem respond to recurrent fires, and how interactions between fire and environmental gradients influence biodiversity. We tested six hypotheses relating to fire and environmental gradients using data on birds, mammals and vascular plants collected in eucalypt forests in southern Australia. We addressed each of these hypotheses by fitting species distribution models which differed in the environmental variables used, the spatial extent of the data, or the type of response data. We found: (1) fire interacted with environmental gradients and shaped species distributions; (2) multiple characteristics of fire regimes influenced the distribution of forest species; (3) common to vertebrates and plants was a strong influence of temperature and rainfall gradients, but contrary to predictions, inter-fire interval was the most influential component of fires on both taxonomic groups; (4) mixed support for the hypothesis that fire would be a stronger influence on species occurrence at a smaller spatial extent; (5) as predicted, species closely associated with direct measures of habitat structure were those most strongly influenced by fire regimes; and (6) the modelled fire responses for birds were sensitive to the use of either presence-absence or abundance data. We have demonstrated that there are general patterns in biotic responses to fire and environmental gradients – but management must carefully consider species, scale and the quality of data to achieve biodiversity conservation.

S.07-18-Poster

Influence of the tree layer composition on the understory vegetation

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The 40% of European forests are mixed forests. There is an increasing number of studies that highlight the benefits of mixed forests as an important source of ecosystem goods and services, such as biodiversity conservation. This study assesses the effect of mixed stands against monospecific stands on the floristic composition, diversity and biological structure of understory vegetation, and tree regeneration. The influence of environmental conditions, as well as stand age, density and mixing rate will be also included in the analyses. To achieve these objectives six triplets, distribute along an environmental gradient W-E and N-S in Spain (in the 'Sierra de la Demanda', between 'Soria' and 'Burgos' regions), were selected. Each triplet consisted of one Pinus sylvestris monospecific plot, one Pinus pinaster monospecific plot, and one plot with both species mixed; plots were circular with a radius of 15 m. Understory vegetation were inventoried in June 2016 into ten 1m x 1m sub-plots per plot. The cover of each plant vascular species, base soil, litter and bryophytes, as well as the number of individuals of tree species regeneration were visually estimated by the same observer. Preliminary results will be presented.

S.07-19-Poster

Indigenous rhizobacteria in native Andalusian Spartina maritima as a tool for the restoration of heavy metal polluted Mediterranean salt marshes

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Heavy metal pollution is a major environmental problem. The joint estuary of Tinto and Odiel rivers in Spain is one of the most polluted areas by heavy metals in the world. It drains the region of the world's oldest continuously operating mine and the area is strongly industrialized. In these estuaries, the indigenous cordgrass Spartina maritima grows naturally, making it useful for phytostabilization of estuarine sediments. Non-restored marshes are being colonized by the invasive S. densiflora, which is displacing the native S. maritima and altering the original ecosystem. This Mediterranean-type ecosystem is protected by provincial and state policy plans and needs restorative intervention urgently. Within this scenario, estuarine soil bacteria come under the spotlight, since inoculation with autochthonous plant growth promoting rhizobacteria (PGPR) may improve S. maritima growth and metal uptake. The efficiency of the proposed strategy was tested under greenhouse conditions with natural plants and soils. Inoculated S. maritima plants increased their belowground biomass and improved their photosynthetic metabolism. Besides, plant metal uptake in roots was stimulated, increasing 20% for As, 25% for Zn or 50% for Cu. On the basis of these results, the inoculation of S. maritima with indigenous metal-resistant PGPR may be used as an efficient method to increase native plant adaptation and growth during restoration experiments. On the whole, this work is an important approach about the utmost important role of this Mediterranean-type ecosystem in facing current challenges as pollution and invasive species in order to preserve Andalusian native ecosystems.

S.07-20-Oral

Drought alters the structure of soil fungal and bacterial communities at the inter-continental scale

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Future climatic models forecast changes in precipitation regimes in many regions of the world, including increases and decreases in rainfall amount and a higher recurrence of extreme rainfall events. This will influence terrestrial ecosystems and the services they provide in unpredictable, yet fundamental ways. In this study, we evaluated the impacts of comparable drought simulation experiments (50% rainfall reduction) on: (i) the activity (i.e., enzymes related to the main nutrient cycles [carbon, nitrogen and phosphorus], (ii) abundance (i.e., quantitative PCR; qPCR) and (iii) community composition (i.e., high throughput next generation sequencing of ribosomal [16S] and ITS markers) of soil microbial communities (bacteria and fungi) across seven experimental sites from two continents (six sites in North America [EDGE project] and one Australia [DRIGrass experiment]). The experimental sites encompassed different types of grassland ecosystems and cover a wide range of climatic and soil conditions. The experimental drought significantly altered the assembly of soil bacterial and, to a lesser extent, fungal communities at the inter-continental scale. Despite community-level effects, none of the main fungal groups was individually affected by drought. In contrast, several bacterial taxa responded consistently to drought: Chlamydiae, total Proteobacteria and Tenericutes decreased, whereas Chlroflexi and Gemmatimonadetes, generally described as more dominant in arid sites, increased. In contrast, two groups formed mostly by pathogenic species (Chlamydiae and Tenericutes) decreased in relative abundance. Our results provide solid evidence that drought will alter the assembly of microbial communities in terrestrial ecosystems at the continental scale, which may have important implications for ecosystem functioning.

S.07-21-Oral

Taxonomic and functional diversity of ants in vegetable gardens under different management regimes: agroecological vs. conventional

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The two common and contrasting trends in agroecosystems of the Mediterranean basin, intensification and abandonment, led to the loss of productive activity in numerous small homegardens in mountain areas of the Iberian Peninsula. In the last years this trend seems to be slightly reverting under diverse management regimes. The impact of agronomic differences on biodiversity is largely studied in medium-to-large-scale farms, but little is known about how small homegardens relate with biodiversity and ecosystem functions. Ants have been proposed as a good indicator of changes in agroecosystems because they are widely spread, moderately diverse, functionally significant and easy to sample. Our objective is to evaluate the effect of two management regimes, i.e. conventional (e.g. when synthetic agrochemicals such as NPK fertilizers are applied) vs. agroecological (e.g. when only natural inputs such as manure or locally-produced remedies are applied) in homegardens of the Sierra de Aracena (Huelva, Spain), on the taxonomic and functional diversity of ants. A sample of 240 pit-fall traps from 12 gardens under conventional management and 12 gardens under agroecological management was collected. The sample was stratified between two valleys with different climatic conditions. In order to account for the effect of the garden in the adjacent environment, half of the traps were located inside the garden and half in the surroundings. The total number of species (taxonomic richness) is calculated and four functional characters are measured in the species identified: body size, eye size, leg size and trophic position. RAO index of functional diversity is calculated.

S.07-22-Oral

Expanding the Ecosystem Functional Type approach to characterize social-ecological systems

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The functional characteristics of natural and human-influenced systems include ecological and sociological processes, and their interactions. However, operational frameworks are still needed for an integrative and functional characterization of social-ecological systems (SESs). Ecosystem Functional Type (EFT) approach has proved useful to characterize ecosystems according to their functioning, but in the Anthropocene, it is also essential to consider the human dimension. Hence, EFT approach could be expanded by the incorporation of the main processes and variables that describe the functioning of social systems. Here, we introduce a conceptual and methodological approach to identify and map Socio-Ecosystem Functional Types (SEFTs), defined as patches of the land surface that share both similar dynamics of matter and energy exchanges between the biota and the physical environment, and similar cultural patterns and socioeconomic dynamics. First, we compiled a list of Essential Social-Ecological Functional Variables (ESEFVs) that capture key processes and functions of SESs at the regional scale and landscape level. To select ESEFVs, we carried out expert workshops, systematic literature reviews, and online surveys. Then, we applied PCA and clustering on a subset of ESEFVs to map SEFTs. As a result, we propose a conceptual framework for functional characterization of SESs, divided into three components (ecological system, social system and interactions), key functional dimensions and a set of potential ESEFVs. As an illustrative example, SEFTs were mapped for a pilot study area. The spatial patterns of SEFTs provided an integrative characterization of the functional heterogeneity of both the biophysical and human components of SESs.

S.07-23-Oral

Using socio-ecological value to define priority areas for conservation in the Andes piedmont in Santiago, Chile

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The central zone of Chile has been recognized as a hotspot for the conservation of biodiversity. At the same time, in this area inhabit 40% of the population and is located 30% of the country's agricultural land use area. This has resulted in great disturbance of natural ecosystems, which have been restricted to mountain areas. We present the results of a study in which we defined priority areas for conservation of both the social and ecological value of the Andes piedmont area, close to the city of Santiago. We aimed to identify areas that required protection or restoration and others that could be managed in a sustainable way, according to their socio-ecological value. We did this by defining spatial planning units and characterizing their ecological value, based on characteristics of fauna and flora, naturalness and singularity. Social value was estimated based on the provision of four ecosystem services (mitigation of flooding, purification of air, prevention of landslides and cultural services). Other variables considered in the analysis were the planning units' vulnerability and the potential negative effects of anthropogenic activities. Land use of each unit was proposed, allowing us to select six areas approved by the Ministry of the Environment for conservation. Finally, we proposed voluntary and obligatory measures to protect these priority areas.

S.07-24-Oral

Towards an ecosystem-friendly management of burned forests in the Mediterranean Basin: synthesis of impacts and best practices

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From 1961 to 2000, 213,000 ha of European forest were affected every year by fire (around 90% in Mediterranean countries) and similar amounts have burned in the 21st century. Burned forests have been increasingly harvested across this period. Harvesting practices have also shift from the use of logs, leaving low-value woody debris on the ground, to a most frequent whole tree harvesting for biomass uses in recent years. The regulation of harvesting in burned areas is usually lax and does little to impede the complete removal of dead trees over large areas. There are, therefore, concerns about the effects that post-fire salvage logging has on erosion rates, levels of soil nutrients, soil compaction, watershed values, carbon sequestration, plant regeneration, nut dispersal by animals, species richness, and biodiversity conservation in these areas. We reviewed over 150 publications to assess current knowledge on the environmental impact of harvesting burned forests, focusing on the Mediterranean Basin. We also discussed with forest practitioners, managers and scientists about best harvesting practices. As a result, in July 2016 we made available online the "Sheets of best practices in post-fire management of burned forests" (http://anifog.wix.com/anifog#!blank/pomi1). This publication helps to select, for different management approaches, those practices that are less harmful and more suitable, taking into account a landscape-scale management, the regeneration of plant cover, the reduction of soil erosion, the reduction of wildfire risk and the conservation of soil fertility, invertebrates and vertebrates. We now would like to spread, discuss and ameliorate these proposals.

S.07-25-Poster

The persistence capacity of the Iberian forests to natural disturbances: main trends and temporal evolution

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In order to implement policy and management decisions designed to ensure the sustainable provision of desired ecosystem services, we need to adequately assess the persistence capacity of forests and its temporal evolution under different ecological and socio-economic conditions, particularly in the current context of increasing environmental uncertainty. We developed a Persistence Index (PI) based on the diversity, abundance, and redundancy of disturbance- and taxon-specific response traits. The index was then used to assess the current and past resilience and resistance capacity to fire, drought, and windthrow of the main Iberian forest types. For this, we calculated and compared PI values in plots of the Second, Third, and Fourth Spanish National Forest Inventory. We found the persistence capacity of the Iberian forests overall to increase along the last 20 years. These results were explained by the increase in both the functional diversity of stands, and in the regional presence of plantations of non-native species, which are well adapted to the considered disturbances. Our analysis allowed to assess the consequences that past disturbances and management decisions had in the adaptive and persistence capacity of the current forest systems.

S.07-26-Oral

Linking provisioning ecosystem services and service providing units in maritime pine landscapes prone to wildfires

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Wildfire regimes are expected to intensify in the Mediterranean region during the next decades. More frequent and severe wildfires, particularly stand-replacing ones, will lead to habitat destruction and disrupt the provision of ecosystem services (ES) causing important economic losses to service beneficiaries. Gathering knowledge on the landscape features that are necessary to deliver ES at the level required by beneficiaries, i.e., the service providing units (SPUs), will be therefore crucial to restore ES provision after fire. We quantified supply and monetary value of provisioning ES provided by fire-prone Pinus pinaster Aiton landscapes over a 10-year period. We further identified and spatially analysed the SPUs that are needed for each ES provisioning at the landscape configuration level with existing GIS sources. We mapped and assessed the extent of 20 SIOSE land cover types and 57 habitat structures differing in origin, age, dominant species, and understorey complexity. Multiple provisioning ES were supplied by the studied pine landscapes, including timber extraction, firewood exploitation, recreational hunting, crop and animal production, resin and honey collection, fruit and edible mushroom harvesting. Timber extraction and hunting yielded the highest monetary profit to local populations. The major provisioning ES were provided by old natural P. pinaster forests and reforestations. Additionally, high habitat heterogeneity enhanced the supply of multiple ES. These findings will contribute to designing post-fire restoration strategies to counteract multiple ES losses in fire-prone landscapes. The study was financed by the GESFIRE (AGL2013-48189-C2-1-R) and the FIRECYL (LE033U14) research projects.

S.07-27-Poster

Forest mortality in southeast Spain after extreme dry and warm years. Possible causes and effects over dry and semiarid ecosystems

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Forests are extremely important for society given the many services they provide. Climate models reflect increases in temperature and less annual rainfall, which will generate hotter and drier environments. Under these conditions, it is predicted that forest ecosystems will be severely affected. In fact in recent years, several studies have accumulated evidence for drought-induced tree mortality as consequence of extremely dry and warm years. Consequently, many studies have attempted to explain mechanisms of survival and mortality in forest species. However, the eco-physiological mechanisms underlying drought mortality and their effects on ecosystem functioning (loss of species diversity, hydrological cycle,) are not completely understood. The aim of the present study was to analyse the effect of an extremely dry year on causing mortality of pines and other shrub communities in southeast Spain, and its recovery. Specifically we studied interactions among drought stress that caused: i) pine mortality and associated factors as carbohydrates reserves and bark beetle attack; ii) shrub mortality mainly focused on Q. coccifera and Q ilex ballota communities iii) Effects of changes in species composition on hydrological cycle of these ecosystems.

Session 08: Consequences of biotic and environmental global changes for MTEs

S.08-1-Invited Lecture

Projections revisited: What have we learned about the vulnerability of Mediterranean Systems to global change impacts?

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Several projections have been made of the potential impacts of global change drivers on the diversity, structure and function of Mediterranean Systems around the world. Several of these have been important in quantifying the potential vulnerability of global biodiversity to climate change, in particular. The resulting policy influence of these projections is hard to quantify with any precision, but has not been negligible at local, national and global levels. I will revisit a selection of these projections with a particular focus on climate change in the Mediterranean region of southern Africa. I will consider how well various projections stand up to scrutiny a decade or more after they were released. I will reflect on the implications of all of this for how this important science and policy interplay might be pursued over the next decade or more.

S.08-2-Oral

Mediterranean ecosystem restoration: Evidence from the analysis of plant diversity, organic matter accumulation, and functional group regeneration in central Chile

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Land cover change is a major driver of biodiversity loss and ecosystem degradation in Mediterranean ecosystems worldwide. Less than 7% of the land in Mediterranean central Chile contains remnants of native vegetation currently under some form of protection. In addition, climate change models predict increasing drought stress and higher incidence of fire in the coming decades in the region. These impacts will jeopardize passive conservation efforts. Proactive measures such as ecological restoration on degraded land to recover some of the components of biodiversity and relevant ecosystem processes are urgently needed in central Chile to mitigate environmental impacts. In the last 20 years, NGOs, private companies and landowners have started restoration projects using different approaches. Among these projects, some have started as compensation measures for land development projects the have caused environmental damage. We analyzed a sample of 28 restoration projects that considered 14 different reference ecosystems, including databases provided by NGOs, private companies, and landowners that were started between 2000 and 2012. We used several indicators of the successful progress of the restoration, including spontaneously established vascular plant diversity, plant cover, organic matter accumulation, litter depth, and total soil nitrogen, and compared these indicators with the respective reference ecosystems. We also classified species in recovering areas in functional groups, using leaf traits, shade tolerance, and fruit dispersal types, to compare their success. These results provide empirical evidence on the potential for restoration actions to mitigate biodiversity losses and ecosystem function in a short period time in Mediterranean regions.

S.08-3-Oral

Growth and water use efficiency of Quercus suber trees affected by Phytophthora cinnamomi. Does scale matter?

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Cork oak (Quercus suber) forests of the Iberian Peninsula are affected by severe decline and mortality, mainly induced by the exotic soil-borne pathogen Phytophthora cinnamomi. Although previous studies have attempted to disentangle the abiotic and biotic factors that modulate the cork oak decline, the spatial variability and cross-scale patterning of this process are still poorly understood. In this work we aim to study how Q. suber trees adjust their physiology, in terms of water use efficiency (WUE) and secondary growth, to oak decline at different scales. We investigated 6 mixed oak forests affected by pathogen-induced oak decline in Southern Spain. Specifically, we model the links between tree physiology and tree decline at individual, local and landscape scales. At individual scale we found that defoliated and healthy Q. suber trees did not differ in WUE or secondary growth, although we found a high plasticity of Q. suber to modify its WUE at the landscape scale. At local scale we found that soil depth (a variable related to water availability) had a negative effect on WUE of healthy trees and defoliated trees, whereas soil pathogen abundance had a positive effect on WUE of defoliated trees. Overall our results suggest that Q. suber trees subjected to soil drought and root pathogens increase water use efficiency to some extent, while this response might not be enough for the trees to overcome the physiological stress associated to the pathogen-induced dieback.

S.08-4-Oral

The role of anthropogenic and natural factors in shaping recent fire regimes in Mediterranean ecosystems

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Although climatic factors are the main agents driving fire regimes during the most of the Holocene, many anthropogenic factors are responsible for the changes in fire regimes during the last century. The aim of this study is to investigate the relative role of the anthropogenic and natural drivers shaping fire regimes in Mediterranean-type ecosystems of Turkey. Fire data gathered from NASA. BIOCLIM variables, NDVI, PET, and geographic variables were used to investigate the effect of natural factors on fire regimes. Data on the road network, human population size, agricultural and livestock activities were included in as anthropogenic factors. The data were analyzed by binomial and zero-inflated negative binomial GLMs. Results showed that temperature and NDVI were the most explaining factors for fire regimes (%13.6 and %3.6 of the deviance, respectively). Elevation had a significant impact on the relative role of the drivers of fire regimes and revealed different effects in certain elevation zones. Considering cropland fires dramatically altered the results of the study. Our findings suggest that despite the presence of an intense anthropogenic activity in the region, natural factors are still the main drivers of fire regimes. In modeling natural fire regimes, cropland fires should be handled with caution since they have a potential to mislead the results. The climate change may have profound effects on future fire regimes as climate is the most influential driver shaping current fire regimes in the study area. This study contributes to close the gap on fire regimes in the study area.

S.08-5-Poster

Are food quality and density determinants of vole outbreaks in NW Spain?

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Rodent population outbreaks have important effects on ecosystems, economy and human health. Rodents such as voles are keystone species of high ecological importance in the North Hemisphere being primary prey of many predators as well as vectors of many diseases. Understanding how biotic and abiotic factors modulate vole demography and population growth is essential for predicting outbreaks and proposing strategies for mitigating their adverse effects. Previous studies have highlighted the importance of density-dependent mechanisms interacting with food supply and/or predators for explaining voles outbreaks. Here we studied how previous vole population density and the phenology and yields of alfalfa crops, used as proxies of food quality for herbivorous voles, predict the occurrence of outbreaks in the NW of Spain. We used 20 years of data informing about the occurrence of outbreaks in three provinces of Castilla-León (Spain), weather data and agronomic models developed for alfalfa crops. Our results showed that the likelihood of vole outbreak depended on (i) previous winter densities (ii) alfalfa crop maturation rate and (iii) summer precipitations. These results indicate that the potential effect of climate change in non-irrigated areas could be dampening vole outbreaks at low latitudes.

S.08-6-Oral

Historical written sources for long-term global change research

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Past processes and events influence present-day ecosystems and ecological patterns, including human impacts on landscapes and organisms. Historical information is thus critical for assessing long-term changes of the distribution of biodiversity in response to global change. In spite of this, environmental scientists and managers are often sceptical about the availability and usefulness of historical data. However, a diverse array of historical sources containing information on biodiversity exists across different regions of the world and can be used to expand the time-window of our approaches to describe the dynamics of biodiversity patterns. Here I will present several examples of the application of historical sources for biodiversity research and conservation in a Mediterranean context, focusing on Spain. Baseline information derives from archival sources, natural history or medical treatises and structured data-gathering initiatives that followed citizen-science approaches, namely the Relaciones de Felipe II (late 16th century) and the Madoz's Dictionary (mid-19th century). I use both animal and plant examples to show how the compilation and analysis of historical information can improve our understanding of the invasion process, of the impacts of habitat loss and different global change processes (land-use changes, global warming) and of the management options to better conserve biodiversity. Most of these approaches can be followed, when not improved, in several other areas worldwide. This yet largely unexplored research line will open new, relevant pathways for global change research and for the management of natural systems.

S.08-7-Oral

The role of understory fuel characteristics in the fire hazard of Mediterranean forests

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Many Mediterranean plant species have morphological and physiological features that increase fire hazard as a result of being highly flammable. At the community level, species composition of Mediterranean forests and shrublands is an important determinant of fire behavior and its effects, but crown fire initiation and spread also depend critically on forest structure, which determines factors such as fuel bulk density of understory and canopy fuels and the vertical separation between them. Understanding the role of understory fuel characteristics in crown fire hazard is key to implement forest management strategies focusing on fire prevention. Here we used forest inventory plots from Catalonia (NE of Spain), a compilation of attributes of Mediterranean species and a fire behavior model to test (1) that the high flammability of understory plants is a key component of fire hazard in Mediterranean forests, and (2) that understory fuel characteristics are weakly correlated with canopy fuel characteristics. The variation across plots in fuel characteristics was as large or even larger in the understory than in the canopy and the correlation between both strata was significant but often weak. The understory and canopy fuel characteristics determining fire hazard depended on the type of forest. Finally, crown fire hazard was substantially affected by changes in moisture content of both understory and canopy fuels. Our results emphasize the need to properly assess the spatial and temporal variation of understory fuel characteristics in Mediterranean forests, in addition to canopy fuels.

S.08-8-Poster

Proximal and remote sensing in adaptive conservation management of Doñana terrestrial ecosystems

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The ADAPTAMED LIFE+ project has as main goal to alleviate the negative effects of Climate Change in the Ecosystem Services of three protected areas in Mediterranean Spain (Doñana, Sierra Nevada and Cabo de Gata). Adaptive management is the backbone of the actions to be implemented at every site in order to enhance ecosystems resilience including tree removal, grazing exclusion and a facilitative setup for seedling establishment. The sampling and management design is replicated at every site and diverse monitoring activities are carried out in the field for soil, plant and animal communities prior to the implementation of the management actions and throughout the following three years. Proximal and remote sensing is being used to estimate site primary productivity at plot scale before management actions and along the regeneration process. A field spectroradiometer is used for spectral signature collection of every woody plant species present in the plot during the full phenological cycle. Herbaceous layer, bare soil and litter are also measured. A multispectral camera was flown onboard of an unmanned aerial vehicle (UAV) providing consistent spatial mosaics of every plot at 11 cm pixel size. Preliminary results point out the large differences between treatments and between the managed and control plots. In addition, spectral differences among woody species evidence the discriminative ability of multispectral images to retrieve species and functional groups productivity. The planned future campaigns will certainly provide better information on phenological species patterns.

S.08-9-Poster

The expansion of monk parakeet in Mediterranean urban areas: implications for the transmission of parasites by native and invasive vectors

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Invasive species may create novel epidemiological scenarios in the invaded areas, playing a key role in the transmission of actively circulating pathogens. Here, we study the effect of the invasion of both the bird species monk parakeet (Myiositta monachus) and the potential insect vector Aedes albopictus in the transmission of avian malaria parasites in the Barcelona metropolitan area. These species have dramatically increased their abundance and distribution in countries of the Mediterranean basin during the last decade. During 2014-15, 214 monk parakeets and 173 native pigeons (Columba livia) were captured and blood sampled. Furthermore, 3733 mosquitoes of different species were trapped, 130 of them with a recent bloodmeal in their abdomen. The presence and identity of avian malaria parasites and related haemosporidians infecting birds and mosquitoes was recorded using molecular tools. DNA obtained from the abdomen of engorged mosquitoes were used to identify their vertebrate hosts. The invasive Ae. albopictus fed exclusively on mammals while 53.8% of the native mosquito Culex pipiens did on birds, including pigeons and monk parakeets. Avian malaria parasites were found in 5.9% of the Cx. pipiens mosquito pools but none of the Ae. albopictus showed evidence of avian malaria infection. In addition, most pigeons were infected with avian malaria parasites, while the prevalence of infection by blood parasites was only 2.3% in monk parakeets. In conclusion, the invasive species Ae. albopictus and monk parakeets play a minor role in the transmission of locally circulating blood parasites affecting birds in mediterranean urban areas.

S.08-10-Oral

Burnt area prediction in Mediterranean Ecosystems

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In the Mediterranean Basin (MB), fire regime characterization is arduous as human impacts there have modified landscape structure and dynamics for centuries. Weather is a major predictor within approaches aiming at modelling fire regime components such as fire frequency or total area burned in a given time period. However, other variables such as fuel continuity or the effects of fire suppression (e.g., perimeter reduction) can largely influence these fire regime attributes. The objective of this study is to unravel key drivers of annually burnt area in Mediterranean-type ecosystems (MTEs) of the MB. To this end, we developed a predictive model based on 1980-2015 fire data from the western MB (Catalonia). Model predictors included fuel variables (forest continuity and composition) and suppression capacity, plus two groups of weather variables related to: (i) structural drought or hydraulic deficit over several months, and (ii) recurrence of adverse synoptic weather situations. Separate models were adjusted for 9 different Fire Regime Units (FRUs), which define homogeneous topography-climate conditions across the study region. Models achieved, in general, high ability to predict burnt area, and revealed variation in fire drivers across FRUs. For instance, fires in high mountain regions were related to windy situations in winter, whereas large fires in lower, interior lands were more contingent on summer heat waves. Additionally, fire suppression exerts a significant role in burnt area evolution over the last decades. These results provide important insights to better understand fire regimes and can serve to enhance prediction of global change impacts on MTEs.

S.08-11-Oral

Fragmentation effects and extinction debt in South African fynbos

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South African fynbos is threatened by fragmentation through land use and anthropogenic changes to fire regimes. We investigated the consequences of these processes for plants and birds. Our natural experiment design allowed us to look for signs of extinction debt (i.e. delayed extinctions). Vegetation and bird composition and trait data were collected in three South Outeniqua Sandstone Fynbos habitat configurations: fragmented patches (associated with anthropogenically driven habitat loss

S.08-12-Poster

Do landscape properties affect the process of post-fire vegetation recovery? A case study from the Taygetos Mountain, Greece

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Fires of 2007 have consumed large areas of Black pine and endemic fir forests in Greece. The current research aims at examining the role of geomorphology and lithology that govern the soil properties upon the post-fire vegetation recovery at the landscape level. A case study from Taygetos Mt, a large part of which was burned in 2007, is presented. Based on the interpretation of a high spatial and spectral resolution satellite image (WorldView-3, 4/2015), GIS thematic layers have been created showing unburned and regenerated patches over various lithological types. A network of sites was selected for field sampling representing various combinations of the above. Data on recovery of the main tree species as well as on total vegetation cover were collected. Results prove the relationship between regeneration ability and plant species traits as well as the existence of unburned patches near the burned ones. Black pine had regenerated from seeds dispersed from cones that have remained intact on unburned or scorched trees, close enough to the burned patches, while Greek fir presented remarkably low regeneration, lacking of any response mechanism. Plant species recovery seems to be controlled by the geology as it was found weaker in plots overlying carbonate, permeable, not easily erodible formations as compared to that observed over clastic, impermeable, erodible formations of schists, even for the same species. In conclusion, post-fire vegetation recovery at the landscape level seems to be a complex process controlled not only from species biology but also from the landscape features.

S.08-13-Poster

Interactive effects of global change drivers on Quercus suber performance: pathogen damage depend on soil water content

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Mediterranean forests dominated by evergreen oaks (Quercus suber and Quercus ilex) suffer from important problems of defoliation and mortality driven by the exotic soil pathogen Phytophthora cinnamomi and climate change (increasing aridity and frequency of extreme climatic events). However, it is poorly understood whether these two factors - pathogens and climate - interact to determine non-additive effects on oak performance. For this purpose, we conducted a greenhouse experiment where Q. suber seedlings were grown under four hydric levels simulating different climatic scenarios (100%, 50%, 40% and 15% soil water holding capacity) and four densities of P. cinnamomi inoculum (0, 50, 100 and 200 colony forming units per soil gram) in a full-factorial design. We found significant interactive effects of soil water content and pathogen density on seedling performance. The negative effects of P. cinnamomi on root biomass were larger at 100% WHC (simulating extremely rainy springs) than at 15% WHC (simulating extremely dry springs). Extreme soil water contents also had negative effects on fine root biomass independently of pathogen presence. As a consequence, root biomass was larger at intermediate soil water levels (simulating current conditions and mean predicted rainfall reductions). Our results suggest that an increase in the frequency of extreme climatic events could have important impacts on Q. suber performance through their interactive effects with the exotic soil pathogen P. cinnamomi.

S.08-14-Oral

Reconciling biogeographical theory with ecological reality: high resistance to drought-linked growth decline at the Mediterranean range edge of Fagus sylvatica

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Theory suggests that rising temperatures should drive species to higher altitudes and latitudes as growth and establishment improves at the poleward edge of a species distribution and declines at the range edge in the opposite direction. In the Northern hemisphere, case studies from populations at the Mediterranean range edge of a variety of temperate woody species have led us to understand that widespread growth decline and distributional shifts are underway. However, in apparent contrast, others report high productivity and reproduction in some range edge populations. We assessed temporal trends in the growth of the widespread European beech tree (Fagus sylvatica) based on random population sampling across its latitudinal range. We explored impacts of major drought events and the implications for predicted widespread growth decline at its Mediterranean range edge. In contrast to expectations, we found greatest sensitivity and low resistance to drought in the core of the species range, while dry Mediterranean range edge populations showed particularly high resistance to drought and little evidence of drought-linked growth decline. We hypothesise that this high range-edge stability is driven primarily by local environmental factors that allow relict populations to persist despite regionally unfavourable climate. Persistence of such populations demonstrates that range edge decline is not ubiquitous and is likely to be driven by declining population density at the landscape scale rather than sudden and widespread range retraction. We highlight the need for a more sophisticated understanding of range edge structure in order to better model population persistence and loss in this region.

S.08-15-Poster

Biocrusts modulates how climate change affects N2O and CH4 emissions in Mediterranenan grasslands

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Methane (CH4) and nitrous oxide (N2O) are trace gases that play a key role in atmospheric warming. The effect of climate change in the emission of these gases is important since it may cause biotic feedbacks that further reinforce the emission of greenhouse gasses. Lichens, mosses and cyanobacteria communities (biocrusts) may cover up to 70% of dryland soils. Despite the importance of biocrusts little is known about how GHG behave in this systems and how they will respond to climate change. Here we studied CH4 and N2O fluxes in a climate change experiment located in a semiarid grassland dominated by biocrusts in central Spain. The experimental design is fully factorial with three factors: warming ([WA]; ambient vs. ~2.5 °C increase) and rainfall exclusion ([RS]; ambient vs. ~30% reduction in total annual rainfall) and biocrust cover (cover < 10% vs. cover > 70%). We sampled N2O and CH4 once per season through a year. Matching these gas measurements, we took soil samples to evaluate the abundance of functional genes from denitrifiers (nosZ) and methanotrophs (pmoA). Both denitrification and CH4 fixation increased under biocrusts. Rainfall exclusion reduced the emission of both CH4 and N2O. Warming also reduced CH4 fixation rates. The effect of rainfall exclusion (in CH4 emissions) and warming (in CH4 and N2O emissions) depended on environmental conditions. Biocrusts increased the abundance of both denitrifiers and methanotrophs, particularly in the control treatment. Our results highlight the importance of biocrusts as modulators of the emission of GHG to the atmosphere in drylands.

S.08-16-Poster

Responses of Helianthemum squamatum to warming and rainfall reduction in a semiarid shrubland

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Warmer and drier conditions associated with climate change could reduce vegetation productivity and cover in Mediterranean-type drylands, thus increasing the risk of land degradation and desertification. We conducted a four-year manipulative study in a semiarid shrubland to assess the effects of experimental warming and rainfall reduction on the performance of Helianthemum squamatum, which was exposed to a ~2.5ºC temperature increase using open top chambers (Warming, W), ~30% rainfall reduction using rainout shelters (Rainfall Reduction, RR), and their combination (W+RR). Warming reduced the net photosynthetic rates of shrubs by ~30%, despite concurrent increases in stomatal conductance and transpiration. The combination of decreased photosynthesis with increased stomatal conductance led to a drastic reduction (~50%) of water use efficiency under warming. W and W+RR plants had lower leaf N and P concentrations and leaf mass area than controls, and experienced a 32-38% reduction, respectively, in shoot biomass production. RR plants showed moderate reductions (10-20%) in net photosynthesis, stomatal conductance and shoot biomass production relative to controls. Warming reduced post-summer plant survival during a dry year, especially in W+RR plants (40% vs. 70% in the controls). Climate change might thus lead to widespread declines in plant nutrient status, growth and survival through a strong detrimental feedback mechanism whereby plants will need to transpire more water in order to gain less carbon under warmer and drier conditions. These results highlight the vulnerability of Mediterranean shrublands to forecasted climate change, which could send dryland ecosystems into a degradation pathway leading to large decreases in primary productivity.

S.08-17-Poster

Nitrogen deposition impacts on microbial abundance and decomposition in three Mediterranean sites: a coordinated study using the NitroMed network

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Despite the importance of establishing networks of experimental sites to investigate the functional response of the ecosystem to global change and help the formulation of sustainable resource management policies, Mediterranean and semi-arid ecosystems are underrepresented in international networks, including those focusing on the effects of nitrogen (N) deposition on ecosystem structure and processes. To fill this gap, the NitroMed network has been recently established putting together three N manipulation experimental sites, namely Arrábida (Portugal), El Regajal (Spain), and Capo Caccia (Italy). All sites present similar characteristics: i) are all located in the Mediterranean Basin and share similar vegetation; ii) host long-term experiments, iii) are subjected to the addition of N loads similar to those projected for the Mediterranean Basin during this century. NitroMed aims at providing "field laboratories" to investigate the effects of N pollution on structure and functioning of Mediterranean ecosystems with different characteristics sharing protocols, experimental design and whenever possible, equipment. In this work, we applied structural equation modelling to data from the current NitroMed network to understand the cause-effect mechanisms that determine changes in decomposition and stabilization rates in response to different N loads. Our results suggest that N deposition increases soil N availability and reduces soil pH which, in turn, has an effect on microbial community structure (lower fungi to bacteria ratio) and overall enzymatic activity, responsible for decomposition rates. Our findings also show how site-specific heterogeneity can greatly influence ecosystem processes, highlighting the importance to increase the number of experimental sites in the NitroMed network.

S.08-18-Poster

Deer browsing shapes plant community structure in Mediterranean shrublands

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Deer have overpopulated many Mediterranean areas in recent decades. The likely impacts of the increased herbivory pressure on Mediterranean plant communities are, however, unclear. Here we assess the community-wide effects of deer browsing in shrublands of Los Alcornocales Natural Park (southern Spain). We compared plant species diversity, cover, height, and damage intensity within and outside of deer exclosures established 10-15 years ago. Although community composition (species richness and diversity) was similar in fenced and non-fenced areas, shrub height and cover were higher within fenced areas. In contrast, browsing damage was much higher in open areas, particularly for late-successional, highly palatable species. Although most plant species were long-lived and highly resilient, sustained overbrowsing might compromise reproduction and long-term persistence in the landscape. Thus, deer overpopulation is shaping the structure of these Mediterranean shrublands, reducing shrub density and selecting against shade-tolerant species, hence delaying succession.

S.08-19-Poster

May the vegetation structure explain the differences in forest mortality induced by extreme drought observed in four similar Mediterranean pine forest and shrublands?

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The frequency and magnitude of climate extremes are expected to increase in the future according to climate change forecasts. Forest mortality is, among others, a consequence of extreme drought events caused by of the increase of temperature and the decrease of precipitation. In the last years, forest mortality induced by events of extreme drought was observed in pine forests and shrublands in four sites in Mediterranean forests of Alicante province. However, under the closely same drought conditions the mortality rates observed in the different sites were distinct. In this work we intend to explore the role of vegetation structure in the observed differences in forest mortality rates in these four sites. A structural characterization of the different vegetation communities has been carried out by measuring tree density, specific composition, canopy cover and LAI.

S.08-20-Oral

Disparity in the climatic sensitivity across altitudinal and latitudinal gradients imply differential forecasted growth through Scots pine distribution range

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Ongoing changes in global climate are altering ecological conditions for many species. The consequences of such changes are typically most evident at distribution edges, where differences in growth or population dynamics may result in range expansions or contractions. Understanding population responses to different climatic drivers along wide geographical gradients is necessary in order to gain a better understanding on the plant responses to the ongoing changes in climate. We selected Scots pine (Pinus sylvestris) to explore growth responses to climatic variability over the last Century through dendrochronological methods, and performed predictive models to forecast growth trends up to year 2100 using climatic projections. Populations were located at the treeline across a latitudinal gradient covering the northernmost, central and southernmost populations and across an altitudinal gradient at the rear edge of the distribution (higher, central and lowermost elevations). Predictive models forecast a general increase in Scots pine growth at treeline across the latitudinal distribution, with southern populations increasing growth up to year 2050, when it stabilises, highest responsiveness at central latitude, reaching similar values to the southern populations by 2100, and moderate growth increase at the northernmost limit. Contrastingly, growth decline is expected at lowland-southern populations, suggesting an upslope range displacement on the coming decades. The results give us a better resolution about the geographical responses of tree species to climate change and demonstrate the importance of incorporating this variability into predictive models for an accurate prediction of species dynamics under a global change scenario.

S.08-21-Oral

Can we better understand land surface phenology changes using hydrological variables instead of climate variables?

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Land surface phenology (LSP) is described as the seasonal pattern of variation in vegetated land surfaces observed from remote sensing. Vegetation phenology derived from remotely sensed multi-temporal satellite imagery can be used as a bio-indicator for climate change thanks to the strong relationship between phenology and Climate. In previous works in a Mediterranean area in SE Spain, results showed that autumn and spring precipitation and maximum temperature are the climate variables that best explain the changes in LSP metrics. However, due to the torrential character of precipitations in the Mediterranean area the vegetation response is not often proportional to the registered precipitation. In this work, we intend to explore the potentiality of using hydrological variables like soil moisture to improve our understanding of LSP changes under different climate scenarios. The eco-hydrological Hydrobal model is used to simulate soil water balance under different vegetation types and climate scenarios in four sites along a climate gradient in Alicante Province. Pixels from MODIS images with homogeneous vegetation structure are selected and LSP changes are studied in the observed period (2000-2012) and projected over the future period 2040-2099.

S.08-22-Poster

Prediction of tree growth under climate change scenarios using tree rings of Pinus pinea L. in Spain

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Forest growth models can provide information about the response of forest ecosystems to climate change, as well as knowledge to implement adaptive management systems. Dendrochronology permits to reconstruct long-term trends of annual tree growth in relation to climate variability. Here we present multiple linear regression models with climate data and dendrochronological data of Pinus pinea to predict tree growth under future climate change scenarios. The tree-ring series (94-228 years) are from 4 sites across a climatic gradient in Spain, and were standardized with dendroclimatological methods. The climate data were obtained from regional simulations of Eurocordex for one historic period and two scenarios (RCP4.5 and RCP8.5) under different greenhouse gas emissions. In each study area, the models were calibrated and verified using historic climate data at different time scales. Annual precipitation and winter temperatures are significant factors of tree growth in all the study areas. Water deficit due to warmer and drier climate in the future may have negative impacts on forest production. Increases of winter temperatures may alter the ecophysiological response and the phenological patterns of Pinus pinea in Spain.

S.08-23-Poster

How do invasive species cope with different environmental conditions? A proteomic study of two alien crayfish: Procambarus clarkii and Procambarus fallax f. virginalis

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Invasive species are often able to cope with variety environmental conditions enabling them to expand to new habitats. Once introduced and successfully established those invasive species, often threaten native species in their ecosystems. New environmental conditions may act as selective pressures that drive organismal adaptation and evolution. However, alongside genetic adaptation, invasive organisms also show a high degree of plasticity in response to environmental challenge. To elucidate whether epigenetic mechanisms allow an organism to respond to the environment, we study how individuals of two invasive crayfish species respond to environmental challenges by means of a cutting-edge proteomic approach. Our objective is to investigate which types of proteins and how many of each type are expressed when individuals are exposed to different environmental conditions. Our target species are two invasive crayfish, i.e. the red swamp crayfish, Procambarus clarkii; and the parthenogenetic marbled crayfish, Procambarus fallax f. virginalis. The use of a parthenogenetic species will allow us to assess whether changes in protein expression are uniquely due to plasticity (as individuals are genetically identical). We conduct an experiment in which we expose the two crayfish species to treatments consisting of different combinations of temperature and water velocity for several days. After exposure, individuals will be collected and immediately subjected to tissue extraction from the muscle, gills and hepatopancreas to examine the proteome responses. Here, we will present the details of the experimental setup and hypotheses tested as well as any available results.

S.08-24-Poster

Interspecific Artemia responses to sublethal zinc exposure

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Conservation of the biodiversity of brine shrimp Artemia spp. in the Mediterranean region is a matter of great concern. The native Artemia (A. parthenogenetica and A. salina) are threatened owing to habitat alteration and mostly to the competitive exclusion by the exotic A. franciscana. Most studies indicate that pollution generally favours invasion of exotic species. However, a recent study shows local adaptation of native populations to contaminated conditions may prevent colonization by A. franciscana. Under this context, the sublethal toxicity of zinc was assessed in natural populations of A. parthenogenetica from the highly contaminated Odiel estuary (southern Spain), one of the few remaining sites with native Artemia, and in A. franciscana from a less contaminated area (Cadiz bay, Spain, SW Spain). Results showed higher survival and growth rate for A. franciscana than A. parthenogenetica. Both species experienced slower growth and higher mortality when exposed to zinc. However, no significant effects were found in final size. Regarding reproductive parameters, A. parthenogenetica had shorter pre-reproductive period, higher number of broods, higher offspring and lower percentage of non-viable nauplii. Both species showed reduced pre-reproductive period, higher offspring per day, and lower percentage of non-viable nauplii when exposed to Zn. Meanwhile, the reproductive period, number of broods, interbrood period and mode of reproduction were not affected by zinc exposure. Zinc increased total offspring and total offspring per brood in A. parthenogenetica but had not effect in A. franciscana. We discuss the implications of our results for the invasion of A. franciscana.

S.08-25-Poster

Cooper (Cu++) effects on growth and photosynthetic activity of Lemna valdiviana Phil., a potential invasive species en Europe, under different CO2 concentrations

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Lemna valdiviana is an aquatic plant native to America, reported as invasive in Europe, and monitoring seems necessary to assess its status and management. We tested the role of cooper (Cu++, a plant nutrient, heavy metal, that has become a widespread toxin) on plant growth and photosynthetic activity. Further, mainly due to human activities, environmental CO2 concentration has increased in the last century from 280 to 380 ppm, and it is predicted to reach 730-1020 ppm by the end of this century. Consequently, an increased growth response of aquatic plants under a CO2-enriched atmosphere has been suggested particularly for emergent aquatic angiosperm. However, we are not aware of any studies testing the synergistic effect of these factors in aquatic environments. We tested the effect of Cu++ on plant growth, along a concentration gradient (0.0, 0.5, 2.5 Cu2SO4 5H2O mg/l), from differences in plant biomass and photosinthetyc pigments, and under two different CO2 concentrations (environmental and enriched). The results showed that, as Cu++ concentration increases, plant biomass significantly decreases, regardless of CO2 concentration. However, a significant interaction between Cu++ and CO2 when analysing photosynthetic pigments, suggests that the detrimental effect of Cu++ is higher in a CO2-enriched environment. The results indicate that Cu++ concentrations >0.5 mg/l (a much lower tolerance than that reported for other Lemna species) inhibit both growth and pigment biosinthesys, thus negatively affecting plant survival.

S.08-26-Oral

Species climatic niche explains species response to extreme drought in Mediterranean shrublands

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In the Mediterranean biome, climate change is producing increases in temperature and the frequency of drought events. Particularly South-East of Spain has recently suffered the driest hydrological year of his historical records. As a result, several plant communities there experienced die-off episodes. This region represents an ecotone between Mediterranean biome and subtropical shrubland of arid lands offering a perfect opportunity to assess how climate change will affect the biodiversity of the Iberian Peninsula. We use four different species distribution models (SDMs) (Mahalanobis distance, GAM, BRT and MAXENT) to estimate the climatic suitability of different shrubland community species before and during the 2013-2014 extreme drought event. For each SDM, we correlate species' climatic suitability with their demographic responses (green canopy loss and mortality). We find that although climatic suitability values vary slightly among modelling methods, the correlation between canopy cover loss and species climatic suitability is consistently significant with the exception of the poorest performing modeling method. Correlation among species mortality and climatic suitability deviations appeared to be more variable. Thus, species climatic suitability partially explains plant demographic responses to extreme drought events, being more vulnerable those species that are closer to their climatic tolerance limits. This study highlights that climatic niche modelling is a robust approach to standardize and compare the behavior of different coexisting species in front of climatic fluctuations. Nevertheless, differences in performance between SDMs reflect their limitations and the need for further exploration in order to determine the most appropriate procedure.

S.08-27-Poster

Ten years of the Sierra Nevada Global Change Observatory

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After the participation of Sierra Nevada in the UNESCO initiative GLOCHAMORE (GLObal CHAnge in Mountain Regions) in 2007, the importance of common approaches for the world wide monitoring of its effects was clearly highlighted. Sierra Nevada Global Change Observatory was conceived as an early alert system of eventual impact of the human-induced changing scenario. Climate change was not the only element considered, since also broad scope factors, like pollution, alien invasive species and land use changes were also regarded as global change drivers. A Monitoring Programme, along with an information modular system (LINARIA) web accessible, were implemented. A key feature of this Observatory is the strong involvement and integration between the scientific and the management teams working together in this protected area. The common aim is to identify strategies and measures to increase the adaptation and the resilience of natural ecosystems and the local socio-economy to Global Change. As a result of this cooperation, a new management paradigm, the adaptive management, is being formulated jointly, based on long-term monitoring of selected indicators with scientifically validated methodologies. After ten years, the Observatory has gathered a big dataset which includes not only the results from the ongoing Monitoring Programme, but also all the available scientific information from the past. An analysis of this information reveals some trends and consequences of Global Change in the Sierra Nevada ecosystems, both at biological and physical levels, to be shown in detail.

S.08-28-Poster

Fire-vegetation dynamics and biotic filtering add variability in climate change indicators

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Community-based climate change indicators have been proposed to reflect the impacts of global warming on community composition. Here we investigated how much variation landscape dynamics and community assembly drivers can explain in climate change indicators. We predicted changes in a widely used community-based climate change indicator ('Community Temperature Index', CTI) along a wide range of fire-vegetation and climate change scenarios. Fire-vegetation dynamics were simulated using a process-based model that reproduces the spatial interaction between fire, vegetation dynamics and fire management under two IPCC climate scenarios. Potential changes in bird community composition were predicted (2000-2050) using a community-level framework which combined macroecological models of species richness, stacked species distribution models and biotic assemble rules. Overall increases in the CTI were predicted due to the combined impact of climate warming and an increasingly severe fire regime. However, the overall increase in the CTI could be partially counterbalanced by forest expansion driven by land abandonment and efficient fire suppression, because cold-dwelling species tend to be associated with forest areas. The inclusion of macroecological constraints and biotic assembly rules also influenced the variability of CTI by removing those species that are expected to be more negatively affected by climate and land use changes. In conclusion, community-based climate change indicators are strongly dependent on the complex interactions among climate change, landscape dynamics, macroecological constraints and biotic interactions. This stresses the need for explicit incorporation of these interactions to successfully use indicators to interpret and forecast the impacts of climate change in Mediterranean-type ecosystems.

S.08-29-Poster

Birds and honeybees in public forest land and protected areas of Murcia region (SE Spain): A strategy for mitigating predation and agricultural impact on beekeeping

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Beekeeping is a traditional extensive activity through which complementary, non-wood forest products are harvested in Mediterranean ecosystems, while providing some pollination services to their flora. This work has conducted an assessment and developed a scale for scoring apiculture settlements, located in public utility forest land, offered by the Autonomous Community of the Region of Murcia (SE Spain). It has generated a quality index (QI), through which each of the settlements has been assessed. The criteria analyzed have been accessibility, environmental protection, land use and, in more depth, the influence of the wildlife interaction of the European bee-eater (Merops apiaster Linnaeus, 1758) with honeybees (Apis mellifera Linnaeus, 1758), whose risk of being preyed has been assessed through a habitat suitability model for the bird. The evaluation has shown the good condition of the settlements offered, buffering agricultural impacts while reducing exposure to bird predation. These advantages and additional incentives or compensations can attract beekeepers to protected areas and help restore some pollination functions therein. A set of guidelines has been established for an appropriate adjustment of claims in apicultural settlements affected by predation. Also, an assessment has been made of the effectiveness of photo-trapping, as a method for the evaluation and quantification of the impact of the bee-eater on apicultural exploitations. The evaluation methodology can also be used to score apicultural settlements outside public land. Combined with adequate claim adjustment procedures, it can serve as a basis for a regional strategy for sustainable apiculture in natural areas.

S.08-30-Poster

Improving the use of blue water resources under high human demand and water scarcity in Mediterranean catchments by One Health approach. Riera de Cànoves catchment study case

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Humans affect streams by changing land uses in the catchment, altering stream channel morphology, and delivering nutrients, emergent pollutants and pathogens from urban and industrial activities into the streams. These activities clearly threaten the ecosystem health, but also can constitute a human health risk, since streams and rivers are a key water resource for human activity. In Mediterranean streams, these problems are additionally compounded by the scarcity of water. MEDSOUL is a coordinated project, which aims at contributing to the needs of the prioritized challenge of climate change and the resource use efficiency, by providing scientific knowledge and tools to face the management of freshwater resources. A multidisciplinary and collaborative approach has been implemented, using the combination of expertises from a) forest ecology, catchment modeling, and fluvial hydrology b) in-stream biogeochemistry and aquatic plant ecology and c) microbial indicators and dissemination and persistence of waterborne pathogens in the freshwater environment. Here, using the concept of One-Health approach, we present the Riera de Cànoves catchment as a case study. This catchment has a medium-size 12 km2 and the stream flow is intermitent, which remains dry over three to four months in Summer, and is highly influenced by the Waste Water Treatment Plant from the area. The catchment covers different human activities such as forestry, agriculture, and urban settlements. The goal of this work is the evaluation of blue water's health under current and different climate change scenarios.

S.08-31-Poster

Widespread invasion of American brine shrimp in Mediterranean salt pans - what difference does it make?

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The invasion of the American brine shrimp Artemia franciscana is causing a dramatic loss of Artemia biodiversity in Mediterranean salt pan and other hypersaline environments and profoundly affecting ecosystem functioning. In this talk we describe the implications of the invasion at different geographic scales and trophic levels and potential consequences for the flux of contaminants through the food web. Native Artemia species themselves have a great deal of population structure and genetic diversity which is being lost. They are also intermediate hosts of a rich community of avian cestodes with an important ecological role. The invasive species, highly resistant to the infection (as per the Enemy release hypothesis), is affecting parasite diversity and all the ecological processes mediated by them. We discuss the impacts of the invasion on bird communities as well as at lower trophic levels (chlorophyll-a concentration, turbidity), most of which are mediated through the effect of parasites on host trophic ecology (diet, microhabitat selection and feeding rate). Finally, we explore interactions with contaminants and consider how the switch from native to invasive species may change bioaccumulation processes and the intake rates of contaminants by birds.

S.08-32-Oral

Assessing forest vulnerability to climate warming using a process-based model of tree growth: bad prospects for rear-edges

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Growth models can be used to assess forest vulnerability to climate warming. If global warming amplifies water deficit in drought-prone areas, tree populations located at the driest and southernmost distribution limits (rear-edges) should be particularly threatened. We address these questions by projecting growth responses to climate of three major tree species (Abies alba, Pinus sylvestris and P. uncinata) in NE Spain. This Mediterranean continental region encompasses wide climatic and environmental gradients, and it includes the rear edges of these tree species. We used tree-ring width data from 110 forests in combination with the process-based Vaganov-Shashkin Lite growth model and climate-growth analyses to forecast growth changes during the 21st century. Climatic projections were based on four ensembles CO2 emission scenarios. Warm and dry conditions during the growing season constrain A.alba and P.sylvestris growth, particularly at the species rear-edge. By contrast, growth of high-elevation P.uncinata forests is enhanced by climate warming. The emission scenario (RCP8.5) with the most pronounced warming forecasted a mean -14% growth-reduction in A.alba and P.sylvestris after 2050. This indicates that rising temperatures could amplify drought stress and constrain the growth of theses rear-edges at xeric sites. P.uncianata growth is expected to increase by +12.5% due to a longer and warmer growing season. The projections of growth reduction in A.alba and P.sylvestris portend dieback and a contraction of species distribution areas through local extinctions of the most vulnerable driest rear-edge stands. Our modeling approach provides accessible tools to evaluate forest vulnerability to warmer conditions.

S.08-33-Oral

Ecosystem consequences of Aleppo pine colonization in dry oak woodlands

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Colonization of plant communities by non-resident species is becoming prevalent as a result of land use changes, with potential implication to the structure of the resident vegetation and functioning of the ecosystem. We studied the consequences of colonization of Mediterranean shrublands and woodlands by Aleppo pine (Pinus halepensis) spreading from plantations, highlighting the importance of the pine colonists' effect on the availability and distribution of limiting resources to the resident Mediterranean species. We show how colonization of dry oak-woodlands is affecting soil resources, litter decomposition, and water availability to the resident drought-resistant oak (Quercus calliprinos). Two years of monitoring the predawn water potential of oaks reveal that the water stress of oaks increased along the dry season, with small oaks becoming more severely stressed than large ones. During the dry season, a neighboring pine colonist increased the water stress of the resident oak. During the wet season, a neighboring pine colonist reduced the water stress (facilitation) mainly for large oaks. Our findings indicate that pine colonization differentially affects resource and water limitation for resident oaks with implications for future development and regeneration. The influence of pine colonists shifted from facilitation to competition along a seasonally increasing water-stress gradient. Our work demonstrates how colonization by non-resident species can influence key ecosystem processes through the redistribution of limiting resources. Identifying these processes is fundamental for understanding the consequences of colonization and for predicting future trends in human-altered ecosystems.

S.08-34-Oral

Post-fire conifer regeneration in severely burned forests: deterministic versus stochastic drivers

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Changes in disturbance regimes have the potential to substantially alter post-disturbance plant community assembly, particularly when regeneration mechanisms become out of synch with the novel disturbance. In mixed conifer forests of California, USA, the foundation conifer species (ponderosa pine, sugar pine, white fir, Douglas-fir, incense-cedar) are well-adapted to a low and moderate severity fire disturbance regime, with some small patches (1,000s ha) in recent decades, which could have significant impacts on forest regeneration. These conifers lack serotiny and generally disperse seeds

S.08-35-Oral

Shifting patterns of California fire and forest landscapes in an era of global change

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Fire size and severity are increasing throughout much of California, influencing many of its Mediterranean-type ecosystems. In this study we further characterize these changing patterns of fire and forest landscape heterogeneity by assessing trends in burn severity class composition and spatial patterns across California's forested bioregions. Such broad shifts in fire regimes are attributable to a combination of forest management and climate change, and have implications for landscape pattern, plant succession, and wildlife habitat quality. We observed opposite trends within the unchanged and high-severity components of fires, with decreases in the proportion of unchanged forest within fire perimeters along with declining distance to patch edge. Conversely, the amount of high-severity fire and distance to high-severity edges are increasing over time. Likewise, areas within high-severity patches isolated from seed sources and at risk of type conversion from conifer forests are increasing in some cases. Conversion or delayed succession would benefit chaparral and hardwood species at the expense of conifer forests and associated wildlife. Our analysis also shows the total edge between severity classes is increasing over time, but that edge density is largely stable. Changes in the amount of edge habitat created by fire may affect the occurrence and abundance of wildlife species sensitive to forest ecotones. Additionally, fire-induced changes in spatial patterns may influence landscape resilience to future burns, which are predicted to continue increasing in frequency and severity as climate change intensifies.

S.08-36-Oral

Towards a better understanding of ecological marginality at the trailing edge of species ranges

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According to biogeographical theory the rapid change in the Earth's climate should become favourable for population expansion at the leading edge of species distribution, and the converse at the trailing edge, where increased drought conditions should constrain population persistence inducing range contraction. However, while populations in the trailing edge are considered to be ecologically marginal, range contractions are rarely reported and the negative impacts of climate change are not restricted to the trailing edge of species ranges. We argue that this disparity is due to the confusion of ecological margins with geographical margins and to the misuse and simplification of the concept of ecological marginality. Here, using as a model species the widespread common beech tree (Fagus sylvatica L.) we present the first results on the population structure and demographic patterns of a field-based approach built upon an experimental design that combines explicitly the concepts of ecological and geographical marginality. Our results show that the expected ecological marginality at the biogeographic scale does not always match with the ecological reality at the population scale. The patterns observed support the hypothesis that some populations might correspond to relict populations which persist locally despite unfavourable regional climates. Disentangling the ecological and adaptive basis on the structure and dynamics of populations at the trailing edge of species ranges will help to advance towards a better understanding on the potential for persistence of populations and to better predict range contractions with changing climatic conditions.

S.08-37-Oral

Large old trees in forests of Mediterranean-climate ecosystems: challenges for conservation

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Interactions between fire and the tree form are a hallmark of forests in fire-prone MTEs (> 65% winter rainfall). Here many species form large old trees, including some of the largest and oldest organisms. One response to fire has favoured investment in long-lasting organs requiring adaptations to cope with low nutrients, avoid damage, and escape the fire trap. Taxonomic affinity and biogeographic history are also important, a reason for a lack of large old trees in the South African (CAPE) MTE. Eucalypts feature in the Australian MTE (AUS) where tall open-forests include several shade intolerant, fire regenerators of rapid early height growth, capable of > 70 m height with senescence after c. 500 years. Among conifers, Cupressaceae is disproportionately represented in MTEs, with several species capable of great age or size in drier Mediterranean basin (MED) climates. The high rainfall North American MTE (CAL) includes the tallest, largest and oldest trees (chiefly Cupressaceae and Pinaceae). These regenerate in tree-fall gaps and grow slowly where return intervals of destructive fires are long, or in semi-arid areas, also with long fire-return intervals. Large old Chilean (CHI) trees include both fire-resistant conifers (Cupressaceae, Araucariaceae) and fire-intolerant angiosperms (Nothofagaceae). The MED also includes many fire-resistant and vertebrate dispersed sclerophyllous angiosperms. MED forested life zones have been modified by 10 000 years of agriculture, pastoralism and resource extraction. Here the scant evidence of primary forest provides a prognosis under anthropogenic global warming. Increased protection and valorisation of individual trees and old growth forests is required.

Sp.01: Across-kingdom mutualistic interactions of Mediterranean endemic plants

Sp.01-1-Main talk

Coexistence in diverse coflowering communities: importance of post-pollination interactions

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In the wild plants exist in multispecies groups and often share pollinators which can lead to exchange of pollen between different species. Interspecific pollen transfer leads to conspecific pollen loss and heterospecific pollen receipt, the latter of which leads to a unique suite of plant-plant interactions on the stigma. The question of how plant-pollinator interactions contribute to flowering plant communities has largely focused on plant traits that mediate pre-pollination interactions, and ignored the potential for traits that mediate these post-pollination processes. In this talk I describe how common and complex post-pollination interactions can be in the wild, especially in the diverse coflowering communities of the serpentine in California. I further explore the diverse effects of heterospecific pollen receipt on plant fitness, with a focus on understanding the traits that mediate this diversity. I put forward a hypothesis for the involvement of post-pollination interactions in plant species coexistence and test elements of it with data from the serpentine seep communities. By understanding the consequences of plant interactions via their shared pollinators we can better predict sustainability of natural flowering plant communities, as well as the consequences of disruption of these from global change, such as climate warming, invasive species, or pollinator decline.

Sp.01-2-Oral

Pollinators can change the plant-plant competition regimes

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Plant coexistence is an important subject of enquiry among ecologist. One of the most important factors that regulates plant coexistence is competence for abiotic resources among plants. Recent advances in coexistence theory posits that is the jointly combination of niche and fitness differences which determine species abundances and community composition at the scale of local interactions. Niche and fitness are usually explored in relation to abiotic conditions. However, the role of biotic resources like pollinators is rarely incorporated despite pollinators can affect both the plants fitness and its niche. Here, we surveyed all annual plants in a grassland community in Doñana National Park (Spain) and measure for several individuals its fitness (i.e. seed set), competition levels and pollinator attraction and combine the measured biotic and abiotic factors in mathematical models describing plant-plant competition. As expected, results indicate that competition plays an important role in determining species coexistence, with plants surrounded by more neighbours experiencing lower seed set. However, this relationship is modified by pollinators. For example, for Chamamelum fuscatum, at low competition increased pollination increases the overall fitness, but at high competition there is no gain from having more pollinators. Overall, we highlight the importance of considering complex multitrophic interactions when looking for mechanisms of species coexistence.

Sp.01-3-Oral

On the ecological integration of Eucalyptus globulus in NW Spain: new pollination and mycorrhizal interactions with local birds and fungi

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Blue Gum (Eucalyptus globulus) has been extensively planted in many Mediterranean countries for pulpwood production. Its introduction in Europe dates back to the early 19th century, and massive planting in NW Spain occurred especially since the 1980's. The ability of alien species to naturalize and expand in new areas highly depends on the establishment of new interactions. In this study we analyse new mutualist interactions between E. globulus and the local avifauna for pollination, and with the local fungal community for the formation of mycorrhizae. Blue Gum is pollinated mainly by birds in its native area in Australia, where bird pollination is common. In Europe, however, there are no specialized nectar-feeding birds and plant adaptation for bird pollination is extremely rare among plants. Despite this fact, the presence of Eucalypt pollen in local birds in NW Spain is common among passerines in the proximities of plantations, which shows the extensive use of this resource. Differences in the pollen content between individuals of different sexes and body condition were analyzed for Sylvia atricapilla, the species showing more pollen. In regard to mycorrhizal interactions, Blue Gum showed less diversity of mycorrhizae than native pines (Pinus pinaster) and oaks (Quercus robur), but eucalypts established in native forests showed more diversity, including interactions with native mycorrhiza, which might facilitate the naturalization and expansion of eucalypts in this area of introduction.

Sp.01-4-Oral

Why pollinators cooperate with rewardless deceit pollinated plants?

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The persistence of deceit pollination can be explained in part by plant strategies developed to attract and cheat pollinators, and by the constrained neuronal capacity of pollinators. The stability of this animal-plant relationship depends on the mechanisms utilized by the partners involved in the interaction to avoid overexploitation by any of the participants. For example, insects have developed the capacity to recognize deception and learned to avoid it quickly, affecting negatively plant fitness. In this study we assessed the effect of blow flies, the main pollinators of the self-incompatible plant A. chilensis (Aristolochiaceae), on reproductive success. We also evaluated the capacity of insects to avoid deception and the potential benefits offered by the plant to compensate for the pollination service. Our study shows that flies increase plant fitness and, after flower visitation they tend to avoid other flowers suggesting that they are capable of learning. Our results also show that plants may compensate insects for the pollination service by offering shelter for copulation and an adequate thermal environment provided by the plant´s thermogenic activity. Our results suggest that collaboration between partners is necessary to maintain the evolutionary stability of the mutualism.

Sp.01-5-Oral

Mutualisms in the balance: Review of the pollinating seed predation interactions between Silene species and Hadena moths in the light of recent data from Mediterranean species

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Pollination is always the first cited example of plant-animal mutualisms. However, pollinator animals do not always act as mutualists for plants, and the balance between mutualism and parasitism sometimes depends on the ecological context and the presence of third-parties. A clear example is the so-called nursery pollination, or pollinating seed predation: when pollinators use the reproductive structures of the same plant to feed their offspring. These systems can be highly specialized, like figs and some wasps, or facultative for the presence of co-pollinators, like many Silene and other Caryophyllaceae plants and Hadena moths. In these facultative systems the interaction between the nursery pollinator and its host plant may shift between mutualism and parasitism, depending on the pollination-predation net outcome and on the importance of co-pollinators. The only revision of the Silene-Hadena system to date, ten years ago, was based mainly in species with wide distribution from north and center of Europe and North America. However, there was no information from the Mediterranean region, which is paradoxically one of the global diversification centers of Hadena and Caryophyllaceae. The aim of this presentation is to review the state of knowledge of this pollinating seed predation system with the addition of recent data from Spain. We will assess the diversity, degree of specialization and geographical variation of this system, with special reference for Mediterranean endemics and partners not described before. We will also assess the ecological conditions that may shift the interaction between mutualisms and parasitism in the light of recent case studies.

Sp.01-6-Oral

Cascading effects of differences in pollinator diversity and service between endemic and widespread Aquilegia from western Mediterranean mountains

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Narrowly endemic taxa from plant diversity hotspots of the western Mediterranean Basin tend to occupy marginal, harsher habitats than wide-ranging congeners, and they may also differ with regard to their mutualistic interactions with animals, breeding system, and population genetics. All these aspects have been rarely considered simultaneously for particular endemic-widespread species pairs. We studied populations of wide-ranging Aquilegia vulgaris and narrowly endemic Aquilegia cazorlensis in the Sierra de Cazorla mountains of southeastern Spain, and compared estimated pollinator diversity (Hill numbers framework), pollinator service (per flower per time unit visitation probability), breeding system (spontaneous autogamy, pollen limitation) and within-population inbreeding level (FIS, estimated by genotyping individuals with microsatellites). Pollinator diversity estimates (Hill numbers for q = 0 to 2) and pollinator service were both significantly higher in A. vulgaris than in A. cazorlensis. Spontaneous autogamy levels were much higher in A. cazorlensis, which depended much less on pollinators for fruit and seed production than A. vulgaris. As expected from the contrasting breeding systems, A. cazorlensis populations were substantially more inbred than those of A. vulgaris. Taken together, our results show that the ecological marginality of endemic Mediterranean plants may have cascading consequences in terms of pollinator diversity and service, breeding system and genetic diversity. Impact of inbreeding on the population dynamics and evolutionary trajectory of narrowly endemic plants will ultimately depend on population fragmentation, genetic drift, the magnitude of inbreeding depression, and gene immigration frequency ('genetic rescue'), all of which are expected to act in very species-specific ways.

Sp.01-7-Oral

Using diversity profiles for addressing facilitation effect of shrub in a Mediterranean grassland

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Quantifying diversity is a central goal in ecology. Many indices have been proposed to perform this task but the use of a single index underestimates the multidimensional nature of biodiversity. To solve this limitation, some authors have proposed the use of diversity profiles that engage multiple diversity indices in a unified plot (Hill, 1973, Patil and Taillie, 1982, Tòthmérész, 1995). Our aim is to investigate biodiversity patterns in a secondary succession process after fire disturbance. We study a twelve-year series of cover data in a Mediterranean grassland exposed to high grazing pressure. We hypothesized (1) that there are great differences in biodiversity profiles among communities situated under and far from shrub canopy; (2) that communities situated in open field are more influenced by year-to-year environmental fluctuations than the ones that are covered by shrubs. We estimated “true diversities” proposed by Jost (2006) that are based on the calculation of effective numbers of species (Hill, 1973). We used these values to plot diversity profiles that allowed us to compare different communities and helped to reveal underlying patterns in community structure. In order to group communities according to their similarity, we also applied multiple-site similarity measures for abundance data and multivariate analysis. Our results showed that there were differences in biodiversity profiles depending on the influence of shrub canopy and that the environmental conditions do not affected them the same way: dissimilarity between plots was higher in bad years.

Sp.02: Filling current knowledge gaps: understanding the role of plant-soil interactions in the MTEs

Sp.02-1-Main talk

Plant-soil feedbacks exacerbate the detrimental impacts of warming and rainfall reduction on vegetation in a semiarid shrubland ecosystem

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We conducted a 4-year manipulative experiment in a semiarid shrubland in Southeastern Spain in which we simulated the warmer and drier climate conditions forecasted for the Mediterranean Region. We evaluated the effects of warming (W), rainfall reduction (RR) and their combination (W+RR) on the performance of a native plant community, with a focus on six coexisting shrub species. Warming (W and W+RR treatments) consistently decreased net photosynthesis rate and water use efficiency across species throughout the study. Shoot dry biomass production was strongly decreased by the three climate manipulation treatments in all the target species. Leaf nutrient (N, P, K, Fe, Zn, Cu) concentrations and pool sizes in foliage were decreased by warming across species, indicating reduced plant nutrient uptake and status. Plant survival rate at the end of the 4 yr. study period was also drastically decreased by experimental warming. In contrast to the strong detrimental effects of warming on plant performance, microbial biomass in rhizosphere soil increased in response to warming. However, despite increased soil microbial biomass, the activity and/or production efficiency of key microbial extracellular enzymes for soil nutrient cycling (phosphatase, urease, glycine-aminopeptidase) were significantly decreased by warming, suggesting slowed N and P mobilization and cycling rates and increased microbial immobilization, especially in the W+RR treatment. Overall, the data indicate that a warmer and drier climate could shift the competitive balance between plants and soil microbes, thereby exacerbating nutrient limitation of photosynthesis, with detrimental feedback effects on vegetation productivity and cover in this primarily water-limited ecosystem

Sp.02-2-Oral

Soil respiration in drylands: controlling factors and thresholds

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Soil respiration (SR) is a major component of the global carbon cycle and plays a crucial role in ecosystems feedback to climate change. Although the importance of drylands for the global carbon cycle has been long recognised, a proper understanding of the response of SR to environmental variables in these ecosystems is still lacking. Empirical modelling is an essential tool for predicting ecosystem responses to climate change as well as provide important data for feeding and calibrating process-based models. Many studies on SR dynamics and its abiotic drivers in drylands have been published recently but so far these data have not been gathered and analysed properly to identify the thresholds and the relationship between them in these dry environments. This synthesis study aims to explore the relationships between soil temperature and moisture thresholds that control SR and local climatic variables across twenty arid and semiarid shrublands with different climate regimes (maritime, continental and alpine). Specifically, we aim to: i) identify soil temperature and moisture thresholds of SR across drylands with different climatic conditions; ii) explore the relationships between soil temperature and moisture thresholds of SR and local climatic variables; and iii) understand the interactions between thresholds. Preliminary results show higher threshold values of soil temperature at the warmest sites while lower threshold values of soil water content were observed at the driest ones, suggesting an important adaptation of the soil system to the site-specific abiotic conditions.

Sp.02-3-Oral

Plant-soil interactions as modulatory mechanism of adaptive capacity to global change in relict conifer forests

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The Natural Park of Sierra de las Nieves in Málaga, Spain, hosts the main extensions of Abies pinsapo Boiss. forests, a relict conifer tree currently threatened by global change effects such as intense droughts, fungal pathogens, fire and overgrazing. Many climatic models have focused on two widely known factors of forest vulnerability: exposure and sensitivity. However, forest's adaptive capacity is a third factor that has gained much less attention despite its importance to develop protocols against global change effects. In this context, our purpose was to integrate plant-soil interactions as a modulatory mechanism of adaptive capacity to global change by characterizing the role of the ectomycorrhizal (ECM) and microbial community in the re-colonization processes of Abies pinsapo forests, both in the lowest (rear-edge) and in the highest distribution limit (front-edge). Thus, we collected 140 samples of root tips colonized with ECM from trees previously georeferenced and biometrically characterized. Subsequently, we extracted the DNA and sequenced the ITS and 16S regions with Illumina MiSeq technologies in order to characterize fungal and bacterial diversity and to analyze which ECM and soil bacterial groups might be involved in the processes that mitigate the forest retraction in lower ecotones and promote the colonization process in upper ecotones. We hypothesize that vulnerability to global change not only depends on climate sensitivity but also on modulatory mechanisms of their adaptive capacity to change such as plant-soil interactions, which have been less considered in spite of their potential role.

Sp.02-4-Poster

Biocrusts role on labile carbon and microbial communities from underlying soils in drylands

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Biocrusts cover most of the soil surface in drylands playing a crucial role in carbon cycle. Nevertheless little is known about the influence of different biocrusts types in the labile C decomposition and its effect in microbial communities from underlying soils. This allowed to know the differences of carbon labil in diverse biocrust. Furthermore, metagenomic analysis gave us differences in structure, size and composition of microbial communities from underlying.

Sp.02-5-Poster

Lichen translocation in gypsum disturbed environments: A tool for the recovery of biological crusts affected by quarrying

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The loss of biological soil crusts represents a challenge for the restoration of disturbed environments, specifically in particular substrates hosting unique lichen communities. However, the recovery of lichen species affected by mining has rarely been addressed in restoration projects. In this study, we evaluate the applicability of translocation to restore a representative species of gypsum lichen communities affected by quarrying. We collected thalli of Diploschistes diacapsis from their pre-disturbed habitat and experimentally translocated them onto gypsum spoils. We tested whether a selection of adhesives could improve their attachment to the substrate without compromising their vitality (as CO2 exchange and fluorescence) in rainfall-simulation and field experiments. Adhesives included: water, hydroseeding stabilizer, Arabic gum, white glue, synthetic resin glue and a control with no adhesive. Thalli attachment differed depending on the adhesive only in the field experiment with glue and water performing best, whereas any of treatments seemed to compromise CO2 exchange or affect fluorescence yield. Interestingly, we did found wet spoils followed by subsequent drying allowed thalli to bond to the substrate, playing a central role in lichen attachment. The amenability to translocation of D. diacapsis was confirmed over the short term validating the methods used. The satisfactory results simply using water on gypsum spoil encourage to test this methodology with other lichen species with similar characteristics. Implementing these measures in restoration projects would not only help to recover lichen species in the disturbed areas but also to take advantage of an extremely valuable biological material that otherwise would be lost.

Sp.02-6-Poster

Improved soil degraded by excess salt through treatment with plants for use in crops

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The southwest of the Iberian Peninsula is influenced by the prevailing environmental decompensation, an example is the process of desertification affecting that area adding salt to soil. In fact, the half of irrigated agricultural areas, are mainly in arid and semi-arid areas are affected by salinization. Besides the plants of agricultural interest are often not adapted to saline environments. Salinization is a reversible process and a new way for the recovery of contaminated areas is the phytodesalinization (more natural and cheaper than others). Arthrocnemum macrostachyum is a halophyte plant species used in the process of phytodesalinization in this research. After treatment for 35 days, the concentration of sodium in the stem of Arthrocnemum macrostachyum rose from 51 mg/g to 121 mg/g dry weight. Reflecting this accumulation in the plant was a decrease of 58% of electrical conductance in soil, and the total sodium decreased by 26%. All this, showed in a recovery of the soil, initially which have been infertile and recovered to 20% of germination of wheat; and barley was increased to 30%. In conclusion, Arthrocnemum macrostachyum can be very helpful in restoring degraded soil by the presence of salts, and therefore recovery both areas for agricultural use or natural restoration of ecosystem.

Sp.02-7-Oral

Estimating the water resource of forest stands in the Mediterranean basin using the eco-hydrological equilibrium hypothesis

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In water-limited ecosystems, such as Mediterranean ones, the amount of water plants can access (the Available Soil Water Content, ASWC) is a key determinant of forest demography (tree growth, mortality) and function (water and carbon fluxes). Although the link between ASWC and the soil physical properties can be modelled through pedotransfer functions, the local estimation of the ASWC is limited by the difficulty to measure the rooting depth (Z) of trees and their Fine Roots Distribution (FRD) in the soil profile. Here, we estimate Z and FRD for different forest plots, located in Catalonia (North-East Spain), using the Eco-Hydrological Equilibrium hypothesis and a simplified representation of plant hydraulics. We assume that forest stands conform to this hypothesis and therefore maximize transpiration within the limits of acceptable drought stress, characterized using species-specific critical leaf water potentials. We simulate leaf water potential and transpiration for different combinations of Z and FRD with a simple water balance model. Using our Z and FRD estimates generally improved the fit between simulated and observed transpiration (derived from sap flow measurements) relative to simulations using previously available values of Z and FRD. Furthermore, the Z and FRD estimates obtained using our method at the driest plots approached the values corresponding to the best fit to observations. Our method has the potential to palliate the lack of data concerning ASWC using only information on stand structure and plant hydraulic properties and could therefore enhance the modeling of water fluxes at large spatial scales.

Sp.02-8-Oral

Drought stress alleviation induced by Plant Growth Promoting Rhizobacteria (PGPR) in Caesalpinia spinosa, a fog forest tree

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Caesalpinia spinosa (tara) is the dominant legume tree in the Atiquipa fog forest, a hotspot of biodiversity and natural resources sustained by seasonal fogs, in the middle of the inhospitable Peruvian coastal desert. Intensive land use and deforestation are threatening this fragile ecosystem and restoration projects are urgently needed. Indigenous PGPR adapted to local environmental conditions may act as efficient plant growth promoters, enhancing the plant establishment in the field. The main objective of this study was to evaluate the growth promotion and drought alleviation capacities of autochthonous bacterial strains on tara seedlings, to be used as inoculants in ecological restoration projects. Chemical fertilization produced a clear positive effect on plant morphology, although under drought, it caused a higher water stress on plants, reducing their photosynthetic capacity. By contrast, bacterial inoculation (i.e. biological fertilization) did not promote the growth of tara, but some strains improved the capacity of plants to tolerate drought. The Pseudomonas strain RC5.5 increased the water content, photosynthetic rate, WUE and photochemical efficiency of drought-stressed plants, and it has been delineated as a good candidate for inoculation of plants destined to reforestation or restoration in the area. Our results indicate that inoculation with selected PGPRs may represent a viable fertilization option to produce quality seedlings in nursery. Moreover, selected rhizobacteria can modulate the physiological response of trees for better withstanding environmental stresses.

Sp.02-9-Poster

Quercus suber decline alters soil food webs as indicated by soil nematodes

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In the last decades many forests worldwide have experienced an increase in tree defoliation and mortality associated to global change drivers. The implications of tree decline for the structure and function of soil communities is however poorly understood. In this work we analyze the impacts of the decline of Quercus suber in the Iberian Peninsula on the structure of soil food webs as indicated by soil nematodes. Soil nematodes comprise different trophic groups and are strongly linked to the microbial community; therefore they are considered valuable bio-indicators of the response of soil food webs to changes in environmental conditions. We took soil samples in four different forest sites using a spatially-explicit design and identified nematodes to the genus level. We used neighborhood models to predict the abundance, diversity and trophic structure of the nematode community as a function of the distribution and health status of the tree and shrub community. Our results did not support any effect of neighbor health or identity on nematode abundance and diversity. However, we found that tree neighborhoods dominated by defoliated and dead Q. suber trees showed higher abundance of bacterial-feeding nematodes, higher values of the Enrichment Index (indicative of an increment of opportunistic nematodes), and lower values of the Channel Index (indicative of the predominance of the bacterial decomposition pathway) than healthy neighborhoods. Overall, our results suggest that the decline of Q. suber causes major shifts in the structure of nematode communities and the channeling of energy through decomposer food webs.

Sp.02-10-Oral

Effects of litter quality on soil microbial community composition and CO2 fluxes in a Mediterranean ecotone forest

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Over recent decades, altitudinal shifts from Scots pine forest to Pyrenean oak forest has been observed in Mediterranean ecosystems due to global change. The forest conversion from conifer to broadleaf species in ecotones involves changes in the quality and quantity of plant litter inputs to the soil. How different plant litter quality might affect soil microbial community composition and functioning is still uncertain. We conducted a full-factorial microcosms experiment to investigate the effects of three types of litter (needles, mixed 1:1 needles-leaves and leaves) in soil microbial community composition and soil CO2 emissions. We used three soil inoculums representing different sequential habitats of the secondary vegetation succession (pure pine, mixed pine-oak and pure oak forest) with contrasting soil microbiota, C and N stocks. Changes in nutrients, soil microbial biomass and composition were assessed in soils prior and after the incubation period. Litter amendments increased soil CO2 fluxes compared to controls in all treatments due to several mechanisms of priming effects (PE). First, a negative PE occurred in all cases suggesting a preferential substrate utilization by microbes. Then, a positive PE took place due to the high microbial growth. Litter treatments affected differently the microbial demand for labile fractions of C and N in soils from different forest type. Several mechanisms of positive PE could be behind this different nutrient demand, supported by both changes in microbial biomass and PLFA patterns. Therefore, changes in litter quality could modify microbial composition and functioning, which may affect the biogeochemical cycles.

Sp.02-11-Poster

Effect of forest management and ungulate grazing on litter quality of holm oak (Quercus ilex L.)

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Litter quality is crucial for the exchange of carbon and nutrients between aboveground and belowground ecosystem compartments through its effect on litter decomposition. Although the effect of grazing on forest ecosystems has been investigated in various studies, the interactive effect that native ungulates and forest management can have on litter quality and litter decomposition is not clear. We analyzed litter quality of Quercus ilex leaves in Cabañeros National Park (Ciudad Real province, Central Spain), following a factorial design that compared holm oak trees growing inside and outside ungulate exclosure plots with contrasting forest management (closed forest versus open savannah woodland). Results show significant differences in the content of carbon (C), nitrogen (N), phenols, cellulose and hemicellulose between treatments. In particular, leaf N content was affected by both the presence of ungulates (less N in exclusion plots) and management (less N in forest than in open woodland). Leaf C content, on the contrary, followed and opposite pattern, which exacerbated the differences between treatments in C/N ratio, an important indicator of litter quality. On the other hand, phenols were positively, rather than negatively, affected by ungulate exclosure, which may be explained by indirect positive effects on small herbivores such as many insects that pupate on the ground. In conclusion, interactions between management and the pressure of large herbivores have a great impact on C and N cycles through their influence on litter quality of Quercus ilex.

Sp.02-12-Oral

Rates of heterotrophic respiration and their sensitivity to temperature in a gradient of Quercus ilex dieback

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Despite being a species adapted to the harsh environmental conditions of the continental Mediterranean areas of the Iberian Peninsula, holm oaks (Quercus ilex subsp ballota) are already experiencing signs of vulnerability (evidenced by defoliation) to the increasingly drier and warmer conditions associated with climate change. In this study, we tried to understand how climate-change induced defoliation in holm oak stands might affect plant-soil interactions. More specifically, our objective was to understand how holm oak die-off could potentially affect soil carbon dynamics as well as the soil heterotrophic respiration (RH) and its sensitivity to temperature (Q10, relative increase in RH per 10 degrees Celsius). We selected 18 different plots throughout the Iberian Peninsula, 13 from holm oaks population showing defoliation and dieback symptoms (affected plots) and 5 from healthy holm oaks populations (control plots). Soil samples were collected under the influence of Quercus ilex (0,5 m radius around the trunk) at different stages of defoliation (healthy, defoliated, dead and under no tree influence). We measured soil carbon, nutritional properties and pH for each soil, as well as the sensitivity to temperature of RH using a temperature-response curve ranging from 5 to 35 ºC. While soil heterotrophic respiration was, in general, very sensitive to increasing temperatures, we also observed differences in rates and temperature sensitivity of RH between soils from different locations and soils under canopies of different health. Rates of RH were positively affected by tree presence, but both rates and Q10 were strongly modulated by the health of the tree.

Sp.02-13-Poster

Warming and biocrusts alter soil P fractions in a semi-arid ecosystem

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Climate change is expected to increase the degree of aridity experienced by drylands worldwide. This increase will have a major impact on biogeochemical cycles and may produce an imbalance in the nitrogen (N): phosphorus (P) ratios. At the same time, the role of P as limiting factor of primary productivity in terrestrial ecosystems can be exacerbated and extended to those ecosystems affected by increasing atmospheric N deposition. Despite this, the resilence of organic and inorganic fractions of P in semiarid ecosystems is unknown. We hypothesized that in arid ecosystems warming might cause an increase the inorganic P fractions versus the organic ones due to the decrease of biological activity, and that these changes may be modulated by the presence of biocrusts, a key biotic community in drylands worldwide. The aim of this study was to evaluate how warming, rainfall exclusion and biocrust cover affect inorganic and organic fractions of P in a 5-yr field experiment. We quantified proportions of organic and inorganic P in surface soils. Biocrusts had a strong influence in all P fractions, increasing both inorganic and organic fractions, but with a net increase in the inorganic:organic ratio. Soil warming significantly increased the labile inorganic P (NaHCO3-P) fraction and altered the inorganic:organic ratio in the fractions associated with calcium carbonates and sulfates (HCl-P). Reductions in rainfall did not affect the P fractions measured. Our results suggest that climate change may influence the P biogechemistry both directly and indirectly, by influencing the cover and performance of biocrusts in drylands.

Sp.02-14-Oral

Understanding feedback processes between holm oak (Quercus ilex) and their ectomycorrhizal fungal symbionts in trace-element polluted soils in Mediterranean ecosystems

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Ectomycorrhizal (ECM) fungi might play a major role in host plant establishment in polluted soils, by increasing plant nutrient supply and providing protection against pollutants. At the same time, host plants modify soil environment and allocate C substrates to ECM fungi, influencing the composition of associated ECM communities. These bi-directional relationships between host tree species and ECM communities are largely unexplored for Mediterranean ecosystems. Here, we characterized ECM fungal communities associated to Holm oak (Quercus ilex subsp. ballota) saplings in soils with a broad range of pH and trace element pollution, in Southern Spain. ECM species composition and relative abundance varied significantly among the studied sites. Soil abiotic conditions, such as pH and Ca, were influential in the ECM species distribution. Moreover, we found significant relationships between host tree traits and the ECM species distribution pattern. Specific leaf area (SLA) and the concentration of K, Mn, Ni and Cd in leaves were significantly correlated with the main trend of variation of ECM communities. Root chemical traits also correlated with the distribution of ECM species; in particular the concentration of macronutrients such as Ca, Mg and P, and trace elements such as Mn, Co, Cu and Cd. We explored causal models, through a structural equation modelling (SEM), to elucidate whether the influence of soil chemistry on host functional traits is mediated by changes in ECM diversity.

Sp.02-15-Oral

Contrasting effects of wildfires on above- and belowground phylogenetic diversity

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Wildfires alter the community structure of plants and soil microbes leading to changes in their phylogenetic diversity. While fire decreases the phylogenetic diversity of plants based on the recruitment of evolutionarily related species with post-fire seed persistence, it increases that of soil microbes due to stronger competition for newly available resources between close relatives. Furthermore, phylogenetically diverse plant communities enhance soil fertility, what can in turn reduce soil microbial phylogenetic diversity by favouring a few competitive clades. We postulated that post-fire recovery, by restoring plant diversity and thus soil fertility, might lower down the levels of soil microbial phylogenetic diversity. We established three 20-year chronosequences including 25 Mediterranean sites which had experienced a single fire event between 1994 and 2014, and 25 unburned sites in a paired design. We registered plant composition and abundance, and collected soil samples, along 150 25m-transects (n=3 per site). We analysed soil fertility and pyrosequenced the SSU rRNA genes of soil fungi, bacteria and archaea. Fire had opposing effects on plant and soil microbial (fungal and bacterial) phylogenetic diversity, while it did not alter archaeal diversity. Plant phylogenetic diversity increased to control levels after ca. 15 years. In parallel, fungal phylogenetic diversity decreased driven by the restoration of soil mineral nitrogen and moisture contents. Organic carbon and nitrogen, main determinants of bacterial phylogenetic diversity, did not recover after 20 years. The contrasting effects of fire on above- and belowground communities, and their differential resilience, highlight the need of using multi-domain approaches when addressing ecosystem disturbance.

Sp.02-16-Poster

Factors driving humification rates in four active blanket bogs in northern Spain

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Active blanket bogs, i.e. supporting a significant area of peat-forming vegetation, are globally confined to cool and wet oceanic climates. The southernmost distribution of these habitats in Europe occurs in the summit areas of Serra do Xistral (Lugo, NW Spain). The environmental constrains (low temperature, acidity, waterlogging conditions, etc.) shape the plant and soil communities of these systems. Therefore, in this study, we tried to link peat decomposition rates to soil physico-chemical and biological properties by comparing the decomposition state of four habitats dominated by either vascular (graminoids, sedges and heather) or non-vascular plants (mosses). Samples from the surface horizon (0-14 cm) were collected in January 2016 for quantifications of mesofaunal communities and microbial biomass together with determinations of peat bulk density and porosity as well as C, N and fiber contents. Results showed that decomposition rates followed the order grass = heather > sedge > moss and were unrelated to C/N ratios. Due to the organic nature of these soils, N content is usually very low and represents a strong limitation for the plant and soil communities. Since the peat was more decomposed at the drier sites with the highest abundances of invertebrates and the lowest values of microbial biomass and soil pH, it is possible to speculate that oxygen exposure and less recalcitrant litter led to accelerated soil organic matter turnover by soil fauna, resulting in increased availability of humic acids with great cation holding capacity. We conclude that both vegetation and abiotic conditions determines peat humification processes.

Sp.02-17-Oral

Assessment of the recovery of functional diversity of ectomycorrhizal fungal communities in metal polluted soils

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Ectomycorrhizal (ECM) fungi associate with plants to conform one of the most important symbioses in terrestrial ecosystems, with important incidence in the provision of some ecosystem services. In 1998, a mine tailing spill affected an extensive area in the Guadiamar valley (Seville, Spain), causing a severe pollution by trace elements (TE). Remediation measures included top soil removal and amendments addition, followed by native tree species afforestation. Since then, monitoring activities have recorded several aspects of the biotic and abiotic conditions during the recovery of this degraded land, however, information about the soil organisms and their functional diversity is scarce. ECM fungal communities associated to planted holm oaks (Quercus ilex) were characterized both functional and taxonomically. We recorded 55 operational taxonomic units and found no differences in diversity between polluted and non-polluted plots. However the ECM fungal community composition was found to be dependent on soil characteristics such as pH, Ca and K content and to trace element concentrations. Functionally, a key trait for ecosystem functioning of ECM communities, the hyphal exploration type, was found to be dependent on the TE concentration in soil. This result points out the relevance of functional approaches when studying ecosystem restoration processes.

Sp.02-18-Oral

Soil functioning and ecosystem services: using trees to remediate contaminated soils

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Ecosystem services are the direct and indirect contributions of ecosystems to human well-being. Despite the importance of soil services, they are often underestimated and largely unrecognized. We introduce briefly the framework recently proposed by Schwilch et al. (2016), and present some results of the potential use of different tree species to remediate contaminated soils on Mediterranean conditions. Disruptions of biogeochemical cycles by human activities act as a direct driver of global change. The Guadiamar Green Corridor (Seville, Spain), is an example of extensive soil contamination by trace elements originated by mining activities. In the large-scale remediation and restoration plan, soil was cleaned-up, amendments were added, and trees of several native species were planted (Domínguez et al. 2008). We present some approaches to study tree-soil interactions, soil functioning and the provided ecosystem services. 1) Potential of trees for the phytostabilization of soil contaminants. The immobilization of contaminants by plant roots, litter decomposition and their associated microbes means an improvement of soil quality and therefore a regulation service. We measured the effects of different tree species (Marañón et al. 2015). 2) Carbon storage in soil. We assessed the effectiveness of different tree species in providing this regulation service. 3) Promoting soil biodiversity. We evaluated the colonization by mycorrhizal fungi of roots of Quercus ilex planted on different soil conditions of acidity and contamination level. References Domínguez MT et al. (2008). Environmental Pollution, 152: 50-59. Marañón T et al. (2015). Web Ecology, 15: 45-48. Schwilch G et al. (2016). Ecological Indicators, 67: 586-597.

Sp.02-19-Poster

Do Quercus ilex woodlands undergo abrupt non-linear functional changes in response to climatic variation and human disturbance?

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Drylands are experiencing major alterations as a result of complex interactions between climatic fluctuations and disturbances caused by human activities. Theoretical models suggest that these ecosystems are particularly prone to suffer critical transitions with abrupt non-linear changes in their structure and functions in response to climate variation and human disturbance. How drylands undergo environmental change has become an important issue in ecology which needs empirical data to validate theoretical models. We studied the functional response of holm oak (Quercus ilex) woodlands to human disturbance along an aridity gradient (from semi-arid to sub-humid conditions) in eastern Spain, using (a) remote-sensing estimations of precipitation-use-efficiency (PUE) from enhanced vegetation index (EVI) observations performed in 231x231 m plots of the Moderate Resolution Imaging Spectroradiometer (MODIS) and (b) soil parameter determinations (extracellular soil enzyme activity: phosphatase, ß-glucosidase and urease, and associated nutrient cycling processes) from soil sampled in the same plots. We evaluated and compared the shape of the relationship between ecosystem functionality (in terms of PUE and soil parameters) and disturbance intensity for our holm oak sites along the aridity gradient by fitting the experimental data to linear vs. non-linear model equations. Overall, our results demonstrated that climatic conditions along the aridity gradient played a relevant role in the shape of the functional response of Quercus ilex woodlands to human disturbance. Whereas sub-humid areas showed a linear decrease with an increasing disturbance intensity, semi-arid areas were characterized by non-linear dynamics with the existence of abrupt changes at critical disturbance intensity values.

Sp.02-20-Poster

The effect of fire on allelopathic interactions between litter and Eucalyptus globulus Labill

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Plant litter is an important reservoir of organic matter in terrestrial ecosystems. It contains organic substances that may affect plant development, influencing vegetation composition. Fire changes chemical composition of litter. Little is known about fire influence on allelopathic and autopathic interactions between litter and plant development. This study aimed to assess how litter previously submitted to heat may affect the early development of Eucalyptus globulus. Litter sub-samples of 4 species (E. globulus, Acacia dealbata, Pinus pinaster, and Quercus suber) were either unheated or heated at 6 temperatures (100-600ºC). Then, they were analysed by 13C nuclear magnetic resonance spectroscopy. E. globulus seeds were sown on the resulting 28 litter types. Changes in litter chemical composition have been reported at temperatures ? 300ºC, being similar across all studied species. Amounts of alkyl C, O-alkyl C, and methoxyl and N-alkyl C decreased, while amounts of aromatic C increased. Litter composition was correlated with both germination success and rootlet growth. Differences were observed on effects of several litter species. The most noxious was conspecific litter. Unheated and slightly heated litters were mostly phytotoxic, whereas severely heated litters either stimulated early development or had no effects. Litter chemical changes caused by fire might be critical for (re)colonization of forests by E. globulus. As this species is a widely cultivated exotic in some Mediterranean regions, ecological problems may arise, especially under scenarios of increased fire frequency. Therefore, attention should be paid after fire to areas where its seeds are available, despite the dominance by other species.

Sp.02-21-Oral

Mechanisms of leaf litter decomposition under climate change: trait, microbial, and environmental effects

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Leaf litter traits, microbial composition and environmental conditions are important factors driving litter decomposition. Changes in these factors in response to climate change could alter C and nutrient cycles in semi-arid ecosystems, thus increasing their vulnerability. We conducted a manipulative field experiment in a semi-arid ecosystem in central Spain dominated by Helianthemum squamatum shrubs. We simulated future climatic conditions and assessed the direct effects of warming (W, 2.7ºC), rainfall reduction (RR, 30%) and their combination (W+RR) on litter decomposition rates, and their indirect effects through climate manipulation-induced changes in leaf litter traits and microbial biomass. Direct effects were evaluated using a common litter substrate (litter from control plants under current ambient conditions) incubated inside treatment plots. We also incubated leaf litter from the W, RR and W+RR treatments in control plots (trait and microbial effects) and in their own manipulated environment (trait, microbial and environmental effects combined). Leaf litter traits, mainly lignin content, and microbial and fungal biomass drove litter decomposition under common environmental conditions. Additionally, control leaf litter decomposition rates in W and W+RR plots were 16% and 14% lower, respectively, pointing out to a strong negative effect of high temperatures. Similar patterns were observed with original leaf litter incubated in situ pointing out to environmental effects overruling trait and microbial effects. In a concurrent study, we observed reductions in topsoil labile C and N contents in W and W+RR plots, which may be explained, among other factors, by the observed lower decomposition rate of leaf litter under warming.

Sp.02-22-Oral

Structural and functional responses of fungal communities to biotic and abiotic factors in Mediterranean pine forests

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Fungi are key actors in forest ecosystems involved in nutrient biogeochemical cycling and tree's productivity. However, to what extend the surrounding environment affects fungal communities is still poorly understood. This work aimed to study the impact of biotic (tree genotype) and abiotic (season, site) factors on the diversity and assemblage of fungal communities, and to explore the potential derived functional consequences. We performed a high-throughput sequencing approach combined with enzymatic tests and soil analyses to study the fungal communities associated with different genotypes of Pinus pinaster in ~50-yr-old plantations. The tree genotype and spatial-temporal factors were crucial structuring fungal communities mainly influencing their assemblage and filtering certain fungi, particularly ectomycorrhizal ones. Site dependent responses of fungi related with the tree genotype raised. Diversity variations in total community and/or in that of specific fungal guilds, together with edaphic properties and the productivity of trees, explained activities involved in carbon turnover and phosphorous or nitrogen mobilization. Our results reveal that structural shifts in fungal communities produced by biotic and abiotic factors can affect relevant ecosystem processes, which can have essential implications for the resilience of Mediterranean forests under future climate change scenarios.

Sp.02-23-Oral

Differential effect of soil microbiota from nine shrubs on the diversity of a semiarid annual plant community

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Shrubs play an essential role structuring the vegetation and diversity of semiarid Mediterranean areas. Soil microbiota from nurse shrubs can have positive effects on annual plants but examining the effect of soil microbial communities from coexisting shrub species is needed to understand their different role on plant community dynamics. We tested the effect of soil microbiota extracted underneath nine shrub species and from adjacent open spaces without woody vegetation (gaps) on the composition and diversity of annual plant communities. We selected a range of shrub species with known positive to negative or neutral effects on annual plant communities in the field. Seeds were collected from eight common annual species in the field and a greenhouse experiment was run for three months until annual plants started flowering. The identity of the shrub inoculum was a significant factor influencing annual plant community size, similarity, diversity and functional diversity. Soil microbiota from benefactor shrubs - Retama sphaerocarpa, Anthyllis cytisoides, Genista umbellata and Hammada articulata - resulted in a positive effect while soil biota from Tamarix sp. had a negative effect on the size and diversity of the annual plant community. No differences were found between gaps and some of the studied shrubs. Plant productivity was not related to community diversity or size. The differential effect of soil microbiota from nurses was not fully explained by direct effects on germination, thus, soil microbiota must affect seedling survival and plant interactions in the community.

Sp.02-24-Poster

Drying-rewetting cycles decouple carbon and nitrogen mineralization overriding the effect of forest die-off

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Ecosystem functioning in the Mediterranean region is largely governed by water availability. Mediterranean holm oak (Quercus ilex) forests have been lately suffering drought-induced tree defoliation and mortality, and this situation is likely to worsen in the coming decades. Large efforts have been made to understand the effects of forest die-off on Mediterranean ecosystem functioning. However, we still lack an integrative understanding of how projected increases in forest die-off may affect the response of Mediterranean ecosystems functioning to changes in water regime. Our main objective was to study the interactive effects of forest die-off and changes in the water regime on soil microbial functioning. In spring and summer 2013, we collected soil samples under the canopy of holm oak trees with different defoliation degree and in open areas (outside of tree influence) of a holm oak forest located in the continental central part of the Iberian Peninsula. Then, we carried out 40-days soil laboratory incubations under two different watering treatments (constant vs. drying-rewetting cycles) and measured carbon (C) and nitrogen (N) mineralization rates. Preliminary results show that the drying-rewetting treatment decreased soil N mineralization but increased soil C mineralization compared to constant moisture regime in soils collected under holm oaks with different defoliation degree. These results suggest a likely decoupling in C and N mineralization processes with drought-rewetting episodes regardless of tree defoliation degree.

Sp.02-25-Oral

Plant litter mixture partly mitigates the negative effects of intensive drought on decomposers and litter decomposition in a Mediterranean oak forest

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This study has been partly supported by the BioDiVMeX CNRS Mistrals program. This program aims to develop our understanding of long-term natural and anthropogenic processes that have shaped the Mediterranean biodiversity but also to evaluate current changes effects on Mediterranean biodiversity and ecosystem functioning. Determining the responses of plant and animal communities and ecosystem processes to future environmental conditions is a major challenge of current ecological research. Ecosystems respond to climate change in complex ways, and the outcome may significantly depend on biodiversity in most cases. This study focused on the relative effects of enhanced drought and of plant-species diversity on soil biota and on litter decomposition in a Mediterranean downy oak forest. We experimentally reduced precipitation through a dynamic rain exclusion device, accounting for seasonal precipitation variability, and created a single-species litter (Quercus pubescens) and two multi-species litter mixtures (Q. pubescens + A. monspessulanum and Q. pubescens + A. monspessulanum + Cotinus coggygria). Globally, drier conditions affected decomposers negatively, directly by reducing fungal biomass and detritivorous mesofauna, but also indirectly by increasing the predation pressure on detritivorous mesofauna by predatory mesofauna. This is reflected under drier conditions in that Collembola abundance decreased more strongly than Acari abundance. One Collembola group (i.e. Neelipleona) even disappeared completely. Increased drought also strongly decreased litter decomposition but the presence of several plant species in the litter mixtures appeared to mitigate this impact. In fact, mixing litter from multiple plant species improved soil biota communities and led to a more efficient litter decomposition process.

Sp.02-26-Poster

Interactions between time since cultivation stop and the colonizer species in soil macronutrients biogeochemical cycles

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Soils accumulated a large proportion of the organic carbon of the biosphere. Therefore, changes in land use are very relevant to the global carbon dynamics. In this work, we evaluated the changes in soil macronutrients biogeochemical cycles in a Mediterranean landscape dominated now by sclerophyll Mediterranean vegetation that was previously dedicated to vineyard cultivation. The general objective was to study the interactions between the time since cultivation stop and the colonizer species in the dynamic of soil organic matter, N and P in the abandoned vineyards. The total carbon soil (TOC) content was incremented under all the sampled species during the course of the chrono-sequence period (0-50 yr). Nevertheless, the accumulation patterns were different between species. At the end of the study period, the TOC was greater in permanent grasslands and Retama shrubs than under annual grassland and Lavandula shrubs. The temporal evolution of total N content was quite similar to that of the TOC. The biogeochemical cycles of both elements were quite related as suggested also by the high correlation between them (r= 0.97, n=141). The temporal evolution of the available P was different to the one described for TOC and N and was related of the plant type. The fractions of organic matter obtained by acid hydrolysis (labil and recalcitrant fractions) do not changed significantly during the chrono-sequence under any of the considered species but in general, there is a decrease in the labil fraction and an increase in the recalcitrant one.

Sp.02-27-Oral

Effects of ecohydrological processes on the establishment of late-successional tree species in Mediterranean-dry reclaimed slopes

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It is an important issue in restoration of post-mine reclaimed sites to understand how ecohydrological processes drive the establishment of late-successional tree species. An experiment was carried out during 3 years in two representative reclaimed hillslopes along a gradient of overland flow from Utrillas coalfield in Teruel (Spain), under Mediterranean-Continental climate, in which we studied the influence on survival and growth of Quercus ilex and Pinus nigra seedlings in different ecohydrological microsites: northern and southern side of Genista scorpius shrubs as nurse plants and runoff sink and source vegetation patches according to the Trigger – Transfer – Reserve – Pulse (TTRP) model. Our results show that the northern side of Genista scorpius and the runoff sink vegetation patches enhance growth of Quercus ilex and survival of both species due to an amelioration of environmental conditions in the first case and a higher resource availability in the latter. Furthermore, seedlings' survival in runoff sink vegetation patches in conditions of high overland flow was higher than under the canopy of nurse plants with no influence of overland flow where, however, growth was always higher, which suggests a trade-off relationship between survival and growth along the overland flow gradient. Our results highlight that the use of ecohydrological criteria improves the success of restoration processes by accelerating the establishment of late-successional species, which also may enhance heterogeneity of reclaimed sites and drive them towards self-sustaining ecosystems.

Sp.03: Mediterranean Ecosystem Services

Sp.03-1-Poster

Gross Primary Production assessment of three European ecosystems by time series analysis

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Gross Primary Production (GPP) represents the C uptake of ecosystems through photosynthesis and it is the largest flux of the global carbon balance. GPP estimations are necessary to assess the dynamics of the global carbon cycle and to plan a sustainable management of ecosystems. Remote sensing (RS) is the most useful tool for monitoring ecosystems at different temporal and spatial scales. Therefore RS GPP estimations are frequently obtained from Light Use Efficiency (LUE) models or related to spectral indexes. These measurements are usually validated through the use of eddy covariance (EC) flux towers. The high temporal resolution of both EC measurements and RS data makes the statistical time series analysis (TSA) an excellent method to analyze these data and has been recently used to assess the phenology of different forest and agricultural ecosystems. In this work our overall objective is to assess the GPP dynamics of three different European ecosystems by TSA comparing (1) the GPP provided by the MODIS MOD17A2 product, (2) the GPP estimated by a LUE model taking into account site-specific ecological and meteorological parameters and (3) the GPP derived from spectral indexes with the EC measurements. In conclusion, the study of ecosystems must be approached from a dynamic point of view, that is, temporal evolution at different scales.

Sp.03-2-Oral

Ancient and new natural resources and ecosystem services in SW Spain

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SW Spain from Sierra Morena ranges to the littoral from Portugal to Gibraltar, presents a mild Mediterranean type climate (summer drought and winter rains). Climate induced a fluctuating primary productivity pattern and strong variation of river debits. Early game and husbandry (cattle, horses, sheep, goats and swine) expanded pasturelands opening woodlands to a savannah like park (dehesas) of fruit bearing trees (acorns). Shifting cultivation (cereals) followed by grazing in 7-10y cycles. Prescribed fire regimes induced self-succession of pyrophyte vegetation while soils lost organic horizons. Olive trees, fig trees and vines were important cultures. Ploughing favoured soil erosion. A regional bonus were mines (gold, silver, lead, cooper, iron), prompting an early industry of cooper and bronze. Mine tails contaminated soils and River Tinto only surviving extremophiles. Timber, charcoal and fuel wood were supplied by receding woodlands. Wide plantations of pines and eucalypts occurred in S XX. Since 1950 tractors, fertilizers and pesticides expanded technical agriculture. Reservoirs served Irrigation also supplying towns easing climatic dependence. Sewage discharges degraded water quality. Self-purification became a relevant ecosystem service. Paddy-fields entered Guadalquivir marshes since 1926 and hunting, collection of water birds and fishing dwindled. Since 1960 greenhouses in dune fields grew strawberries exploiting aquifers. Water table drop dried out ponds and vegetation. In 1969 Doñana National Park was created and conservation rose as an ecosystem service. Two recent services (XXI c.), are sun irradiation and wind for power generation.

Sp.03-3-Oral

Ecosystem services provided by scavengers through social perceptions

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In the current research agenda, one of the major goals is the need for approaching biodiversity conservation from a socio-ecological perspective. Our main aim was to examine the social perceptions of ecosystem services provided by scavenging vertebrate species and to identify which social and ecological factors determine the consideration of scavengers as providers of benefits or damages. To do so, we performed face-to-face surveys with farmers at seven large extensive livestock systems in Spain. The scavenging service was the most important benefit identified while that the role of some scavengers as predators and the conflicts with livestock were the most important damage recognized. Farmers perceived vultures as the most beneficial scavengers to provide ecosystem services, followed by raptors, non-raptor birds and mammals. Farmers perceived the importance of scavengers to provide beneficial services when species have less distributional range and their populations are declining. Farmers perceived higher diversity of ecosystem services when species richness and functional diversity is higher in the ecological community. The socio-economic characteristics of farmers can determine their perceptions, the experience in the field seems to influence farmer's perceptions of scavengers as beneficial or harmful. Transhumance determines the perception of beneficial services provided by scavengers and the past and current experience to leave livestock carcasses in the field influences farmers' knowledge about scavengers. Our results suggest two main actions for the conservation of scavengers: to promote positive perceptions of scavengers through traditional extensive farming management and to pursue illegal poisoning of facultative scavengers.

Sp.03-4-Oral

Future provision of soil erosion protection by Mediterranean forests under global change pressures

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Mediterranean forests are biodiversity-rich and complex ecological systems, with a long history of close interaction with human societies to which they provide a wide range of ecosystem services. These systems are particularly affected by ongoing global change, especially by the increase in both the frequency and the intensity of disturbances associated to climate and land-use change. In this study we evaluate the effects of climate change, fire regimes and management strategies on the provision of soil erosion protection by Mediterranean forests, using the forests of Catalonia (Spain) as a case study. We calculate the provision of the service 'soil erosion protection' following the framework proposed by Guerra et al. (2016), where soil protection is a function of vegetation cover, intrinsic soil properties, rainfall patterns and topographic conditions (the Universal Soil Loss Equation). Future provision of the service is estimated under two different climate change scenarios (RCP 8.5 and RCP 4.5; these have a direct influence in fire regimes) and two different fire suppression management strategies (being fire one of the main drivers of forest loss and forest compositional change in Mediterranean environments) for the 2050 horizon. To estimate changes in forest cover under these two scenarios we use the landscape dynamics model MEDFIRE. Using this evaluation we identify areas at threat of irreversible soil loss where management efforts (through fire suppression or forest management) should focus in the coming years. Guerra et al. (2016) Ecological Indicators, 60: 213-222.

Sp.03-5-Poster

Non-economic valuation and improvement of ecosystems services at small scale: a proposal

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Usually the Ecosystem Services Assessment is applied to at large scale ecosystems such as protected reserves and landscapes. However, the management is carried out by owners at small scales (farms, units in which territory is divided), although often conditioned by upper scale economic and policy decisions. Because farms may provide all kind of services, it is necessary to develop methodologies to quantify the supply of ecosystem services based on technical criteria. If we accept the growing influence of the Ecosystem Services concept, Society will need technical arguments to demand from farms to improve the service supply. A method which was applied to typical Mediterranean agro-silvo-pastoral systems is proposed. The method has five steps: i) identification of characteristic ecosystem services, ii) description of the farm (soils, hydrology, slopes, vegetation units, infrastructures, historical management), iii) description of the Current State in the supply of ecosystem services, iv) description of a Sensible Sustainable Scenario (SSS) based on a list of benchmark-values for the ecosystem services, and v) proposal to reach the SSS. The Current State is defined by drivers and state indicators of each one of the characteristic services, while the SSS involves trade-offs and synergies to reach the best bundle of services.

Sp.03-6-Poster

Endozoochory seed dispersal by a sheep transhumant flock in Spain

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Walking/herding transhumance trough drove roads is a live heritage of historical and cultural interest in Spain. In spite of its dramatic reduction in the last decades due to social and economic reasons, transhumance still provides relevant ecosystem services, including seed dispersal by means of endozoochory and exozoochory. The objective of our work was to assess the seed dispersal service of a transhumant sheep flock in one section of the Conquense Drove Road (CDR). In November 2015, we collected sheep faeces from a 3,000 sheep flock walking from the summer pastures to dehesa lowlands along four days of the CDR (around 86 km, ca. 20% of the total length of the route). Ten samples of fresh faeces were collected randomly three times per day (120 samples in total). Sampling sites were geo-referenced by means of GPS device. Each sample was placed on a nylon cloth on a tray with a layer of peat. Any germinated seedling was recorded and identified during 16 weeks. From the tenth week, samples were treated with gibberellic acid to stimulate germination. No significant differences were found due to sampling time of the day. Higher germinated seedlings were recorded in day 2 vs. 3. The most abundant germinated species was the ruderal Atriplex patula especially in days 1 and 2, linked to dominance of crops in the 2-4 previous walking/grazing days. The sheep transported up to 50 viable seeds/100 gDW faeces, showing high ability to provide the seed dispersal service by endozoochory, even in Autumn season.

Sp.03-7-Oral

Assessing forest Ecosystem Services in a highly populated region of the Mediterranean Basin: analysis of spatial patterns of ES indicators and measuring the scale effects

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Forests provide a wide range of ecosystem services to society. Development of accurate methodologies for their analysis is key to inform management and land planning. In this work we analysed the ecosystem services (ES) supplied by forests of a highly populated region in the Mediterranean Basin (Catalonia, NE Spain). We used a set of 15 indicators of different ES (including provisioning, regulating, cultural and biodiversity), aggregated at the municipality level. These indicators are based on forest inventory data (more than 10,000 plots), detailed land cover maps and statistical and process-based models of ecological processes. We assessed the spatial patterns of ES and the relationships among them and between them and climatic and socio-economic variables by using correlations and linear mixed-effects models. We also explored the effect of the spatial level of analysis by comparing the spatial patterns for a subset of indicators at three different levels: local, municipality and county. Our results showed a substantial clustering of ES (particularly provisioning and regulating ones) and a dominance of positive (synergies) over negative correlations (tradeoffs). Most ES were strongly driven by climate, although social variables were also important, particularly for cultural ES. In addition, our results revealed differences between ES patterns depending on the level of analysis, with municipality and especially county levels resulting in a substantial simplification of patterns and loss of information. These results constitute a promising example of the integration of different data sources and types for the analysis of forest ES to aid regional land planning.

Sp.03-8-Oral

Valuing Ecosystem Services in Chaparral-Dominated Watersheds of Southern California

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The US Forest Service, University of California-Davis, and Michigan State University are leading a three-year project to assess ecosystem services in chaparral-dominated watersheds in southern California. The principal purpose of the project, which uses the Santa Clara River watershed as a demonstration area, is to create a useful, transparent framework for assessing changes to ecosystem services caused by wildfire, management actions, and future climate change. Target ecosystem services include carbon storage, water quantity (runoff and recharge), flood protection, erosion/sedimentation regulation, biodiversity, and recreation. Measurement is via a combination of geographic data, remotely sensed data, and modified regional spatial models. Economic valuation includes willingness-to-pay and benefit-transfer methods, recreation is being valued using a primary survey. Now that baseline data have been compiled, we are embarking on three tasks: (a) measure the impact of wildfires on the quantity and value of ecosystem services; (b) assess the impact of climate change on the measured ecosystem services; and (c) develop a decision-support tool for natural resource managers permitting estimation of cost and impact of selected management activities on ecosystem services. Outputs will include publications; maps and spatial data with quantitative valuation of the ecosystem services and their value pre and post fire, after management actions, and under future climates; an interactive web-based tool that permits user-driven assessments of ecosystem services; and a website to host spatial and economic data relating to ecosystem services in southern California. After finalization of the Santa Clara assessment, the methodology will be applied to other chaparral-dominated watersheds in California.

Sp.03-9-Oral

Analyzing ecosystem services from the socio-ecological history: The case of the agro-ecosystem Huerta de Murcia (South-East of Spain)

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In the Mediterranean Basin the ecosystems and social systems have historically co-evolved, for¬ming what is currently denominated socio-ecosystem. This study examines the services supplied by the agro-ecosystem Huerta de Murcia along the socio-ecological history through a literature review, and the driving forces of change during the different periods. A total of 31 ecosystem services (13 provisioning, 10 regulating and 8 cultural services) have been evaluated in eight successive historical periods: pre-Islamic period (before 713), Islamic (713-1243), Christian conquest (1243-1492), XVI century (1492-1613), XVII century (1613-1700), XVIII century (1700 -1799), XIX century-1959 (1800-1960) and Modern Huerta (1960-2015). These periods have been delimited taking into account different economic, socio-politic and cultural events. The results show a notable variability in the services supply during the different periods. We detected the greatest number of ecosystem services during the Islamic period and an alarming decline in provisioning and regulating services during the current period (Modern Huerta). On contrary, a significant increase in cultural services have been detected. The results obtained provide useful information for the management of this singular socio-ecological system.

Sp.04: Eco-evolutionary dynamics in a changing world: integrating genes, traits and ecosystems

Sp.04-1-Main talk

The ecology and evolution of interdependent networks

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Many biological systems consist of elements that interact with each other in complex ways. For example, genes regulate each other within regulatory circuits, neurons interact in the nervous system, individuals compete and cooperate, and species evolve in response to each other in ecological communities. These systems can be depicted as networks, each represented by nodes connected by links. The structure and dynamics of these networks are traditionally studied in isolation, neglecting the interdependencies among the systems they represent. In this talk, I define interdependent networks as sets of interacting systems connected across either biological, temporal or spatial scales. I advance new directions towards understanding how the interaction between different networks induces novel dynamics properties in biological and ecological systems.

Sp.04-2-Poster

Tuber melanosporum improves freezing tolerance in Quercus faginea and Q. ilex seedlings

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In Mediterranean continental climates, frost stress can play an important role in the living status of seedlings. In inland areas are matching with favourable lands to plant and to cultivate orchards for truffle production. In this study we have addressed the freezing tolerance in Quercus faginea and Q. ilex subsp ballota seedlings associated to three different ectomycorrhizal fungi: Hebeloma mesophaeum, Tuber aestivum and T. melanosporum. Freezing tolerance was determined in leaf and fine roots (mycorrhizal roots) by relative electrolyte leakage (REL), calculated like percentage damage, from 0º C (control) to -15º C. The REL test indicated that the lethal temperature for 50% of root samples (LT50) was found at temperatures below -4° C. In leaves, freezing tolerance has high in all temperatures tested. The mycorrhizal treatment with T. melanoporum affected positively the freezing tolerance of seedlings. These results suggest the importance of root injury for the growth of mycelium and, subsequently, for the truffle production.

Sp.04-3-Oral

The spatial theatre of eco-evolutionary dynamics

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Species live in spatially structured environments where population dynamics are largely determined by dispersal. Dispersal therefore needs to be considered as a central trait in life history. While a substantial body of theory demonstrated the putative importance of dispersal ecology and evolution for the functioning of metapopulations, range expansions and adaptation to novel environments, we lack empirical insights from more natural systems. By integrating experimental evolution -using spider mites Tetranychus urticae as a model- with transcriptomics and modelling, we show that spatial variation in habitat availability imposes strong selection on life histories, though not always as predicted by theory. These evolutionary dynamics strongly feedback on the population dynamics and thereby affect important components of metapopulation functioning . Our multidisciplinary approach allows us to pinpoint links between general stress resistance evolution, trait evolution and kin competition, and to demonstrate how spatial eco-evolutionary dynamics eventually impose rescue under global change.

Sp.04-4-Poster

Intraspecific variation of Scost pine under experimental increased of temperature

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Natural tree populations consist on individuals that exhibit intra- and inter-specific variation at different geographic scales, as a result of the balance between gene flow and selection. The extent and magnitude of such variation will influence the adaptive capacity of trees under forthcoming changing environmental conditions. Scots pine in Scotland is the iconic species of the remnant Caledonian forest and appear in a relatively narrow geographic area with a steep East-West environmental gradient, increasing in rainfall and temperature. We hypothesised that western populations could be better adapted to warmer conditions and, as a consequence, could perform differently to predicted increased temperature. We performed an experiment under strictly-controlled conditions with a nested hierarchical design including region (East vs. West), population and families. We used two temperature scenarios, current temperature and increased temperature, and analysed germination and growth of above and below-ground traits. The largest amount of variation occurred at the family level. Nevertheless, regional and population differences were detected, where eastern populations invested more in roots and western populations had a greater number of stomata rows and thicker roots. In addition, increased temperature had strong effects on early growth similar in the two regions, with advanced germination, enhanced growth and biomass about 10 times, but it was not accompanied by shifts in biomass partitioning. Despite the intra-specific variation found in Scots pine populations, our results reveal consistent effects of increased temperature on growth and germination.

Sp.04-5-Poster

Habitat fragmentation and genetic diversity in western Mediterranean Pistacia lentiscus populations

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Mastic (Pistacia lentiscus L.) is an evergreen shrub widely distributed across the Mediterranean Basin. Its wide human-use in the past together with the current process of deforestation, has led to the fragmentation of the mastic populations. Thus, the study of the genetic diversity and structure of P. lentiscus populations is fundamental to determine its conservation status. Previous analyses of the genetic diversity of P. lentiscus in the Mediterranean Basin with RADP markers revealed low differentiation among the populations. Given the low reproducibility of these questioned markers, we assessed the genetic diversity and population structure of P. lentiscus populations from the north of Africa (Argelia) and the Iberian Peninsula using highly polymorphic and accurately scorable microsatellites. Furthermore, we have analysed the relationship between genetic parameters and landscape fragmentation through the analysis of satellite images (Landsat). Results hitherto reveal the existence of gene flow among the populations yielding to a lack of genetic structure, and high levels of genetic diversity. These results should be taken into account to support future conservation measures.

Sp.04-6-Oral

Food Web Engineering (FWE): using knowledge in Ecology and Evolution to reduce uncertainty in biological pest control

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Biological pest control (BPC) is in urgent need of integrating course-of-actions and tools able to effectively reduce the chronically low rates of pest control success obtained with present BPC strategies. This situation is expected to be aggravated in the future because of the uncertainties pertaining to climate change. With the aim to reduce current and future failures in BPC, we introduce Food Web Engineering (FWE), a tool that integrates community ecology and evolutionary biology into the management of agricultural systems, and pursues pest control through the management of communities as a whole, while considering abiotic environmental effects. FWE uses experimental ecology and evolution to measure traits in natural enemies, and how they evolve in scenarios with ecological and climate stressors, to feed a novel eco-evolutionary simulation platform, Weaver, to identify which "species x trait" combinations maximize pest control. The ultimate goal is to offer solutions "à la carte" for specific agricultural systems with present and future unresolved pest problems. We present the results of simulations of a trophic chain composed of 20 species, in scenarios with different degrees of connectance and spatial heterogeneity, mimicking two different climate scenarios, and allowing for evolution of 13 traits. Results show that the ecological and evolutionary patterns found are in agreement with the most novel strategies currently being implemented in BPC. Although this approach is still in its infancy, results suggest that FWE is a powerful approach that can reduce uncertainty in BPC, potentially leading to a higher percentage of successes in the future.

Sp.04-7-Oral

Eco-evolutionary dynamics in soil food webs: implications for climate change in Mediterranean-Type Ecosystems

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Eco-evolutionary dynamics is a relatively new field of research which studies the feedback between ecology and evolution at ecological time scales (e.g., within a few seasons or generations). Due to the involvement of different levels of complexity in ecological networks, linking genes to ecosystems, trying to address this type of questions becomes a major challenge. Soil communities, which are responsible for terrestrial nutrient cycling and carbon sequestration, embed in some of the most complex ecological networks that we know today. How climate change (e.g., droughts) may affect these eco-evolutionary feedback loops is largely unknown. We will present the first set of simulations after parameterizing and reprogramming Weaver, an Individual-Based Model which serves to address eco-evolutionary questions in food webs. Weaver is spatially-explicit and uses multiple quantitative functional traits with multidimensional genetic basis. Here, we will present results from simulations addressing the following questions: How do changes in temperature and water availability in Mediterranean soil food webs affect their persistence? Does genetic variation in the embedded species affect the persistence and performance (bottom-up and top-down control) of these food webs when drought periods increase? Predictions stemming from these simulations can then be explicitly tested with specifically-designed manipulative experiments.

Sp.04-8-Oral

Coupling floral traits and plant pollinator interactions via plant genetic background

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Promoting pollination is a key objective in developing sustainable agricultural practices. In order to achieve this, we need to clearly understand plant-pollinator interactions. Much of the focus to date has been on determining differences among plant species in their ability to attract pollinators and the formulation of multi-species plant mixtures that provide sustained floral resources throughout a season. While valuable, this approach tends to ignore the often-considerable variation within species in floral traits and that this variation often has a genetic basis. We used common garden trials to examine the effect of different plant genetic backgrounds for both cultivars and wild populations of red clover (Trifolium pratense) on their floral traits and their ability to attract the common carder bee (Bombus pascuorum). We found that the bumblebees favoured certain cultivars and populations over others and that the patterns of attraction could be explained by differences in the floral traits of the plants. We also found more general differences in the floral traits measured between the cultivars and populations that suggest the G-matrix of red clover has been altered following artificial selection for forage traits. We show that the genetic background of a single species can be a factor in determining the ability of a plant to attract pollinators, which in turn has implications for developing sustainable agricultural systems.

Sp.05: Insights on the fourth dimension: the palaeoecological approach to modern ecological questions

Sp.05-1-Main talk

Palaeoecology: introduction and examples from terrestrial and marine archives useful for conservation and management

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Global Change is accelerating and becoming a pressing issue in socio-political agendas. Humans are having dramatic, and negative, impacts on all ecosystems worldwide, so large that the term Anthropocene has been proposed to label the last centuries, or even millennia, of a human-dominated geological epoch. The increasing rate of biodiversity loss and degradation of ecosystems has led to increased concern in developing mitigation and conservation strategies. However, policy makers do not take into account long-term data. Knowledge of the long-term ecology of ecosystems is critical to their conservation and palaeoecological research is an invaluable tool to decipher the complex evolution and dynamics of ecosystems and the separation of the so-called 'natural' and 'anthropogenic' roles throughout long periods of time. Palaeoecologists know that ecosystem dynamics involve several time scales, from decades to centuries, and even millennia, and that responses to perturbation could be delayed, triggering thresholds as well as unexpected biological responses. Biotic proxies such as plant and animal remains; and abiotic proxies such as chemical elements, isotopic composition, organic matter compounds, etc. enable the reconstruction of ecological processes occurring on timescales ranging from >50 years to millions of years. Sedimentary archives - such as marine, lacustrine or peat - are like 'books' that could be read in chronological order, and unravel complex ecological histories. Using these 'books', we are able to reconstruct biodiversity baselines and targets, examine ecosystem resilience, variability and thresholds, and understand the drives and rates of change to ecosystem services.

Sp.05-2-Poster

Responses of metacommunities to environmental changes during the late Miocene

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Metacommunity becomes a relevant topic on paleoecological research which involves the analysis of connections among biological assemblages across different spatio-temporal scales. However, the study of how long-term changes affect these metacommunities is also required to fully understand links between biological assemblages and evolutionary patterns. We focus this work on the study of late Miocene rodents from the Iberoccitanian region due to their great quality and amount of their fossil record, and many detailed studies and data published for this faunal group. We applied multivariate statistical analyses, diversity and biomic specialization tests using a big-data matrix of extinct rodent faunas in order to analyse faunal changes. Our results showed that the late Miocene rodent faunas from the Iberoccitanian region was classified into metacommunities sharing ecological affinities. Moreover, these metacommunities followed non-random temporal and environmental assembly and disassembly patterns. The ecological specialization of these rodent faunas was driven by environmental changes that are not only linked to temperature changes. However, there is also an influence of variation in aridity described for this region during the late Miocene. The diversity patterns of rodent assemblages was more influenced by temperature than by humidity-aridity conditions in the northern sites, linked to effects of temperature and thermal seasonality on these dominant forest environments. Finally, this work showed the great relevance of rodent faunas for large scale macroecological and macroevolutionary studies. Assisted by multivariate analysis techniques applied to palaeocommunities, rodent assemblages information showed the effects of high resolution environmental fluctuations in their multiple generations.

Sp.05-3-Oral

Ancient mammalian predator-prey systems: an approach to understand modern trophic foodweb change

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Assessing the impact of environmental perturbations on the long-term structure of predator-prey relationships is difficult if relying solely on modern observations due to their restricted temporal scope. Studies of ancient communities can shed light on this issue. We investigate resource and habitat use by applying stable isotope tecniques to two Spanish Late Miocene localities: Los Valles de Fuentidueña (~9.6 Ma, LVF) and Cerro de los Batallones (~9.1 Ma, BAT). The temporal window represented by LVF and BAT was crucial in the shaping of current Iberian mammalian structure because it corresponds to the first stages of a faunal turnover episode and regional environmental change at ~9.5–8.5 Ma (Vallesian-Turolian transition). Considerable resource and habitat overlap is observed within LVF and BAT carnivores, although an amphicyonid and specially a hyaenid seemed to avoid competition by taking prey from more open areas. Herbivore and carnivore d13C and d18O values do not point to significant shift in either the vegetation cover or the hydrological regime during the time lapse represented between LVF and BAT. The environmental shift recorded around the Vallesian-Turolian boundary may have occurred later in time since LVF and BAT ages are synchronic with the onset of the turnover event. Low seasonality of precipitation during these initial stages may have promoted high levels of primary productivity with abundant biomass, permitting resource overlap. The investigation of ancient predator-prey relationships can contribute to the understanding of long-term changes in trophic interactions in the event of biotic and abiotic perturbations.

Sp.05-4-Oral

Century long assessment of herbaceous plants' physiological responses to climate change in Switzerland

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The isotopic analysis of archived plant material offers the exceptional opportunity to reconstruct the physiological activity of plants over long time periods and thus, to assess plant responses to environmental changes during the last centuries. In addition, the stable isotope analysis of herbarium samples offers the opportunity to reconstruct the physiological processes of a large range of different plant species and from different environments. Interestingly, only few studies have to date assessed these archives. Previous studies analysing the physiological activity of plants over long time periods have largely focused on the stable isotope analyses of tree ring chronosequences. In Switzerland, trees represent however less than 2% of the plant species. The objective of this study is to assess the long-term physiological responses of herbaceous plant species from diverse environments and functional groups to changes in climate occurred during the past centuries in Switzerland. Given their physiological preconditioning, we expect that plant species with different functional strategies and from contrasting environments will show different long-term physiological responses to changes in climate during the last centuries. In order to do so, leaf herbarium samples from a large number of herbaceous plants species are analysed for their stable oxygen, carbon and nitrogen isotope ratios. Samples are collected from the unique herbaria hold at the University of Basel which cover 600'000 specimens collected mostly in Switzerland since the 18th century for a wide range of species and environments in Switzerland.

Sp.05-5-Oral

Bridging the gap between ecologists and paleovegetation data: EPDr package to import standardized European paleopalynological data into R

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Integrating paleodata into ecological studies is gaining momentum to address multiple ecological questions: shifts in ecological niche or spatial distribution, biodiversity drivers (climate, human pressure, biotic interactions, etc), ecosystem resilience and post-disturbance dynamics, or study changes in community assembly among others. Simultaneously, an increasing amount of paleodata is available in specialized databases. Most of these databases are available online but are also little known and/or difficult to explore by non-specialist, hindering a broader use of these data by the ecological community. The European Pollen Database (EPD) is a cooperative effort of European palynologist to store and share paleopalynological data at continental scale. Data in the EPD are frequently from different studies at local or regional scales, but altogether offer the oportunity to perform new analysis at continental scale, such as to reconstruct late-Quaternary vegetation dynamics or to study the niche dynamics in European trees. However, the EPD is a very complex database (45 interrelated tables), that store original data from many different sources without any standardization and lack a user-friendly interface to query data, remaining underutilized. Here, we present "EPDr", an R-package that provide a dynamic and user-friendly interface to query and standardize data from the EPD. More specifically, the package perform queries from an EPD server in an easy to use format (community matrices: time x species), and standardizes taxonomy and age-depth information across sites. The resulting data can be easily exported to other software or processed in R. We further illustrate how to analyse and map vegetation dynamics.

Sp.05-6-Oral

Species range dynamics under changing climates: from proxy evidence to Bayesian synthesis

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Ongoing climate change is challenging the predictive ability of ecologists and biogeographers. We know many species will have to stay in refugia or shift ranges, yet we are struggling to forecast which populations may persist in place, or if species will move at the required pace. Investigating species responses to past climate changes can of course bring many key insights. But reconstructing the past is not easy either, as all sources of evidence (fossil records, genetic data, niche modelling) suffer from their own biases and intrinsic limitations. A rigorous way to overcome this problem is to integrate these data sources into a statistical framework that explicitly accounts for their biases and assumptions. We are developing a Bayesian dynamic model of species range dynamics that assimilates multiple sources of information to provide a synthesis of knowledge regarding species responses to past climate changes. In particular, we can estimate actual distributions and migration rates in the past, as well as persistence in as yet undocumented refugia. Hence, this framework appears promising to tackle long-standing debates in palaeoecology, such as high-latitude tree persistence during glacial periods or the speed of postglacial recolonisation. Importantly, our approach also helps us to identify knowledge gaps ('known unknowns') which can guide further research and field data collection. Hence, integrative reconstructions of the past using rigorous quantitative frameworks represent a promising way to advance ecological understanding and improve forecasts of biodiversity dynamics under future climate change.

Sp.05-7-Oral

Concepts of foraminiferal paleoecology: studying their ecology to understand the past environment

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Foraminifera are an ecologically important group of modern heterotrophic amoeboid eukaryotes whose naked and testate ancestors are thought to have evolved ~1 Ga ago inhabiting all marine environments. Because different species of foraminifera are found in different environments, micropaleontologists use the fossils to reconstruct environments in the past. Foraminifera have been used to map past distributions of the tropics, locate ancient shorelines, and track global ocean temperature changes during the ice ages. If a sample of fossil foraminifera contains many extant species, the present-day distribution of those species can be used to infer the environment at that site when the fossils were alive. If samples contain all or mostly extinct species, there are still numerous clues that can be used to infer past environments. These include species diversity, the relative numbers of planktonic and benthic species, the ratios of different shell types, and shell chemistry. The latter is useful because it reflects the chemistry of the water in which shell grew. Measurement of stable oxygen isotopes in planktonic and benthic foraminiferal tests from sediment samples worldwide have been used to map past surface and bottom water temperatures. This data helps us understand how climate and ocean currents have changed in the past and may change in the future. Aim of this contribution is to provide a brief summary of the foraminiferal palaeo-ecological studies considering them as a key also for modern ecological studies in order to achieve a better understanding of marine ecosystems functioning.

Sp.06: Evolutionary and ecological assembly of plant assemblages in biodiversity hotspots

Sp.06-1-Main talk

Understanding the evolutionary and ecological assembly of high alpine floras

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The rapid diversification and ecological dominance of Angiosperms since the mid-Cretaceous has long fascinated evolutionary biologists since Darwin, who referred to this phenomenon as an “abominable mystery”. The origin of famous Darwin’s cry of frustration emerged from his reading of John Ball’s intriguing, and highly speculative, essay about “The origin of the Flora of the European Alps”. Despite their deep historical rooting, many questions about the origins of high alpine floras remain largely open. (i) How did certain plant clades experience explosive diversification in the harsh conditions of high alpine environments, whereas it is classically expected that rates of evolution should rather increase towards warmer and richer, typically tropical environments? (ii) How past evolution and contemporary coexistence mechanisms shape the structure of alpine plant communities at the physiological limits of plant life? I will synthesize recent work on the phylogeny, population genetics and community ecology of alpine plants, with a special emphasis on the high alpine vascular flora of Europe (2,000-4,500m a.s.l.). I will also show how some results may be considered at odd with current theories on the origins of biodiversity. These results are important for understanding the evolutionary and ecological mechanisms that shaped biodiversity patterns and the particular species-rich assemblages of certain biomes.

Sp.06-2-Oral

Assembly and diversification of the American oaks

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In the Americas, the oaks (genus Quercus) have the highest biomass and species diversity of all woody genera in both the United States and Mexico. As a consequence of their abundance, as well as high endemism and diversity, oaks provide critical ecosystem services to the benefit of humanity. How did the oaks come to dominate North America? One hypothesis is that when the Earth cooled circa 35 MYA they dispersed over emerging land bridges, possessing exaptations that allowed them to persist and diversify in the expanding temperate forest biome into ecological spaces vacated by tropical taxa. Here we explore how the diversification process, in concert with phylogenetic constraints and environmental filtering has led to the wide range of microhabitats occupied by temperate and subtropical oaks of the Americas. We examine the importance of historical climate change in range retraction, examine patterns of introgression and discuss its putative role in local adaptation. Finally, we discuss the importance of standing genetic variation and plasticity in long-term persistence.

Sp.06-3-Oral

Integrating ecology and evolution to investigate multi-trophic species assemblages : a case study from temperate European mountains

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We present results of the ODYSSEE project that aims at integrating ecology and evolution to understand and predict the dynamics of multi-trophic species assemblages in two high-elevation ecosystems : subalpine grasslands dominated by Nadrus stricta and alpine meadows dominated by Carex curvula. These nowadays highly fragmented ecosystems have undergone severe periods of contraction and expansion over the last two millions years. Although these historical footprints have been documented for a few species, there has been no such investigation for multi-trophic species assemblages including plants, soil microflora and soil mesofauna. Our dataset comprises more than one hundred sites distributed in four mountain ranges (Pyrenees, Alps, Carpathians and Balkans) and in which several components of biodiversity were investigated: taxonomic and functional diversity of plant communities, soil molecular diversity using DNA metabarcoding, within and between-population genetic and functional diversity for Nardus stricta and Carex curvula. This provides unique opportunities to examine spatial co-variations across levels of biodiversity and across multi-trophic species assemblages at a biogeographic scale. The presentation focuses on the contrasting biogeographical distribution of bacterial, fungal and springtails (Collembola) communities. The effects of plant species assemblages and geography on beta diversity patterns of soil communities are examined and dicussed in light of the postglacial history, spatial connectivity and disturbance regimes. Finaly, we highlight the usefulness of such a case study to develop meta-community models able to track the response of species assemblages to environmental changes in a dynamic landscape.

Sp.06-4-Poster

Novel systematic insight in the genus Helianthemum supported by phylogenetic data

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Helianthemum is the largest and the most widely distributed genus in the Cistaceae family, and it is also characterized by complex systematics and taxonomy. Some taxonomically isolated species usually belonging to monoespecific sections (i. e. H. squamatum, H. caput-felis, H.lunulatum, H. somalense or H. songaricum), have been traditionally considered ancient lineages of evolution within the genus due to particular morphological features and/or their singular geographical distributions. We performed a phylogenetic reconstruction on an extended sampling of Helianthemum taxa (two subgenus, 10 sections, 86 species and subspecies) using nuclear (ITS) and plastid (trnL-trnF, psbA-trnH and ndhF) sequences to assess the infrageneric phylogenetic relationships using the New World species of this clade (Crocanthemum/Hudsonia) as outgroup. The results confirm that the genus Helianthemum is a natural monophyletic group integrated by three major Clades in quite concordance with current taxonomy: Clade I fully coincided with the subgenus Plectolobum whereas the subgenus Helianthemum was retrieved in Clades II and III. Nevertheless, unresolved polytomies remained towards the tips of the tree (species and subspecies). Also, we found that (i) no species occupied a basal position with regard to the rest of the genus; (ii) H. caput-felis was closely related to the subgenus Plectolobum; and (iii) the sister-taxa relationships between H. squamatum and H. syriacum as well as between H. lunulatum and H. pomeridianum.

Sp.06-5-Oral

Richness and endemism in the California flora measured using both species-based and phylogenetic approaches

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California's vascular flora is one of the most diverse and threatened in the world. We revisited patterns of richness and endemism in the vascular plants of California based on objective spatial units (15 x 15 km grid cells), specimen-based distributional data from the Consortium of California Herbaria and other collection databases (1.38 million records) for all 5255 species-level taxa treated in the Jepson eFlora, and a RAXML phylogeny for 1083 OTUs (i.e., terminal clades representing genera or monophyletic parts of genera). We used the Biodiverse software package to map several metrics: species richness (SR), species weighted endemism (WE), corrected weighted endemism of species (CWE), phylogenetic diversity (PD), phylogenetic endemism (PE), relative phylogenetic diversity (RPD), and relative phylogenetic endemism (RPE). We used a spatial randomization to develop null hypotheses used for statistical tests of the above indices, including Categorical Analysis of Neo- And Paleo-Endemism (CANAPE). Using these tests we can determine whether: more species endemism is present in an area than expected (WE and CWE), more or less of the phylogeny occurs in an area than expected (PD), branch lengths in an area are longer or shorter than expected (RPD), and greater concentrations of long or short-branched endemism occurs in an area than expected (RPE as applied in CANAPE). We look at phylogenetic turnover measures among the discovered centers of endemism. Joint interpretation of these complementary measures can be used to help infer ecological processes and the evolutionary history of Californian plants, and are useful for practical purposes in conservation prioritization.

Sp.06-6-Oral

Spatial phylogenetics of the native vascular flora in Mediterranean Chile

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Phylogenetically-based methods are increasingly important tools for conservation. The flora of Chile, especially the Mediterranean climate region – a recognized biodiversity hotspot - has interesting potential for studies using such measures. The combination of ancient and more recent geological processes makes evolutionary history crucial to the understanding of distributional patterns. This study addresses questions about diversity and endemism across Chile, using Phylogenetic Diversity (PD), Phylogenetic Endemism (PE), Relative Phylogenetic Diversity (RPD), and Relative Phylogenetic Endemism (RPE) along with statistical tests based on spatial randomizations. Also, we used phylogenetic turnover analyses to address biotic transitions. We used a genus level phylogeny of the native vascular plants of the entire country of Chile. Distribution for each genus was determined using georeferenced information from field work, literature, and herbaria. Mediterranean Chile showed the highest concentration of taxon richness; however, PD and RPD were significantly higher than expected in the south of the country (below 35º latitude), while the north showed less PD and RPD than expected. Many areas of significant PE were found in the north of the country, with a concentration of neo-endemism. Fewer areas of significant PE were found in the south, with a concentration of paleo-endemism. Range-weighted phylogenetic turnover analyses reflected geographic bioclimatic patterns well, especially in the Mediterranean region. Our study suggests additional hotspots to be considered for conservation of Chile's native flora. In the future the results of these studies will be compared to ongoing spatial phylogenetic studies of the five other Mediterranean-climate regions of the world.

Sp.06-7-Oral

Patterns of endemism and species diversification in the Alps

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Most of endemic plant diversity in the Alps is clustered in particular geographic areas. These hotspots of endemism have traditionally been explained in two ways: (i)those areas are glacial refugia, and current floristic patterns are linked to survival-recolonisation dynamics during the Quaternary, (ii)those areas are in high mountain ranges and endemism is caused by increased speciation rate due to steep environmental gradients, free niches or specific reproductive and dispersal strategies of high mountain plants. Although both hypotheses can explain presence of endemic hotspots, they rely on contrasting evolutionary processes, and different types of hotspots should thus carry a different signature in phylogenetic structure. In particular, species linked to glacial refugia should be phylogenetically random or overdispersed, due to non-selective conservation and possible competition during glacial periods. Species in high mountain hotspots should be phylogenetically clustered, due to increased speciation rate and habitat filtering. Using a formal spatially explicit model, we show that areas of high endemism can indeed be explained by presence of quaternary refugia and high mountain ranges. Moreover we show that refugial endemics are typically range restricted, whereas high mountain endemics are common within the Alpine arc. To test our predictions concerning phylogenetic structure, we developed a bayesian method for accounting for phylogenetic uncertainty in community phylogenetic data. We found that glacial refugia show strong phylogenetic overdispersion –a signature of non-selective conservation forces and competition during ice ages. High mountain ranges show phylogenetic clustering– a signature of recent diversification and environmental filtering of certain plant clades.

Sp.07: Contrasting worldwide functional trait trends in Mediterranean-type ecosystems

Sp.07-1-Main talk

Trait-based ecology: a functional approach to plant diversity

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Biological diversity, the variety of living organisms on Earth, is traditionally viewed as the diversity of taxa, and species in particular. However, other facets of diversity need to be considered for a comprehensive understanding of evolutionary and ecological processes. Here, I will show the advantages of adopting a functional, trait-based approach to diversity. By concentrating on traits, which are generalizable properties of organisms, it is possible to move between scales of biological organization and between geographical locations despite the idiosyncratic details of each site, taxonomic assemblage, or geographical location. There is a growing consensus that such an approach based on the use traits has a strong potential to address several pending questions in ecology. A non-exhaustive list includes: (1) the functioning of organisms and how it relates to the environment, (2) the understanding of unsolved questions in community ecology such as the identification of rules governing the assembly of communities, and (3) the understanding of how the functioning of organisms scales up to that of ecosystems and controls some of the services they deliver to humans, including those delivered by agriculture. These different aspects will be illustrated using examples taken from various types of plants and for different Mediterranean-type ecosystems.

Sp.07-2-Poster

Plant community economics spectrum in Mediterranean shrublands by soil water availability in north central Chile

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Shrublands communities in Chile's north-central coasts are patchily distributed throughout the landscape. This spatial pattern can be linked with the heterogeneous distribution of water as a result of variations in soil characteristics. In this environment, water acts as a filter that modulates plant strategies through traits related to the trade-off between growth and survival. In consequence, a change in community structure can be expected due to a water gradient in the soil. If this occurs, a Community Economics Spectrum (CES) can appear, with plants having a strategy of fast use of resources in areas with more water availability and a conservative strategy in areas with less availability. We tested this hypothesis using RDA analysis with trait community metrics in six communities with similar climatic conditions, but located in different soil types. Results show a CES associated to sand content and water holding capacity (WHC) with two independent axes determined by vegetation height and the leaf economic spectrum respectively. Communities in soils with more WHC at -1.5 MPa and coarser sand had higher Hcwm, whereas sites with more fine sand had lower Hcwm. Clay content was associated with higher LDMCcwm and lower SLAcwm, while sites with more WHC at -1 MPa showed the opposite relationship. These results suggest that CES is related to the capacity of soil to infiltrate and retain water of rain events with different intensities. Thus, the conservative strategy occurs in soils with better capacity of water retention, while a fast strategy occurs in soils with better infiltration.

Sp.07-3-Oral

Foliar trait variation along a rainfall and soil nutrient gradient in Chile and contrasts between Mediterranean type ecosystems

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Variations in precipitation, temperature, and soil nutrient availability are assumed to promote convergence in plant traits. The range of foliar trait variation is generally considered to represent plant adaptations to environmental factors that affect plant growth and community composition. In this study we will explore if traits of species from within Chilean and Mediterranean Type Ecosystems (MTE) follow worldwide trends (e.g. the leaf economic spectrum) and discuss whether tends are related to nutrient or water use efficiency. Preliminarily, we found that within worldwide leaf traits spectrum, mediterranean woody species tend to have higher mean LMA compared to mean LMA of other ecosystems. However, mean LMA of Chilean species had lowest LMA and highest coefficient of variation. We will discuss whether traits are more correlated with climatic variation or with nutrient limitation, either soil P or N availabilities.

Sp.07-4-Poster

A functional approach to explore the drivers of mycorrhizal trait variability in Mediterranean plant communities

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Mycorrhizal symbiosis may be critical under stressful conditions, especially in Mediterranean forests constrained by water stress and resource scarcity. This study is particularly novel due to the use of a community-level, trait-based approach to explore the drivers of mycorrhizal trait variability in nine Mediterranean plant communities of south Spain distributed along a gradient of soil resources. Thus, we explored how the degrees of colonization by ectomycorrhizal (ECM) and arbuscular mycorrhizal (AM) fungi (including AM vesicles) were related to other root and leaf traits associated with the use of soil resources. Moreover, we identified the main abiotic factors driving this mycorrhizal trait variability. And finally, we explored if the variability of community mycorrhization was due to plant species turnover or intraspecific differences among the selected sampling sites. Our results showed that ECM colonization was positively related to the abundance of evergreen species and to tissue dry matter content (in leaves and roots), but negatively to specific root length and specific leaf area. The best abiotic predictor of ECM colonization was soil moisture, with higher ECM colonization in drier sites. However, AM colonization was not related to any of the plant traits studied and was positively related to soil Cu and other physico-chemical soil properties. Changes in community mycorrhization were primarily due to plant species turnover with a remarkable importance of plant intraspecific variability in the case of AM colonization (especially in vesicles). The proposed mycorrhizal trait-based approach could be useful to integrate the influence of mycorrhizal associations on plant community functioning.

Sp.07-5-Oral

Convergence and evolutionary predisposition in the assembly of Mediterranean-type floras

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Convergence – the independent evolution of functional traits in response to a similar selective regime – has long been recognized as an important process to explain the functional similarities between the five Mediterranean-Type Ecosystems (MTEs). This model predicts that MT floras have been assembled from independent floristic elements. However, several angiosperm genera are shared among MTEs, suggesting that 'predisposition' of functional traits and long-distance dispersal may have additionally contributed to the assembly of MTE floras. Here, we test the relative contributions of convergence and evolutionary predisposition to the assembly of MT floras, by assembling a genus list for woody plants of the five MT regions. Using simulations, we find that the number of unique genera in each MT region is higher than expected under a null model overall, but at least forty genera occur in two or more regions, with nine occurring in three regions. The greatest number of shared genera is between the MTEs of South Africa and Australia, reflecting both their shared biogeographic history and the greater overall diversity. These results suggest that convergence may be the strongest contributor, but predisposition of traits and biogeography may have played an additional, previously underestimated, role in the assembly of MT floras.

Sp.07-6-Oral

Worldwide geographic and phylogenetic distribution of lignotubers

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Many plants worldwide are able to sustain disturbance by resprouting. There are different resprouting-types, depending on the location, amount and protection of dormant buds. In some woody species, basal resprouting occurs from the lignotuber, an ontogenetically programmed woody swelling at the root-shoot transition zone that conceals numerous buds. Traditionally, the lignotubers has been associated to Mediterranean climate-type ecosystems. The huge number of buds located in the lignotuber and the high degree of heat protection conferred by the soil, allow resprouting after the high frequent crown fires characterizing these ecosystems. This suggests that the lignotuber has evolved as a response to this particular fire regime. However, the little knowledge of the geographic and phylogenetic distribution patterns of the lignotuber hampers the possibility to discern the evolutionary pathways of this structure. We conducted an extensive compilation of lignotuber occurrence within resprouting species worldwide, and evaluated its geographic and phylogenetic distribution by comparing our results to the distribution patterns of other resprouting-types. Contrarily to species regenerating from roots, rhizomes or the root crown, lignotuberous species are not randomly distributed, but they are geographically aggregated, being more frequent in ecoregions with high frequency of intense fires. They are phylogenetically overdispersed, being present in almost 50 families, including some gymnosperms. Our results confirm that resprouting from the lignotuber is one of the mechanisms of vegetative regeneration most tightly linked to frequent crown fires. The phylogenetic distribution of lignotuberous species suggests that fires have been repeatedly a selection pressure for evolution of plants.

Sp.07-7-Oral

Effects of soil microbial communities on plant traits and community dynamics in Mediterranean ecosystems

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There is growing evidence on the critical role soil microbes play in regulating plant communities. Indeed, soil microbes influence plant growth in positive or negative ways, for instance as N fixers or as pathogens, and in turn influence plant traits and species competitive ability. Soil microbial communities also respond to plant traits such as leaf nutrient content, litter decomposability, or root exudates. As plant traits change along resource gradients, soil community structure and activity change accordingly, and are directly or indirectly involved in community processes such as competition and facilitation. We will show how plants from Mediterranean ecosystems actively select for specific microbial groups in their understory and how soil microbial communities, in turn, affect plant traits and plant community dynamics.

Sp.07-8-Oral

What delineates a Mediterranean-Type Ecosystem? Abiotic template or the biotic milieu?

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The fynbos of South Africa is characterized by rapid turnover in species between sites, but most communities contain representatives of all the major growth forms and families found in the region. This uniformity in phylogenetic and functional composition across steep environmental gradients poses interesting conundrums for ecology and the trait-based approach. Are traits important for the assembly of fynbos communities? Does trait uniformity result in similar biotic effects on ecosystem processes across the region? Has the fynbos constructed it's own niche? And what does this mean in the context of global change? We explore these questions using a range of approaches and consider the relevance of defining ecosystems on the basis of their abiotic template.

Sp.07-9-Oral

Functionality of stomatal and vein traits – evidence from eucalypts in south-western Australia

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Photosynthesis drives ecosystem productivity and transpiration is a major component of ecosystem water balance. Both processes relate to the traits discussed in this presentation. Stomatal size and density define maximum stomatal conductance, a key trait of the leaf economic spectrum. Maximum stomatal conductance scales with photosynthetic capacity, and is not necessarily low in leaves in arid or seasonally dry environments (such as Mediterranean-type environments). In such conditions, transpiration rates can be very high, requiring a large hydraulic capacity to provide leaves with water, made possible by a dense network of veins. While vein density is expected to scale with stomatal density, a recent hypothesis also suggests that the lateral distance between veins should be similar to the distance from these veins to the epidermis, which would predict a low vein density for thick sclerophyllous leaves of Mediterranean regions. To test trait-trait and trait-climate relationships, we measured leaf hydraulic, morphological and photosynthetic traits of 63 eucalypt species along an aridity gradient in southwestern Australia. Our observations reveal that vein densities increase along the aridity gradient and reach very high levels. Modelling suggests that the apparent over-investment in leaf venation may be explained from the selective pressure of aridity, under which traits associated with long leaf lifespan, high hydraulic and thermal capacitances, and high potential rates of leaf water transport confer a competitive advantage.

Sp.08: Fire and Plant-Animal Interactions

Sp.08-1-Main talk

Fire and biotic interactions: the benefits of the disruption

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In the recent years we have learned a lot about plant responses to fires. Information on animals responses is also quickly growing. However, there is a considerable lack of knowledge about the effect of fires on another key biodiversity component: the interaction among species. Given that the interacting species are likely to response differently to fire (e.g., pollinating insects or seed predators vs plants, host vs parasites, small preys vs large predators), fire is likely to disrupt many biotic interactions. The duration of these disruptions may depend on the size of the fire, and the strength of the interaction (generalists vs specialists). In addition, the disruption of biotic interactions may have contrasting effects depending on whether they are mutualistic (negative effects) or antagonistic. In this talk we review recent research on the effect of fire on biotic interactions, with emphasis on how fire may benefit plants, insects and vertebrates by disrupting antagonistic interactions. This process may contribute to explain the success of some species living in fire-prone ecosystems.

Sp.08-2-Oral

Fires do not jeopardize reproduction of Chamaerops humilis despite disrupting its pollination

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Fire shapes landscapes and biotic communities in many ecosystems. However, there is a considerable lack of knowledge on the effects of fire on plant-animal interactions. Here, we studied the interaction between the dwarf-palm Chamaerops humilis and its specialist pollinator, the weevil Derelomus chamaeropis after fire. We predicted that in plant-insect specialized interactions, postfire recovery depends strongly on the size of the fire. We studied the interaction after two wildfires in Eastern Spain during two years, in burned and adjacent unburned plots. We counted the number of weevils on inflorescences along a distance gradient from the fire's edge to the interior. We also counted the number of flowers and fruits produced per plant to estimate plant fruit set. Chamaerops plants from burned plots showed a lower presence of D. chamaeropis weevils than unburned plots. Moreover, we detected a significant decrease in the number of weevils in relation to the distance from the fire perimeter. However, fruit set of C. humilis did not differ neither between burned and unburned plots nor with the distance inside the fire. Our results suggest that the reduced number of D. chamaeropis postfire are enough to ensure C. humilis reproduction. This, together with the great resprouting capacity of the dwarf-palm contributes to explain its success in a fire-prone ecosystem such as the Mediterranean.

Sp.08-3-Oral

Importance of fire-created habitat mosaic on diversity of faunal communities in Pinus brutia ecosystems

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Fires and fire caused habitat changes are very important in structure and dynamics of animal communities in Mediterranean ecosystems. Pinus brutia forests which commonly distributed in low altitudinal ranges of East Mediterranean region exist as fires created habitat mosaic consisting of sites at different stages of succession. The mosaic structure consisting of different forests and successional stages was very important to maintain species diversity of many faunistics groups of many fire-induced ecosystems. Variations in habitat characteristics such as height and stratification of vegetation, canopy closure, and spatial pattern of different successional stages increase the habitat diversity of the area. Here it was aimed to evaluate fire created habitats in different successional ages in terms diversity of small mammal and certain insect communities. In Marmaris National Park, Mugla, Turkey and its surrounding areas, small mammals and insect communities were sampled with different sampling techniques between 1999 and 2006. These studies revealed that vegetation and surface characteristics significantly varied among successional stages in different ages. The sites had different habitat attributes were occupied species had different habitat preferences. Especially in middle and late successional stages, more number of species was found for many groups in comparison with early stages and mature forests. While high species diversity in these sites, early successional sites were represented dominancy of less number of species. Consequently, high habitat diversity consisting of sites in different successional stages significantly increases faunistic diversity in large-scale.

Sp.08-4-Oral

The effects of forest fire buffer zones on pollination webs

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Pollinating bees are declining worldwide. Their sustainable management, especially in biodiversity hot-spots, requires better understanding of community composition and interactions. We studied how management of forest fire buffer zones in a Mediterranean forest affects its pollination system. The Mount Carmel nature reserve, Israel has experienced many recurring forest fires, exhibiting a mosaic of post-fire regenerating plant communities. It is a typical Mediterranean habitat known for its high plant and bee diversity, mainly in forest clearings generated by human activity. To decrease future fires, buffer zones of reduced tree biomass were established in 2014. Low plant biomass is maintained in the buffer zones by mechanical cutting or sheep grazing. We compared flowering plants and their visitors in cutting, grazing and control (no-maintenance) plots in the buffer zones. The plots varied in fire history and were sampled three times over the 2015-2016 spring seasons Buffer zone management, sampling session, and plot fire history significantly influenced the composition of flowering species. However, the number of flowering plant species, the number of visiting bee genera, the diversity bee and flower communities and their composition were not affected. Pollination webs tended to be more specialized in managed than in the control plots, due to a significantly higher number of interaction links per species. We conclude that the fire management regimes applied in our study area did not disrupt pollination webs in the short term. Future monitoring is needed to assess the long-term effects of these management practices on fire prevention and on plant-pollinator interactions.

Sp.08-5-Oral

Two unusual dispersal systems of very large seeds in Cape fynbos

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Ceratocaryum argenteum (Restionaceae) occurs in coastal sandy fynbos and has very large hard seeds, one of the biggest in Cape fynbos. Large seeds are prone to fire damage because they do not easily get passively buried. Camera traps showed C. argenteum seeds are rejected by small mammals. However they are rolled and buried by two unrelated species of dung beetles. Scent analysis suggests chemical exploitation of the dung beetles by the plants as there is no reward for the dung beetles. Heeria argentea (Anarcardiaceae) an endemic Cape tree is found only in rocky outcrops and also has a very large seed, in this case covered by a leathery outer layer over a thin fleshy layer. Camera trap analysis showed that the species is dispersed to rocky crevices by the Namaqua rock rat, Michalemys namaquensis. Only this rodent is attracted to these seeds and it eats the fleshy layer. This species relies on this rodent for both directed dispersal to fire refugia and for germination.

Sp.08-6-Poster

Post-fire burnt wood decomposition in Mediterranean pine afforestations: a 10 years study

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Dead-wood after a wildfire represents an important biological legacy with effects on physical structure and nutrient availability, providing shelter and food for many organisms and enhancing ecosystem regeneration. The rate of wood decomposition is critical for these processes, as it modulates nutrient release and determines the physical structure of the post-fire habitat. After the fire of Lanjarón in 2005 (Sierra Nevada, Spain) a study was conducted to analyze the rate of dead-wood decomposition across an elevational gradient in a Mediterranean-type ecosystem (1400 to 2200 m). Samples of standardized size (75 cm length) of burnt pine trunks were arranged and harvested six times over 10 years. The rate of decomposition of the wood ranged from 5 to 10% during the first 4 years, increasing in 2015 up to 13-33%, depending on the altitude. The plot located at higher elevation showed the lowest weight loss of the wood. We conclude that the decomposition rate of burnt pines in the Mediterranean mountain is fast enough to support ecosystems functioning, and is affected by conditions that may be related to both species identity and climatic conditions.

Sp.08-7-Oral

Post-fire regeneration and herbivory might be driving flower colour polymorphism in Erica coccinea (Ericaceae)

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Apart from the regeneration polymorphism (seeder and resprouter individuals), the Cape fynbos heath Erica coccinea is characterized by a conspicuous variation in flower colour. Besides, a strong association between flower colour and regeneration form exists in this species: seeder plants are mostly yellow-flowered and resprouters are mostly red-flowered. Red-flowered plants are anthocyanin producers (A+), whereas yellow-flowered plants are not (A-). An analogous flower colour polymorphism in other species has been explained by pollinator preferences. However, both red and yellow flowers in E. coccinea are indistinctly visited by the orange-breasted sunbird Anthobaphes violacea, its only pollinator. As seeder populations re-establish solely by post-fire recruitment, those phenotypes with higher recruitment success would be favoured by natural selection. The inability of yellow-flowered (A-) plants to synthesize anthocyanins might provide them with an extra supply of flavonols. If this occurs since early seedling stages, it would favour seedling protection against pathogens and/or herbivores, thus promoting recruitment success. Therefore, the association of yellow-flowered plant with seeder habit in E. coccinea might be a “side effect” of this selective pressure for seedling protection and effective post-fire recruitment. If pollinators do not play a role, why red-flowered individuals are preponderant in resprouter populations? Although all flavonoids act as antioxidants, the antioxidative role of anthocyanins is more pronounced and effective. Therefore, being A- would come with a cost in terms of earlier leaf and whole-plant senescence. Nevertheless, seeder A- plants would not be affected by this disadvantage because they will likely be killed by fire before reaching senescence.

Sp.08-8-Oral

Fire diversity begets plant-pollinator community diversity

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Fire has a major impact on the structure and function of many ecosystems globally. Pyrodiversity, the diversity of fires within a region (where diversity is based on fire characteristics such as extent, severity and frequency), has been hypothesized to promote biodiversity, but changing climate and land management practices have eroded pyrodiversity. To assess whether changes in pyrodiversity will have impacts on ecological communities, we must first understand the mechanisms that might enable pyrodiversity to sustain biodiversity, and how such changes might interact with other disturbances such as drought. Focusing on plant-pollinator communities in mixed conifer forest with frequent fire in Yosemite National Park, California, we examine how pyrodiversity, combined with drought intensity, influences those communities. We find that pyrodiversity is positively related to the richness of the pollinators, flowering plants, and plant-pollinator interactions. On average, a 5% increase in pyrodiversity led to the gain of approximately one pollinator and one flowering plant species and nearly two interactions. We also find that a diversity of fire characteristics contributes to the spatial heterogeneity (beta-diversity) of plant and pollinator communities. Lastly, we find evidence that fire diversity buffers pollinator communities against the effects of drought-induced floral resource scarcity. Fire diversity is thus important for the maintenance of flowering plant and pollinator diversity, and predicted shifts in fire regimes to include less pyrodiversity compounded with increasing drought occurrence will negatively influence the richness of these communities in this and other forested ecosystems.

Sp.08-9-Poster

Effects of the distance from the burnt area perimeter on the recovery of rodent populations and on seed removal by rodents after wildfire

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Rodents are an important component in the functioning of forest ecosystems. Rodents respond quickly to the changes in structure and composition of disturbed habitats. Wildfires affect rodents both directly and indirectly. Although rodents may resist the passage of fire, survivors depend on resource availability and suitable structure of the habitat. Food availability and plant cover, as shelter in front of an increased predation pressure, are paramount for local survival. Rodents may therefore recolonize burnt areas from individuals that survived the wildfire or this colonization may occur mainly from the surrounding unburnt area. Here we assess the relative role of each hypothesis on rodent abundance and seed removal by rodents after wildfire. To this aim we studied four large burnt areas, using sampling stations at increasing distances from the perimeter of the burnt area (0 to 800m within the burnt area and 0 to 100m in the surrounding unburnt area). In the first six months after fire the abundance of Apodemus sylvaticus and seed removal were highest near the perimeter, although individuals were also found far from it, suggesting that this pattern is best explained by immigration from the surrounding unburnt habitat. In contrast, Mus spretus appeared more than three months after fire, colonizing from open habitats. Moreover, rodent abundance was low in recently burnt areas with little plant cover. When vegetation recovers after some months, resources are likely less limiting, competition is still low and dispersing individuals from the unburnt area may take advantage of an empty habitat.

Sp.08-10-Poster

Experimental assessment of predation rates on cicadas in burned and unburned Mediterranean forests

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Cicadas live belowground for most of their life, appearing aboveground as adults for just a few days. Several forests cicada species in Mediterranean Europe live as adults on tree trunks. Cicada orni has a grey body colour and after a forest fire emerging adults escape from burned areas to mate on surrounding unburned forest. In contrast, Tibicina quadrisignata is mostly black and sings and mates well-exposed on burned trunks. This study aims to compare potential predation by visual hunting predators on both species and two natural backgrounds: grey unburned tree bark and black burned tree bark. To this aim we used wax cicada models of grey and black colour in three burned areas in Catalonia (NE Spain) and their surrounding unburned forests. We nailed a total of 480 cicada models to trees and used 15 camera traps to determine predators and their interaction with models. Most predators were birds, including Dendrocopos major, Garrulus glandarius, Lanius senator, Parus major, etc. Black models showed a higher rate of predation attempts (mostly beak imprints) than grey models on unburned background in the three study areas. In contrast, grey models showed a higher rate of predation attempts on burned background in two of the three study areas. These results provide empirical evidence that visual hunting predators have higher prey discovery rates for those cicadas whose colour do not match the background substrate. They also suggest that predation may have a role in the different behaviour of Cicada orni and Tibicina quadrisignata after fire.

Sp.09: Local adaptation in the Mediterranean

Sp.09-1-Main talk

Why do we need to incorporate phenotypic variation into species distribution models?

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Here I will focus on trees and explore i) how considering phenotypic variation can change species distributions ii) the difficulties arising for accounting for phenotypic variation due to the experimental designs and iii) how species and populations models based on the phenotypic variation can be used in management decisions. Extensive experiments with translocations of several tree species across Europe do exist and can be used to estimate the amount of the variation due to plasticity and to local adaptation with statistical approaches that account for the origins of phenotypic variation. However, in some cases, these experiments do not cover the entire range of the species because they have not been designed to understand the ecophysiological limits of the species. . Including phenotypic variation into species distribution models gives a more realistic output than classical species distribution models and allows us to visualize the phenotypic variation at species and population levels, a useful tool to design assisted migration programs for the future.

Sp.09-2-Oral

Ecological mechanisms underlying hybridization and its constraint in genus Erysimum

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Hybrid zones have the potential to shed light on evolutionary processes driving local adaptation and speciation. Secondary contact hybrid zones are particularly powerful natural systems where study the interaction between divergent genomes to understand the mode and rate at which reproductive isolation accumulates during speciation. Using 10 microsatellites markers we studied five populations from two Erysimum (Brassicaceae) species presenting a secondary contact zone in Sierra Nevada Mountains (SE Spain). We have estimated the genetic differentiation, the genetic structure, and the amount of recent gene flow between populations. We found a narrow unimodal hybrid zone where the hybrid genotypes were more frequent than the parental genotypes. Afterwards, we carried out two experiments to explore the pre-zygotic and post-zygotic reproductive barriers underlying the origin and maintenance of this narrow hybrid zone. Post-zygotic barriers were evaluated performing over 1000 hand crosses on 44 plants from both species till the second generation. While to evaluate the pre-zygotic barriers, a plot of parental and hybrid flowering plants were presented to the pollinators in the natural populations to evaluate their preferences. We did not identify any significant reproductive barrier at the generation of F1 hybrids nor the pre-zygotic barriers. However, we identify a strong and significant postzygotic reproductive barrier in the F2 hybrid production. Our results suggest that the pollinators are the main promoters of the hybrid zone, but a constant migration of plants from the parental population would be necessary for the long-term maintenance of that narrow hybrid zone.

Sp.09-3-Poster

Spatio-temporal flowering patterns in Mediterranean Poaceae. A community study in SW Spain

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Grasses are one of the largest plant families and they are worldwide distributed. Numerous studies have focused on the phenology of different plants. However, lower attention has been given to grass species and to the effects of different land covers. The goals of this work were (i) to study the grass community composition in different land covers; and (ii) to assess the importance of the species and the land cover in the grass flowering phenology start and duration in two study years. Twenty-nine sampling points were randomly selected in three different land covers. We found differences among plants covers in grass species composition, showing the scrub the highest number of species. In addition, we detected differences on the flowering start date for some species –i.e. Hyparrhenia hirta (L.) Stapf was the earliest species whereas Melica magnolii Gren. & Godr. was the latest one-. Moreover, we detected differences for the land cover type and the study year. Species in the scrub flowered the latest whereas they flowered the earliest in the pasture in 2014 and in the riverbank in 2015. In general, the flowering start occurred later in 2014 than in 2015. In relation to the phenological length, differences for some study species were detected, being the shortest season for Aegilops triuncialis L. and the longest one for Hyparrhenia hirta. This study provides information for species and, especially, a spatially dependent answer, which might be important in the scenario of the predicted climate change.

Sp.09-4-Oral

Clinal variation in phenological behavior, size at flowering and biomass allocation reveals adaptation to climatic divergence in annual Thrincia hispida across its range

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Understanding and predicting the consequences of global change on species persistence and distribution requires considering the extent and potential for local adaptations. It is generally accepted that local adaptation in plants is a widespread phenomenon. However, recent theoretical and empirical work suggests that adaptation could be constrained in short-lived plants during range expansions due to demographic processes and phenotypic and genetic correlations among traits. Our aim is to produce new experimental evidence of evolutionary mechanisms during plant range expansions. Here we present preliminary data on population differentiation in several life history traits: time to germination and flowering, size at flowering and biomass allocation in 42 populations covering the whole range of the short-lived colonizing plant Thrincia hispida. We found significant phenotypic variation among population in all measured traits in a common garden experiment. The timing of germination and flowering followed environmental clines with temperature and inter-annual variation of precipitation, indicating potential drivers of selection. Size at flowering was strongly correlated with phenology. Compared with plants from northern populations, plants from southern populations germinated later and flowered earlier, were smaller and allocated more biomass to reproduction. We conclude that southern populations have evolved to face short growing periods by evolving traits favoring short life cycles. This study provides clear evidence for local adaptation in phenological traits in response to environmental varying selection, and highlights the role of selection on phenological traits in explaining the variability in other correlated traits (e.g. size) closely linked to fitness.

Sp.09-5-Oral

Reproductive isolation of colour morphs in Lysimachia arvensis through a combination of incomplete pre- and postzygotic barriers

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The boundaries that define plant species have been much debated. Although absolute reproductive isolation is accepted as an unequivocal sign of speciation, partial isolation between divergent populations can also lead to speciation. Evolution of reproductive isolation depends on a considerable number of barriers. Tto understand the speciation process, it is necessary to identify all reproductive barriers that limit hybridization. In this study, we estimated the strength of prezygotic and postzygotic barriers between the two flower colour phenotypes, red and blue, of the herb Lysimachia arvensis. Our study points to a temporal separation between morphs at two stages: the blue morph begins to flower 10-20 days earlier than the red morph; and blue flowers open about 1 hour earlier in the morning and close about 1 hour later in the evening that red flowers. Pollen flow between morphs carried out by pollinators was always less frequent than expected, based on morph frequencies. Pollen of each morph showed the same fertilization capacity on the ovules of the other morph. F1 and F2 hybrids had lower seed production than parental plants. Our results indicate that none of these barriers to hybridization are complete, but it seems that a sum of incomplete barriers may cause effective isolation of each morph, reducing the chance of F1 hybridisation and contributing to the speciation process.

Sp.09-6-Poster

Adaptive divergence despite small population sizes and strong genetic drift in English yew (Taxus baccata L.)

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English yew (Taxus baccata L.) is a dioecious long-lived gymnosperm occurring in a great diversity of habitats in most of the European continent. However, populations are often small and isolated, show irregular size/age structures and biased sex ratios, and neutral genetic diversity is highly structured, so that the ability of this species to cope with local changing conditions in the face of impending climate change may be severely reduced. Here we provide an overview of our research on adaptive patterns of variation in this conifer, both at the phenotypic and molecular levels. Results from a clonal common garden experiment revealed the existence of two basic adaptive phenological patterns according to the regional origin ("mild-type" and "continental-type") associated to temperature and precipitation clines. At the molecular level, new-generation outlier detection and environmental association analysis of 25,726 SNPs (1,210 candidate genes) in 120 individuals distributed along an environmental gradient in Europe identified several outliers associated with temperature and precipitation. In particular, 4 SNPs located on an early-responsive to dehydration stress protein (ERD4) were identified as a target of selection by all the different approaches used. Our results suggest that, despite small population sizes and strong genetic drift, divergent selection have contributed to population divergence in this conifer. However, we found that both current and past climatic data could explain the environmental associations detected, so adaptive patterns might be likely reflecting processes occurred in the distant past.

Sp.09-7-Oral

Epigenetic isolation-by-environment supports a role for non genetic factors in local adaptation of a perennial herb

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Studies of local adaptation in plant populations have traditionally emphasized the role of adaptive genetic differentiation as the main source of variation in fitness-related traits between conspecific populations. More recently it has been suggested that epigenetic variation may underlie population differentiation in functional traits and might also be contributing to local adaptation. To address this unexplored possibility, we conducted a comparative analysis of isolation-by-distance (IBD) vs. isolation-by-environment (IBE) in patterns of genetic and epigenetic differentiation in 10 populations of the perennial herb Helleborus foetidus in Mediterranean montane habitats of southeastern Spain. Plants were characterized genetically (AFLP and SSR markers) and epigenetically (MSAP markers), and we tested the significance of the relationships of pairwise genetic and epigenetic population differentiation with geographical distance and environmental dissimilarity between populations. Environmental dissimilarity was assessed using a synthetic coefficient that combined information on elevation, life zone, successional status, and ground-, shrub- and tree-layer cover, of each sampling site. Populations were strongly differentiated genetically and epigenetically. Pairwise genetic and epigenetic differentiation between populations were directly related to both geographical and environmental distances. After controlling for geographical distance, however, the relationship between genetic differentiation and environmental distance nearly vanished, while the corresponding relationship for epigenetic differentiation remained highly significant. Our results illustrate the potential complexity of patterns resulting from combined IBD and IBE patterns of genetic and epigenetic variation in natural plant populations, and lend circumstantial support to the hypothesis that persistent epigenetic marks induced by local environments can broaden the potential for local adaptation in plants

Sp.09-8-Poster

Population, individual and subindividual fitness variation in a Mediterranean shrub

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Population and individual variations in phenotypic traits with fitness consequences have been broadly analyzed in plant ecology due to their direct consequences for population persistence and plant adaptation to environmental conditions. However, there are few studies that analyze the fitness contribution of within-plant variation in such phenotypic traits. This study reports the relative relevance of population, individual and within-individual variations in the evergreen shrub, Lavandula latifolia, a characteristic species of southeast Mediterranean mountains that typically grows in open sites at middle elevations. Five clearly separated modules were selected in each of the 15 L. latifolia plants sampled in two different populations and for each module we take measurements of maternal fecundity traits (seed size and seed production), germination parameters, and offspring size (height) and growth. The results suggest that within-plant variation in maternal phenotypic traits is substantial and contributes to explain variation in germination and offspring size and its growth (8.9 % - 15.9%). Moreover, variation among individuals explains a large proportion of variance (>20%) for maternal fecundity traits and offspring size. Finally, variation among populations also explains an important part of the variance (>22%) in seed production and offspring size and its growth. Thus, this study supports that within-plant variation affects offspring production and phenotype in this shrub being, therefore, a relevant hierarchical level to understand population dynamics.

Sp.10: Resilience and criticality in Mediterranean ecosystems

Sp.10-1-Oral

The interplay of regeneration strategies and compound fire-drought regimes shapes resilience of Mediterranean ecosystems

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Despite general understanding of the impacts and climate-related alterations of specific disturbance regimes on terrestrial ecosystems, the influence of possible interactions among them is not well understood. Given their climatic characteristics and sensitivity, Mediterranean-type ecosystems (MTEs) can be used as a model system to increase our understanding of the potential effects and interactions of multiple disturbances (e.g., fire, drought) on long-term vegetation dynamics. In MTEs, variation in plant functional traits associated with responses to disturbance (resprouting, seeding) could act as a major ecological filter driving future ecosystem composition and function under global change. We developed a spatially explicit state-and-transition modelling framework, explicitly incorporating fuel built-up and major plant post-disturbance recovery strategies, to test how the interaction of short- and long-term feedbacks may drive the composition of MTEs and compromise their resilience under different scenarios of compound fire-drought regimes. Resprouters dominate under individual, moderate disturbance regimes of fire and drought, whereas the interaction of the two disturbances promotes the long-term coexistence of the two regeneration strategies. However, shrubland expansion and persistence at the expanse of forests is favored by increases in drought recurrence and associated fire-drought interactions. The interplay of moderate fire and drought recurrence can act as a strong mechanism generating the highly heterogeneous, mosaic-like landscapes in which different regeneration syndromes coexist, as observed in MTEs. However, our framework also strongly suggests that the effects of compound disturbance regimes increase the long-term likelihood of sudden ecosystem shifts and uncertainty in prediction of vegetation states at local scales.

Sp.10-2-Poster

Assessing the effectiveness of prescribed fire for managing biodiversity and resilience in a fire-prone ecosystem of Northeastern Spain

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The occurrence of large fires increased in northern Mediterranean countries in recent decades, mainly due to landscape changes caused by human activities. This situation may worsen under climate change. In order to minimize negative impacts on the ecosystems, a wildfire prevention-oriented forest management becomes necessary. Prescribed burning is a fuel reduction treatment that is still poorly accepted and applied in the Mediterranean region. Its use is particularly constrained by knowledge gaps about its effects on the ecosystems (soil, vegetation). We assessed the short-term effects of a spring prescribed burning on the understory vegetation of a Pinus halepensis forest located at El Perelló (Northeastern Spain). The shrubland, dominated by Pistacia lentiscus, Quercus coccifera, Erica multiflora, Rosmarinus officinalis and Ulex parviflorus, was sampled both before and ten months after a burning conducted under the canopy. Results show that the plant community recovered after the burning, with no remarkable changes in species' richness, diversity nor composition, though the relative abundance of some species was modified. Contrarily, most vegetation structural characteristics were significantly altered. The shrub layer height, cover and phytomass decreased. The treatment was particularly effective for reducing the presence of Ulex parviflorus, a highly flammable seeder species, whereas resprouters (shrubs and herbaceous) rapidly recovered in terms of species' frequency. Indeed, the frequency of resprouters in relation to seeders strongly increased. The resulting community is less fire-prone and likely more resilient to fire. Further studies are needed to assess its mid-term dynamics and better understand the effects and limitations of understory prescribed burnings.

Sp.10-3-Oral

Resistance and resilience metrics as tools for managers of protected areas: a remote sensing approach

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Protected areas (PAs) cover around 15% of Earth surface and are conceived as key areas for conservation of biodiversity. Classically these areas have been seen as islands of nature with restricted human perturbations. However, currently they face the impact of climate change, being needed for managers to understand the consequences of this new scenario to reduce or even mitigate its consequences. This conservation challenge becomes of special relevance in Mediterranean ecosystems, where water availability is one of the main constraints of ecosystem functioning. Although in these environments vegetation shows different strategies to cope with droughts, an increase of drought, in length and intensity, can lead to unpredictable and in some cases catastrophic shifts in ecosystem structure and function. This creates the need for metrics that allow assesing and monitoring such effects. We analysed resistance and resilience of ecosystems to drought in 3 PAs in Andalusian region following a gradient of aridity and altitude. We performed a time series analysis of the Enhanced Vegetation Index (EVI) from MODIS sensor, an index related with biomass. We analysed the short term responses to drought calculating resistance (Rt) as the magnitude of the change in primary production (through EVI) at the moment of the disturbance (drought), and Resilience (Rs) as the rate to which an ecosystem returns to a steady state previous perturbation. We have developed easy-to-use and intuitive Rt and Rs metrics useful for managers of PAs based on remote sensing data.

Sp.10-4-Oral

Severely defoliated holm oak trees show reduced growth rates compared to heathy ones, but similar responses to climatic conditions

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We studied secondary growth time trends (1980-2009) of Quercus ilex L. subsp. ballota (Desf.) (Holm oak) trees and their responses to climatic conditions. All Holm oak trees considered for this study come from agro-forestry dehesa type ecosystems affected by severe defoliation events. The study area is located in the centre of the Iberian Peninsula (Spain, Madrid Community), and is characterized by continental Mediterranean climate. Seventy Holm oaks, gathered in four different groups depending on their canopy defoliation level (from 0% to 100%), were selected for this study and sampled by extracting wood cores. Their tree-ring widths were measured and transformed into basal area increment (BAI) and into dimensionless growth indices that were used in further analyses. Our results showed that growth rates were significantly lower for the severely defoliated trees comparing with the less defoliated ones, probably due to differences in microhabitat conditions (soil, exposure, slope, stoniness, etc.), pointing out a correlation between defoliation and growth. However, the response to inter-annual climatic variations and the resilience after severe drought events did not differ between severely defoliated and healthy Holm oaks. Hence, although all Holm oaks, independently of their defoliation level, have the capacity to recover after severe drought events, their health, on the long term, is mainly determined by the growth rates.

Sp.10-5-Oral

Vegetation resampling along a post-fire chronosequence, 20 years after: evaluating the response of Pinus halepensis communities to different fire regimes in Central Greece

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Mt Penteli is one of the mountains that surround Athens metropolitan area. Until the late 70s, Pinus halepensis forest was the dominant land cover type across its slopes. Since then, numerous and repeated fire events have taken place resulting in the present dominance of shrublands of high spatial heterogeneity. In 1993, a post-fire chronosequence of pine forest stands has been established at northern and southern sites of the mountain and vegetation monitoring has followed for a few years. Nowadays, each one of these stands represents a different case of fire history (i.e. number of fire events, mean fire interval). All stands were last burned in summer 2009. Six years later and more than 20 years after the first available data from vegetation analysis, the stands in question have been resampled so as to determine how the different fire regimes have affected vegetation structure and composition with emphasis on key plant species and functional groups. With the exception of the very low (to zero) regeneration of Pinus halepensis in all studied cases and the increased cover and abundance of perennial grasses (e.g. Brachypodium spp.) in most of them, the contribution of other important elements (i.e. Cistus spp., annual legumes) presented no particular difference from what it is expected for the sixth postfire year, while the total vegetation cover was high. Furthermore, as the Canonical Correspondence Analysis has shown, despite the repeated fire events, each stand has retained each own specific floristic identity as it is determined by the local environmental factors.

Sp.10-6-Oral

Changes in community-level plant interactions balance and vegetation spatial patterns in response to environment conditions

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Changes in environmental conditions influence species abundance and the interactions among plant species, which have significant effects on ecosystem dynamics and performance. In particular, positive interactions that prevent the loss of diversity are very important in harsh environments such as Mediterranean alpine ecosystems, which are exposed to cold temperatures and water shortages at specific times in the year. This study investigated the relationship between environmental conditions and plant community interactions and its influence on plant community structure (species diversity and vegetation spatial patterns). To identify how biotic interactions and plant community structure differ based on environmental conditions; we compared sites that differed in soil properties (Acidic vs. Basic) and geophysical influence related with climate change (north- vs. south-facing slopes). In Sierra Nevada National Park, Spain, the coldest habitats had the most positive interactions, the highest vegetation aggregation, and the highest species diversity. The positive interaction balance and the vegetation aggregation patterns were strongly positively correlated. We provided insights in the conditions under which plant-plant interactions may scale up to cause vegetation spatial patterns. Given current projections for global warming, we predict a break down in plant-plant associations, which will be reflected by a reduction in vegetation aggregation patterns and a loss of species diversity. Those effects will be most pronounced in the nutrient-poor acidic soils.

Sp.10-7-Oral

Microenvironmental change as a mechanism to study global change

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Global change is a set of significant processes that influence all aspects of ecosystem functioning and often-natural services within Santa Barbara County. The sensitivity of coastal and urban systems is certainly very high. However, profound changes are also predicted for arid and semi-arid systems globally, and California is no exception. These dryland systems are less buffered by oceanic processes and typically express high inter-annual variation in precipitation and temperatures in addition to perturbations associated with long-term droughts. However, climate estimates and downscaled values can present challenges in providing evidence at the scale relevant to individual species or individuals, and the importance of biotic interactions must be coupled to these estimates in space and time. Coupled indicators of key micro-environmental measures to both positive and negative interactions between foundation species and other organisms provide a metric of buffering capacity and resilience to global change at fine spatial scales. Consequently, the primary objective of this research project is to provide both the a well-articulated, ecologically relevant micro-environmental big data measure of global change within Santa Barbara County and a coupled estimate of concurrent changes in interactions in key species within the region.

Sp.10-8-Oral

Evidence of coupled NAO and AMO control on Pinus sylvestris mortality in the Iberian Central Range

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Tree mortality is a major driver of change in bioclimatic transitions where dominant tree species are at the edge of their distribution ranges. Tree mortality is a complex process involving disease outbreaks, carbon starvation and hydraulic failure during drought or mechanical damage due to winter storms and avalanches. Recent research points to the existence of global, climatic modes that are directly correlated with the abovementioned sources of tree mortality. However, evidence of tree mortality as a teleconnection of primary modes of climatic variability has only rarely been addressed in the scientific literature so far. Furthermore, evidence of coupled effects of different climatic modes on tree mortality is largely lacking. Here we show empirical evidence of Pinus sylvestris mortality as a function of coupled Northern Atlantic Oscillation (NAO) and Atlantic Multidecadal Oscillation (AMO) controls at the Mediterranean edge of the species' distribution range on the Iberian Peninsula. The relationship between this coupled occurrence of NAO and AMO and climatic variables such as winter precipitation or the Standard Precipitation Evapotranspiration Index suggest that, quite contrary to expectations, at the dry edge of the species distribution, winter storms rather than drought would be a chief driver of tree mortality in this mountain forest. Coupled effects of global climatic modes as drivers of ecosystems locally represent a major research line to accurately identify periods of vulnerability to Global Changes in the present century.

Sp.10-9-Oral

Drought-induced vegetation shifts in terrestrial ecosystems: the key role of regeneration dynamics

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Ongoing climate change is modifying climatic conditions worldwide, with a trend towards drier conditions in many ecosystems, particularly in Mediterranean regions. Vegetation will respond to these changes, eventually adjusting to the new climate. It is unclear, however, how close different ecosystems are to climate-related tipping points and, thus, how dramatic these vegetation changes will be in the short- to mid-term, given the existence of strong stabilizing processes. We review the published evidence for recent drought-induced vegetation shifts worldwide and propose a demographic framework to classify the likely outcome of instances of drought-induced mortality, based upon the survival of adults of potential replacement species and the regeneration of both formerly dominant affected species and potential replacement ones. Out of 35 selected case studies only eight were clearly consistent with the occurrence of a vegetation shift, whereas three corresponded to self-replacements in which the affected, formerly dominant species was able to regenerate after mortality. The other 24 cases were classified as uncertain, either due to lack of information or, more commonly, because the initially affected and potential replacement species all showed similar levels of regeneration after the mortality event. Case studies were not concentrated in ecosystems particularly limited by water (e.g., Mediterranean). Overall, evidence for drought-induced vegetation shifts is still limited. In this context, we stress the need for improved, long-term monitoring programs with sufficient temporal resolution. We also highlight the critical importance of regeneration in determining the outcome of drought-induced mortality events, and the crucial role of co-drivers, particularly management.

Sp.10-10-Oral

Soil and plant community response to fire severity in Mediterranean semiarid pine forest ecosystems

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In the last decades in Mediterranean Basin, the number of large fires (>500 ha burned) increased, reaching high burn severity in wider areas. In spite of the high resilience to fire in Mediterranean ecosystems, these changes implied more vulnerability and reduced natural recovery with irreparable long-term negative effects. There are still gaps in knowledge about how fire severity affects the plant-soil interphase and its relationships, mainly in semiarid areas. Our approach assessed the resilience concept by focusing on the recovery of ecosystem functions and services. We assessed pre- and post-fire diversity of plant community related with microbial activity in soil by the evaluation of four soil enzymatic activities, in addition to several soil properties. We developed a synchronic study, sampling three areas burned in 1994, 2000 and 2012 in Southeast Spain. Our results showed that the time of recovery of plant communities was related with fire severity. In the short term, high burn severity displaced plant communities far away from climacic stages. Meanwhile in soil, macronutrients showed higher concentrations according to increasing time after fire but other soil characteristics showed no significant differences. The enzymatic activity recovered in the medium- and long-term, independent to plant recovery or fire severity. However, the enzymatic activity varied in the short-term according to fire severity, mainly for urease and alkaline phosphatase activity. To model the ecosystem response in burned areas, pre-fire characteristics and fire severity should be included and taken into account in decision making of post-fire restoration planning and management.

Sp.10-11-Poster

Resilience of Tetraclinis articulata (Vahl) Masters. and Pinus halepensis Miller. mixed forests to the effects of fire: observations and models

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The habitat 9570* "Tetraclinis articulata forests" is restricted to the southeast of the Iberian Peninsula (Sierra de Cartagena and La Union, in the region of Murcia). This is a priority European habitat by the EEC Directive 92/2. Tetraclinis articulata is an Ibero-African phanerophyte that has lignotuber, an organ that allows it to quickly recover from disturbances such as wood cutting or fires. Currently, fire is the most important degradative pressure that affects Tetraclinis articulata distribution in the Region of Murcia. The last large fire (which occurred in August 2011) affected over 34.1% of the wild population estimated for the Iberian Peninsula. Pinus halepensis competition is another element of pressure on Tetraclinis populations. Generally, Tetraclinis can be considered as a weak competitor compared to Pinus halepensis, except in South and East orientations. Concerning Tetraclinis articulata, the specimens have been monitored and its type of resprouting response (basal or epicormic) was analyzed. Specimens with epicormic resprout had fruit production after two years of the fire. Concerning Pinus halepensis, germination and seedling survival were evaluated during the years after the fire. Spatial competition for the next 50 years between the two species was modeled using the computer model MELCA from LASS package (Pausas & Ramos, 2006).

Sp.10-12-Poster

Modelling resilience and ecosystem services of soils contaminated by heavy metals under remediation measures and Climate Change scenarios: The Case Study of Guadiamar

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Soil contamination is identified as one of the main threats to soil, largely driven by human activities, normative and technology uses. Climate change predictions in Mediterranean areas including increased CO2 atmospheric concentrations, warming and drought could perform detrimental effects on soil functions and services by promoting erosion, modifying plant uptake and microbial activity, altering soil water and organic matter contents and pH, and hence altering bioavailability of trace elements as soil contaminants. In the context of the RECARE European project (EC FP7 Program;www.recare-project.eu), resilience of soil to contamination by trace elements (namely Cd) and impacts on selected ecosystem services under different management approaches and climate change scenarios in the Mediterranean area, have been modelled by using Bayesian Networks. To this aim, an environmental database of around 30 Mb has been compiled and harmonized, establishing methodological requirements for standardization (a highly demanded need for soil management at the European level), and following previous experience in the European Hydropedological Data Inventory (EU-HYDI, JRC, 2013). Key indicators have been identified on the basis of their role for ecosystem functioning and data availability in regional, national and European databases. Input variables have been divided into climatic, site variables, soil traits, land use and remediation measures, and results from empirical remediation approaches developed in the Guadiamar area have been used, including the application of organic/inorganic amendments. Main obtained results concerning contamination regulation impact on ecosystem services and thresholds are scaled up to the European level.

Sp.10-13-Oral

Land use/vegetation changes and landscape dynamics (1956-2014) in a rural region of Northeast of Catalonia

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The objective of this study was the analysis of vegetation changes and landscape transformations that occurred in 'La Plana de Vic', a representative agricultural mosaic of rural regions in Northeast of Catalonia, during the last 60 years. For three temporary points (1956, 1985 and 2014) vegetation maps have been produced applying a common legend, on the basis of aerial photointerpretation and field work. 30 legend units were defined as detailed as possible, according to vegetation physiognomy, but also trying to make them interpretable in terms of successional dynamics, with the aim of going beyond the usual Land Use/Land Cover (LULC) legends. We have calculated a wide variety of landscape metrics (Patch density; size, edge and shape metrics; Shannon's Diversity Index; etc.) to interpret the evolution of landscape during the periods 1956-1985 and 1985-2014. Overlapping these vegetation covers, transition probability matrices between units have been generated. The determination of their ecological meaning can lead to the creation of new covers which express fine scale trends in evolution of the landscape in time. Slope-dependent changes and exchange rates between functional groups of units have been identified. Among other results, highlights that the 69'54% of territory remains stable along the period 1956-2014; 20'25% showed progressive evolution, in front of the 10,21% which has suffered regressive changes. These trends seemed clearly related with slope. Exchange rates between units were different when compared the different periods. There is a tendency to gain dense woodland (8'58%) at the expense of cleared forests, shrubs and grasslands.

Sp.10-14-Oral

Predicted longer and drier summer drives critical changes in vegetation recovery after fire in Mediterranean basin shrublands

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Wildfires are a recurrent disturbance in Mediterranean Basin ecosystems which in recent decades are becoming largest and more severe. Furthermore, climate change projections predict an increase in the frequency and severity of these fires due to an increase over time of the dry period of summer (either by advancing its beginning or by delaying its end). Our aim was to analyze the effect of induced drought after fire on the germination and sprouting capacity of typical species from these ecosystems. Concretely, our purpose was to investigate the effect of the summer prolongation to the detriment of the rainy season in autumn. For this purpose, experimental burns were performed in summer over three Mediterranean shrublands located in SE Spain. Then we applied rainfall exclusion treatments during the whole autumn rainy season (from October to December). Our results showed a decline in the germination, richness and coverage of species caused by this rainfall reduction in the first months after the fire. However, germination response varied among species. These changes in vegetation composition and coverage suggest that climate change can lead significant changes in Mediterranean vegetation by modifying the critical regeneration period just after fire. Therefore, these results suggest that ecosystem resilience could be threatened within the framework of future climate change by the interaction of two recurrent factors in the Mediterranean Basin such as fire and drought.

Sp.10-15-Oral

Sensitivity of Mediterranean shrubland communities to climatic variability: a trait-based approach

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There is a growing interest in predicting how plant communities will respond to ongoing climatic variability. How sensitive is a particular plant community to inter-annual variability in climate depends on several abiotic (e.g. soil environment) and biotic factors (e.g. functional trait composition and diversity) whose relative importance remains largely unexplored. In this study, we used a trait-based approach to analyze the sensitivity to climatic variability of Mediterranean shrublands located in southwest Spain (Doñana National Park) over a period of nine years, and evaluated the role of functional diversity (FD) and soil environment as drivers of community stability. The studied shrubland communities were clearly sensitive to climatic fluctuations. Particularly, colder and drier conditions induced significant changes not only in total plant cover but also in functional trait composition and diversity, likely because the reduction of plant density after harsh climatic conditions promoted the expansion of functionally dissimilar species in the new open microsites. These climate-driven changes were strongly influenced by FD and soil environment. Thus, those communities inhabiting resource-limited environments and harboring higher values of FD were most stable over time, likely because they were mainly constituted by a large diversity of slow-growth, stress-tolerant species that are potentially better adapted to harsh climatic conditions. We could infer that the increased frequency of extreme climatic events (such as episodes of intense drought and/or frost) predicted by climate change models will alter the functional structure of the studied shrubland communities, with potential repercussions for ecosystem functioning.

Sp.10-16-Poster

Effects of recurrence, fire interval and years since last fire in pine woodland regeneration in Sierra de Gredos (Central Spain)

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More than one thousand fires occurred between 1976 and 2009 in Sierra de Gredos (Central Spain). Most fires affected Pinus pinaster woodlands and in many cases they affected previously burned areas, resulting in a mosaic of areas with different fire recurrences (REC), years since last fire (YSLF), or burned at different intervals (FI). We hypothesized that post-fire vegetation would be conditioned by fire history. Here, we analyse the effects of YSLF in interaction with REC and FI on the vegetation. Based on fire perimeters of fires occurred during the study period, 26 pine woodland sites were selected and sampled in 2013. We selected sites burned one, two or three times (REC) and with short (up to 10 years), medium (11-20 years) and long (>20 years) FI. Our results show that the longer YSLF, the greater the total and woody plant species cover; the longer YSLF, the lower the herbaceous species richness and diversity. REC showed greater influence on the herbaceous than the woody component. Herbaceous cover increased with REC while herbaceous beta diversity decreased with it. Thus, greater REC would increase the abundance of the herbaceous component but this will be more homogeneous. Herbaceous are more sensitive to FI than the woody component, with highest cover and number of herbaceous species for medium FI. Increased fire frequency due climate change and or socioeconomic factors will modify the vegetation and its hazardousness. Herbs may be critical for carrying fire with further consequences on the stability of the system.

Sp.10-17-Poster

Resilience in the functioning of Quercus pyrenaica forests of Sierra Nevada (Southern Spain) after two successive extreme drought events

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Climate change projections predict an increase in the frequency of extreme events (e.g. droughts). This increase could result in reduced resilience of ecosystems, particularly in populations located in the rear edge of their distribution. In this work, we evaluate the drought impacts in the greenness of Quercus pyrenaica forests in Sierra Nevada, a Mediterranean high-mountain (southern Spain). Summers 2005 and 2012 were two of the worst drought episodes ever recorded in this area. Our main objectives were: *(i)* to evaluate how each drought event has affected the greenness of this forest type; *(ii)* to analyze the resilience, resistance and recovery of this ecosystem to successive extreme drought events; and *(iii)* to explore differences in the resilience between populations located in southern and northern slopes. We used Enhanced Vegetation Index (EVI) data derived from MODIS-MOD13Q1 product to characterize vegetation greenness during the period 2000-2015. We calculate EVI monthly anomalies for each drought event (2005 and 2012) in relation to a reference period. Resistance, recovery and resilience of the forest greenness to each drought event were also calculated. Vegetation greenness of 2005 and 2012 were lower than the greenness observed in the reference period, especially for late-spring and summer. The drought of 2005 impacted more deeply to vegetation greenness than the 2012 drought. A substantial reduction of EVI greenness was observed during 2005 summer. Reduction in EVI was higher in northern populations than southern ones. Significant differences were found on resilience between northern and southern populations, with southern behaving as more resilient.

Sp.10-18-Poster

Modelling the role of allelopathy on semiarid ecosystems controlled by plant-water feedbacks

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Plant-plant biotic interactions (i.e. interference and facilitation) are important for the functioning of semi-arid ecosystems. Interference goes beyond competition for resources, and it can involve chemical interactions such as allelopathy. The presence of allelopathy can change the net interaction outcome between plants. For example, allelopathy can be a weapon of an inferior competitor for a limited resource. The output of the biotic interactions between a competitive superior and a competitive inferior plant competing for a limited resource could change if the competitive inferior plant is allelopathic. Moreover, in semiarid ecosystems, vegetation pattern is patchy, and plant establishment occurs predominantly in vegetation patches. Thus, community dynamics are highly dependent on local interactions between plants. Allelopathy could be relevant for plant community dynamics exploiting dynamic and patchy scarce resources, but this mechanism has seldom been explored. We aim to investigate the role of allelopathic interactions on ecosystem dynamics ruled by plant-water feedbacks with a modelling approach to understand its relevance and consequences for semi-arid ecosystems. Allelopathy was included mechanistically, by diffusion of allelopathic compounds with water movements in a spatially-explicit two species model (allelopathic and susceptible plants). We found that the balance between sensitivity to allelopathic compounds and cost of the allelopathic production is key for determining community composition at steady state. Moreover, the range of conditions that presented bistability was widened with the inclusion of allelopathy. These results imply that the ecosystem would be less resilient after perturbations and degraded states could be more stable when allelopathic plants dominate the community.

Sp.10-19-Oral

The resilience of the Mediterranean Fagus sylvatica mountain forests: dismounting the relict interpretation

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Traditionally Fagus sylvatica forests in Mediterranean regions have been interpreted as relicts. This assumption should however be revised in the light of: a) palaeobotanical records which indicate a recent and wider presence of beech forest in the Mediterranean mountains; b) the potential distribution of beech forests c) the success of Fagus colonization after the abandonment of traditional land uses. In order to clarify the relict interpretation of F. sylvatica forests in Mediterranean mountains we have studied some of the F. sylvatica southernmost populations, enclosed within Mediterranean borders, in the Spanish Central Range. Using both historical vegetation maps (1978, 1993) and Landsat satellite images we have being able to track F. sylvatica forests´ distribution and recovery during the last four decades. Moreover, comparing available data from the last 3 cycles of the Spanish National Forest Inventory (1990-2010) together with additional data from field work we have analyzed the population dynamics and demographic trends of the last decades. Finally we have tried to identify the main driving factors that determine the observed patterns of growth increment and recruitment considering biotic, abiotic factors as well as different past forest management practices. Our findings indicate that Mediterranean mountain beech forests might be right now at a turning point where their expansion, motivated by their Holocene inertia and the positive effects of land use abandonment, would be constrained due to the synergic effect of climate change, biotic interactions and past forest management legacies.

Sp.10-20-Oral

Assessing fire-mediated alternative vegetation shifts during climate change

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Forests are a major carbon reservoir and provide multiple ecosystem services. In the Pacific Northwestern USA high elevation dense conifer forests have co-evolved with fire resulting in a disturbance-recovery dynamic that eventually returns to a forested landscape. Drier and warmer conditions are expected as the climate changes in the region, which could favor a stable vegetation state characterized by hardwood and shrub species as the result of changing disturbance (e.g. fire) and recovery rates. It is thus imperative that we assess the potential for a critical transition from mixed conifer forest to a scrubland-hardwood ecosystem. We used LANDIS-II, a forest landscape model, to simulate the potential for alternative stable equilibrium to the current high dense conifer forest in one of the most carbon rich and diverse forests of the USA, the Klamath Region. Climate change simulation corroborated the high potential for a critical transition in the Klamath region, notably through the interaction of increased incidence of fire; and slower forest recovery rates. Most climate change scenarios projected drier conditions for the area, which translated to slower successional dynamics and an increased role of inter- and intraspecific competition. Our simulations demonstrate that there is a potential for climate change to accelerate rapid vegetation shifts.

Sp.10-21-Oral

Resilience and forest dynamics of Castanea sativa Mill. in the Sierra de Francia-Quilamas (west Central System, Spain)

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Chestnut dominated forests covers more than 2.5 million ha in Europe. Highly appreciated from ancient times, the spread and cultivation for food (orchards) and wood (coppices) converted these forests in a widespread component of the landscape in most of the Mediterranean basin. However, during the last centuries the management of C.sativa has been decreased, with an exacerbated decline since the second half of the XX century. Our main objective was to study the resilience of C.sativa abandoned coppices in relation to human management and disturbances. Additionally, we studied the recruitment of C.sativa in close secondary forests dominated by Quercus pyrenaica. We established 11 plots in the Sierra de Francia-Quilamas (Central System, Spain). We selected six C. sativa abandoned coppices and seven Q.pyrenaica secondary forests. We analyzed age distributions, growth patterns, regeneration abundance, and spatial structure of trees and saplings. Old C.sativa coppices converted to high forest showed increasing abundance of shade tolerant Ilex aquifolium; moderate-high seedling regeneration, and suppressed growth of saplings in C. sativa suggested a gap-phase mode of regeneration for this species. In two of the three young abandoned coppices, tree mortality of C.sativa was high and seedling regeneration was nill, in contrast with moderate regeneration of Quercus species. Q.pyrenaica young stands showed episodic recruitment after land abandonment characterized by unimodal age-cohorts, with recruitment dropping drastically as canopy closed, except for small numbers of invading C.sativa trees. We found a significant relationship between the age of the oldest Q.pyrenaica tree and the number of C. sativa recruiting trees.

Sp.11: Evolutionary responses to climate change. Evidence from Mediterranean plant populations

Sp.11-1-Main talk

Candidate genes, population genomics and climate

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Population and ecological genomics hold promise to identify relevant drivers of genetic adaptation to climate, as well as the relevant genes and gene networks associated with this process. Most important variation for adaptation is expected to be polygenic. However, most research to date has been based on single loci. Moreover, there is an urgent need to establish field experiments that help connecting molecular variation with fitness surrogates in a wide variety of natural environments. In this talk, I first provide a conceptual framework for population genomic studies to better understand the genetic bases of adaptation to climate. Second, I will briefly present case studies in European conifers and white oaks, reporting evidence on molecular adaptation to climate, in particular based on own collaborative research in two widespread conifers with highly contrasted population structure, the maritime pine (Pinus pinaster Aiton) and the English yew (Taxus baccata L.). For these two conifers, common gardens and quantitative genetic analyses of fitness-related traits were fundamental to either identify selection drivers (e.g. continentality in yew) or to validate genotype-environment associations (in maritime pine) by associating allelic make-up with fitness under extreme environmental conditions. For maritime pine, we also present preliminary results on the relevance of polygenic adaptation to climate, and on how studies that consider gene interactions may overcome previous limitations to identify relevant adaptive variation in this species. Finally, I will provide insights on risks of maladaptation of current forest tree populations in the face of climate change.

Sp.11-2-Poster

Genomic markers of plant adaptation to climate: Responses from one of the widest screening of natural intraspecific genetic diversity across Europe

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Grassland species are indeed adapted to their local environment, but there is a risk that local populations will often lack sufficient variation to adapt rapid climatic shifts. Our study focus on perennial ryegrass (Lolium perenne L.), which is a major grass species naturally distributed over Europe and surroundings. We perform Landscape Genomics analyses to discover genetic variability involved in climatic adaptation. This study is among the firsts to address a large number (>500) of populations in a pool-sequencing approach (300 individuals per pool) across the whole distribution area of a plant species with several tens thousands of genomic markers obtained by Genotyping-By-Sequencing (GBS). Using genotype-environment correlation-based methods and outlier-detection methods we detected genes that have been presumably subject to natural selection and are associated with environmental factors linked to climate change. Our results aim to contribute to a more comprehensive understanding of the distribution of climatic adaptive diversity in vast landscapes.

Sp.11-3-Oral

Seed bank to study adaptation to global change

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Ex-situ seed banks provide a picture of populations in the past. Comparing past population to current population may allow to elucidate traits shift of organisms face to global change. In this talk, I will present empirical data investigating the adaptation of plant reproductive traits (flowering traits, mating systems) to global change and specifically to pollinator decline. Alterations of plant-pollinators interactions is likely to affect plant mating systems. Using temporal seed collections (1990's versus 2010) in the same location, I will show how traits have changed in time. Two crop weeds with contrasting self-compatibility system were studied: the self-incompatible cornflower (Centaurea cyanus, Asteraceae), the self-compatible field pansy (Viola arvensis, Violaceae) sampled in regions where indications for pollinator decline has been recorded. Common garden experiments allowed to detect the effect of genetic evolution. While both species evolved earlier flowering phenology, the patterns of floral traits evolution detected here differs strikingly. Compared to the ancestral population, the recent population of the cornflower exhibited larger flowers with longer receptivity, and larger floral displays. At the opposite the field pansy evolved smaller flowers with shorter receptivity, and also the recent population showed a steep reduction in the frequency of flower-colored morphs. Parallel with these changes in floral traits, the field pansy has evolved increased autonomous selfing. I will discuss how these different paths may be adaptive face to pollinator decline.

Sp.11-4-Oral

Flavonoids accumulation under Mediterranean stressing environmental conditions: Dissecting the cause of a latitudinal gradient in floral and vegetative secondary metabolites

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Climate change promises to elevate temperature and drought stress on Mediterranean plants. Can plants adapt? We investigated the stress responsive pigments, anthocyanins, and their flavonoid precursors in multiple plant tissues to determine the evolutionary opportunities and limitations that pleiotropic effects may have during the adaptation process. Silene littorea shows a pattern of increasing accumulation of anthocyanins and other flavonoids in petals, calyces and leaves that correlates with increasing solar radiation and decreasing precipitation along a latitudinal gradient on the west coast of the Iberian Peninsula. To disentangle the abiotic stressors along this latitudinal gradient, we performed two greenhouse experiments to examine the effects of solar radiation on the accumulation of anthocyanins and other flavonoids in petals, calyces, stems and leaves. Plants that were exposed to solar radiation showed higher concentrations of these compounds than those grown in the shade, as well as when they were compared to those protected from solar UV. Interestingly, shade decreased fitness, but UV-protection increased fitness. RNA-Seq of white vs. dark pink petals identified several candidate genes in the anthocyanin biosynthetic pathway with significantly decreased expression in white petals. It is unlikely that these are the same genes responsible for the latitudinal cline in vegetative flavonoids since there was no significant correlation within individuals for flavonoids among these tissues. Now, we are using RNA-Seq to examine the transcriptome-level changes that elicits this response to UV stress across multiple tissues and allow the vegetative stress response without affecting the reproductive functions of petals.

Sp.11-5-Oral

Does the inbreeding level impact the ability of forest populations to cope with prolonged drought events?

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Inbreeding, the level of individual or population homozygosity associated to frequent mating among related individuals, impacts the performance of plant populations. Theoretical expectations state that increased inbreeding posses a potential threat to the persistence of populations but empirical studies show mixed results. With forests becoming increasingly isolated due to fragmentation and a steady loss of their dispersal ability, high inbreeding levels might become an insidious but pervasive threat to woodlands inhabiting Mediterranean ecosystems where the intensity and frequency of extreme climatic events are expected to raise. Prolonged droughts have caused extensive forest dieback across the Mediterranean basin during the latest decades. It is unclear, however, what is the relative role of genetic and ecological factors in determining plant performance after a prolonged drought event. Here, we first review empirical evidence to elucidate the role of inbreeding and ecological factors in determining plant and population persistence after a prolonged drought event. Then, we apply quantile regressions to quantify the effect of inbreeding in reducing plant performance. Additionally, we test a mediation hypothesis to clarify the interaction between genetic and ecological factors in determining plant survival by applying a piecewise structural equation model. Our study system includes different populations of phoenicea juniper (Juniperus phoenicea) located across the Iberian Peninsula. These results elucidate the complex network of interactions between the inbreeding level and a set of ecological variables in determining the chances of Mediterranean forest to cope with extreme droughts.

Sp.11-6-Poster

Adaptation to stressful environmental conditions in the Mediterranean Abies species: a molecular approach

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Adaptations to low water availability and extreme temperatures are among the most important answers species can develop in new situations. So as not to be considered a product of phenotypic plasticity, these adaptations should be genetically fixed. The study of the molecular aspects of adaptations is receiving growing attention and SNPs are ones of the most sensitive genetic markers used in order to detect these changes. In this study, we assess this question with all the Mediterranean Abies species, i.e. A. pinsapo (3), A. numidica (1), A. marocana-A. tazaotana (4), A. borisii-regis (3), A. bornmuelleriana (3), A. equi-trojani (1), A. nordmanniana (2), A. cephalonica (3), A. cilicica (3), A. nebrodensis (1) and A. alba (26); number of populations per species within brackets. Departing from previous phylogenetic and phylogeographic reconstructions, we could contextualise the evolutionary direction of the detectable changes. SNPs, derived from a next-generation sequencing-based method (RAD-seq), are used. Considering the geographic location of the studied populations, we try to link their genetic diversity to temperature and water availability related variables, both at an intra- and at an interspecific level. Finally, results are discussed in the context of past climate changes from the last interglacial period and for different climatic models.

Sp.11-7-Oral

Genetic variation and phenotypic plasticity of gypsum specialists: insights into climate change responses

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Mediterranean plants restricted to gypsum soils may have a limited ability to migrate to more favorable environmental conditions as they require the presence of this substrate. Furthermore, habitat fragmentation in these systems may further reduce migration ability as it creates small and isolated populations. Therefore, the ability of populations of gypsum endemics to cope with climate change may largely depend on in situ evolutionary processes. Although there is ample knowledge on the life history, physiology and demography of populations of gypsum plants, little is known on their ability to express adaptive phenotypic plasticity and the amount of functional genetic variation present within populations. Using Centaurea hyssopifolia and Lepidium subulatum, two dominant gypsophiles, as model species, we explore how population characteristics such as fragment size, connectivity and environmental conditions may determine the presence of quantitative genetic variation for key functional traits related to stress adaptation. Furthermore, we assessed norms of reactions of these populations to experimental treatments simulating future climate change scenarios. Preliminary results show that populations of these gypsum plants show substantial genetic variation for growth, morphology and physiology traits, and that these traits are plastic. We discuss the potential role of these aspects of variation in population responses to climate change and how other drivers of global change such as habitat fragmentation may interact to compromise future adaptation.

Sp.11-8-Poster

Spatial and environmental effects on population genetic structure of Mediterranean alpine Silene ciliata in its southernmost distribution limit

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Silene ciliata is a circunmediterranean plant that grows in cryophilic mountain pastures above the treeline. This species reaches its southernmost distribution limit in the Central System of the Iberian Peninsula, where it is found along a highly variable environmental elevational gradient that spans short geographical distances. Occurrence localities can be classified into optimal and suboptimal zones depending on how well they meet the species environmental requirements. Overall, this provides an interesting framework to test the effects of migration, genetic drift and selection in shaping population genetic structure. In this context we studied the genetic structure of S. ciliata populations in its southernmost limit and tested whether it is related to geographical and/or environmental differences among populations. We characterized the populations with microsatellite markers and applied genetic structure analysis (DAPC and graph-methodologies) and Multi Regression Distance Matrix analysis to address three main questions: (i) Are S. ciliata populations genetically structured? (ii) If so, what environmental and/or geographical variables impact the observed genetic structure?; and (iii) Can the resulting genetic structure be explained by patterns of isolation-by-distance (IBD) and/or isolation-by-environment (IBE)? A significant genetic structure was found among the studied Silene ciliata populations partially related to the spatial configuration of the mountain ranges. Genetic structure was not only related with geographical distances but also with some key environmental differences between populations.

Sp.11-9-Oral

Polyploidy and drought-associated phenotypes in Brachypodium distachyon along the aridity gradient in Israel

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Climate change is troubling for plants, due to increasing drought conditions. To understand evolutionary potential of plants facing climate change, genomic tools for crops must be developed. Our research utilizes the natural genetic variation found in plants growing along the aridity gradient in Israel, from Mediterranean to desert climates, to identify genetic and genomic mechanisms governing adaptations to future aridity. We are studying the crop model plant Brachypodium distachyon that grows naturally all across Israel, using both molecular and ecological tools. B. distachyon is an annual grass species comprises of three cytotypes (2n=10, 20, 30). The two small genome size cytotypes are diploids, while the large one is an allopolyploid. Plants from populations along the aridity gradient were phenotyped in a common-garden experiment, to quantify the differences among populations. Results indicate that populations under long-term drought conditions are more adapted to cope with future aridity, mainly by life-history traits. Surprisingly, and in contrast to previous studies on this species, genome size is not associated with increased aridity, hence, relative frequency of polyploids does not increase in desert populations. Moreover, no significant difference in phenotype between diploids and polyploids was found in this study across all populations tested. This leads to the hypothesis that different karyotypes of B. distachyon exhibit different mechanisms of drought tolerance. Alternatively, we hypothesize that plants have developed a mechanism to phenotypically "compensate" the difference in genome sizes. Future research aims to study molecular aspects of drought adaptation, to associate morphological traits with their underlying genetic basis.

Sp.11-10-Oral

Measuring contemporary selection in wild tree populations: methods and challenges

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Tree species typically produce large quantities of seeds, with severe mortality and ample opportunities for selection during early life stages, especially in Mediterranean environments. Early selection on high levels of within-population genetic variation could potentially contribute to evolutionary adaptation of long-living species to rapid environmental changes. There is, however, little empirical data on the strength of selection operating during recruitment stages in natural tree populations, especially at the molecular level, which could be partly due to the lack of suitable selection tests for this purpose. I will first discuss the challenges of contemporary selection studies in natural tree populations, reviewing available methods for identifying signatures of selection in time-series data. Then, I will present statistical approaches to test for neutrality and to estimate selection coefficients from temporally sequential genotypic samples of a cohort of recruits, using numerical simulations and an empirical case study to illustrate their utility and limits.

Sp.12: Establishing linkages between species interactions and ecosystem functioning and services

Sp.12-1-Main talk

Biotic controls of ecosystem functioning in global drylands

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Substantial research efforts are being devoted to predict how attributes of biotic communities such as species richness, composition and diversity (biotic attributes) will respond to global environmental change (GEC). However, its impact on the relationships between biotic attributes and ecosystem processes is poorly known. This is particularly true for drylands, which cover over 41% of the total land surface and host ~38% of the global population. In this talk I summarize the results of recent and ongoing studies that use multiple experimental approaches, biotic communities and spatial scales to evaluate how biotic attributes modulate both the functioning of drylands and their response to GEC drivers such as climate change. We found that the relative importance of biotic attributes such as cover or species richness as modulators of ecosystem responses to GEC drivers varies with the spatial scale considered, being more important at local and regional (~400 km) scales. At these scales, the effects of species richness on ecosystem functions were largely modulated by other biotic attributes, such as the total cover and spatial pattern of the plant/biocrust individuals. At the regional and global scale, abiotic variables such as annual temperature or aridity largely determined the variation in functions related to nutrient cycling and on plant productivity, but attributes such as species richness and composition explained significant fractions of this variation. Overall, our results indicate that biotic attributes are key functional drivers in global drylands, and may partially buffer negative effects of GEC on ecosystem functioning.

Sp.12-2-Poster

Within- and trans-generational effects of livestock grazing and pre-dispersal seed predators

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Large ungulate herbivory shapes the physiognomy and functioning of terrestrial ecosystems by influencing the structure and composition of plant communities, and therefore, affecting other herbivores associated to the plants. In this study, we analysed the independent and/or interactive effects of livestock grazing and a pre-dispersal seed-predator species on the Brassicaceae Moricandia moricandioides. We quantified ungulates and seed-predators within- and trans-generational effects on plant performance and reproduction. Additionally, within-plant variability in the responses to herbivores was analysed by observing if effects varied from the plant (systemic) to the fruit (local) level, as seed predators may select and have effects on within-individual variation. We found variability in the within and trans-generational effects of the herbivores at both levels. Likewise, some within-generational traits such as seed carbon content were affected by ungulates, but not by seed predators at the observed fruit attack rates. However, the presence of both herbivores resulted in transgenerational effects, such as an additive plant level decrease in seedling emergence. At the same time, ungulate effects were strengthened on plants with seed predators, as a higher decrease in seed carbon content and an increase in seedling mortality were observed. Finally, the presence of both herbivores resulted in interactive trans-generational effects by generally reducing seedling palatability to various herbivorous insects, although at different plant or fruit levels depending on insect identity.

Sp.12-3-Poster

Disentangling the role of allelopathy in the net balance of biotic interactions in natural conditions: the case of study of Artemisia herba-alba Asso

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We aimed to assess the impact of allelopathy on seedling growth and seed germination, and the net interaction balance of allelopathic and non-allelopathic species in a field experiment of a semi-arid plant community NE Spain. Specifically, we planted 135 seedlings and sowed 632 seeds of three species (Artemisia herba-alba, Salsola vermiculata and Lygeum spartum) at three microsites (bare soil, beneath the allelopathic shrub A. herba-alba, ART, and beneath the nurse shrub S. vermiculata, SAL). At the ART microsite we applied two treatments: control (i.e. no treatment) and activated charcoal, AC, to suppress allelopathy. After two years, planted A. herba-alba seedlings at the ART microsite grew more in presence of AC than in control, while differences in the growth of L. spartum and S. vermiculata between treatments were not significant. In addition, germination of A. herba-alba seeds was significantly higher with AC. On the other hand, a positive interaction balance was found at the SAL microsite for the all three species in comparison with bare soil, while the net balance at the ART microsite varied depending on the species considered. Particularly, the net balance was slightly negative for A. herba-alba and S. vermicualta seedlings and positive for L. spartum seedlings. This research constitutes one of the few evidences of allelopathy in natural conditions.

Sp.12-4-Oral

Energy flux: The foundational link between food webs and ecosystem function

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One major challenge in ecology has been to understand the relationship between biodiversity and ecosystem functioning. In recent years, stronger focus has been placed on the importance of multitrophic biodiversity and ecosystem multifunctionality, or the simultaneous provisioning of multiple functions in ecosystems. This is because real ecosystems are typically composed of species assemblages spanning multiple trophic groups that contribute to many different ecosystem functions. What still remains very poorly understood is how interactions among these trophic groups are directly linked to specific ecosystem functions, as well as whole ecosystem multifunctionality. By integrating concepts from food web ecology and energetic ecology, we show that energy fluxes in food webs (community energy flux) can be a powerful universal tool for investigating these linkages. Drawing from recently published examples, we find that the concept of community energy flux provides many new insights, such as how perturbations to multitrophic communities can affect ecosystem functioning across different trophic levels, as well as how shifts in various components of community structure—including species interactions—underlie variation in ecosystem functioning. Although the concept of energy flux in food webs is not new and has been well developed and studied in food web ecology, its application in biodiversity-ecosystem function research is in its infancy and presents an exciting frontier of discovery into the linkages between species interactions and ecosystem functioning.

Sp.12-5-Poster

Woody vegetation patch type (native or exotic) determines host plants used by passerine birds to place their nests

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A neglected interspecific interaction is the use of plants by birds to (i) place nests and (ii) use as materials to build nests; these are two important stages that define the success of avian reproduction. As vegetation patches dominated by native plants are replaced by exotic ones, plant-bird interaction could be modified. Here, I report a part of a study that focused on determining the effects of vegetation origin (native or exotic) on the selection that birds do to place their nests. Established in a coastal strip of 151 km in central Chile, I settled 84 sites at 10 locations where trees and shrubs were surveyed at a micro scale (within patches of 314 m2) and mesoscale (within areas of ~ 10 km2), between March to August 2016. At each site, I registered the number of bird nests and the identity of each plant host. Then, I estimated whether the hosts used depend on species frequency and origin. At mesoscale, I observed that as exotic shrubs or trees cover increased in frequency, birds placed their nests on exotic hosts (ß= 0.71, R2 = 0.62, P < 0.05). At a microscale, nests were not located at the most frequent potential hosts; indeed, nests were located on some specific native plants such as Schinus latifolius (Anacardiaceae), Peumus boldus (Monimiaceae) and Echinopsis chiloensis (Cactaceae). These findings warn us about the effects of plant replacement (natives by exotics) that could reduce the sites where passerine birds potentially make their nests. Acknowledgment: FONDECYT Iniciación 11150301.

Sp.12-6-Oral

Microbial diversity drives multifunctionality in terrestrial ecosystems across the globe

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We lack a quantitative understanding of the relationship between microbial diversity and multiple ecosystem functions and services (i.e. multifunctionality) in terrestrial ecosystems. This knowledge gap limits our capacity to predict ecosystem functions under a changing environment and formulate sustainable natural resource management and conservation policies. Here, we used two independent approaches (a microcosm experiment and an observational study including two large scale databases with contrasting geographic coverage -from 78 global drylands and from 179 locations across Scotland, respectively-) to evaluate the relationship between microbial diversity and multiple ecosystem functions in terrestrial ecosystems across the globe. Both empirical approaches provided similar results and indicated that, similar to what have been previously reported for plants and animals, the diversity of soil fungi and bacteria positively relates to multifunctionality in terrestrial ecosystems. The direct positive effects of microbial diversity were maintained even when accounting simultaneously for multiple multifunctionality drivers (climate, soil abiotic factors and spatial predictors) in our observational datasets. Our findings provide novel empirical evidence that any loss in microbial diversity will likely reduce multifunctionality, negatively impacting the provision of services such as climate regulation, soil fertility and food and fiber production by terrestrial ecosystems.

Sp.12-7-Oral

Ecological independence and self-reliance of the dominant plant species loosen ecosystem integration: evidence from 7 years' of changing patterns of nitrogen pulses in a Mediterranean Basin shrubland

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Biodiversity is being lost at an alarming rate, and nitrogen (N) availability is one of the main drivers of this loss. Since Mediterranean ecosystems are N-limited threatened biodiversity hotspots, they constitute perfect model systems for understanding how changing patterns of N availability impact photosynthetic N use efficiency (PNUE), ecological partnerships and ecosystem functioning. With this aim, we took advantage of an N-manipulative (dose and form) field experiment running in a Mediterranean Basin shrubland since 2007, where three N pulses are applied per year. Following a spring pulse in the seventh year of the experiment, we assessed the impacts of the N pulses on: i) the dominant plant species (changes in plant cover over time and PNUE); ii) ecological partnerships with ectomycorrhiza and N fixers; and iii) ecosystem functioning (mineral weathering, biological N fixation and soil protection). Despite promoting plant richness, the higher concentrations of ammonium pulses (alone or with nitrate) affected plant cover and disrupted PNUE, ecological partnerships and ecosystem integration, thus setting the threshold for negative impacts at between 6.7 and 13.3 kg ammonium ha-1. We were able to show how alleviating N limitation in a competitive context promotes ecological independence and self-reliance, disrupts ecological partnerships and has negative impacts on ecosystem functioning. Data highlight that species richness and ecophysiological parameters per se may not be good indicators of the ecosystem's conservation state.

Sp.12-8-Poster

Changes in plant communities along a successional gradient occurring in restored gypsum quarries

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Semiarid gypsum areas shelter rare and very specialized plant communities that are usually endangered by the extraction of the gypsum mineral. The spontaneous recovery of these communities is difficult due to the constraints inherent to semiarid gypsum areas. Pioneer well adapted gypsum specialist species may play an important role on vegetation recovery by acting as ecosystem engineers and thus facilitating the establishment of non-specialist species. The aim of this study was to investigate how plant communities reorganize in different stages of plant succession that occurs in restored mining areas, focusing on the role of gypsum specialist species structuring the plant community. The study was conducted in May 2015 in a restored gypsum quarry of the Middle Ebro Valley (Zaragoza, NE Spain). In different phases after the mineral extraction, the pits were refilled with the mine spoil, an organic amendment and the original topsoil. Vegetation cover was spontaneously regenerated from the original seed bank. We selected two sites restored in different years (2008 and 2010) and a control site in the surrounding non-disturbed communities. At each site, all the species found every 20 cm in six linear 'point-intercept' transects (250 m-long) were recorded. Preliminary results showed a low proportion of shrub species in the youngest community, being Gypsophila struthium (gypsum specialist) the most abundant. High species richness accumulated near this gypsum specialist. Our results suggest that G. struthium play an important role facilitating the colonization of non-specialist shrub species that replace it at the end of the successional process.

Sp.12-9-Oral

New insights into how frugivores influence community dynamics under global change

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Many plants across the world's biomes depend on frugivorous animals to disperse their seeds. By promoting key ecological functions such as initial colonization and local immigration, frugivores play a pivotal role in plant community dynamics. Besides, by fostering vegetation recovery after disturbance, frugivores provide important ecosystem services, including erosion prevention or habitat provisioning for other taxonomic groups. Information on the way in which frugivores operate is therefore essential to understand and forecast these functions and services. Yet, there is still an important knowledge gap on how multiple frugivore species disperse seeds through space, especially in a context of habitat loss and climate change. In this contribution, I will present new empirical evidence on how multiple frugivores disperse seeds through the matrix of fragmented landscapes, and how they help plants to shift their ranges in response to global warming. Finally, I will focus on those frugivore traits that explain the observed seed dispersal patterns, and argue about their usefulness to forecast community dynamics in changing ecosystems.

Sp.12-10-Poster

Relationship between weed diversity and crop productivity affected by resource availability and imbalance

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Sustainable farming systems need to balance crop production with the conservation of weed diversity to maintain the ecosystem services provided by these species. To this aim is relevant to characterize the relationship between weed diversity and crop production. This relationship could be affected by weed diversity response to both resource availability and resource imbalance. We assessed whether increasing the supply of limiting resources reduces weed diversity and functional divergence of weed communities, and whether greatest values of these variables occur when multiple resources are supplied at balanced ratios. We further analyzed whether higher weed diversity allow a reduction in weed-crop competition. We used data collected in 2014 from a long-term experiment (Broadwalk, Rothamsted, UK) in which plots were cropped with wheat and subjected to a fertilization treatment. Treatments varied in both resource abundance and imbalance due to different combinations of nutrients applied at contrasting doses. In each plot we computed weed species richness (S), community diversity (eH') and functional divergence using SESFDis (with 6 traits). We recorded the number of nutrients added, as well as resource availability and imbalance using previously developed formulas. Our results showed that S and eH' were not related to resource availability but decreased as more nutrients were added. The increase in the availability of resources led to higher functional divergence in weed communities, but SESFDis was not related to resource imbalance. On the contrary eH' was higher in plots where resources were supplied more balanced. Higher values of S, eH' and SESFDis reduced yield loss.

Sp.12-11-Oral

Biodiversity's interactome: mapping complex networks of ecological interactions and their functions

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No single species on Earth persists without interacting with other species. The complex web of biotic interactions is Biodiversity's interactome: the whole suite of ecological interactions that support the Web of Life providing functional links among species. Quantifying and characterizing this interactome is urgent and demands that a large fraction of these interactions be experimentally or computationally probed. The number of actual pairwise interactions among species in local assemblages scales very rapidly with species richness in real interaction webs. These webs would be within the range of n= 10^3-10^5 or even n= 10^4-10^6.5 component species, depending on spatial scale from local to regional and up to continental spatial scales. To fully quantify the size of these interactomes we need to focus on the macroscopic properties of complex interaction networks. We need new approaches based on the identification of forbidden links, functional modules, and compartments, and on exploring how complementary or functionally redundant are ecological interactions. Most recent studies of plant-animal interaction networks have focused on frequency of interaction to map interaction patterns and to estimate interaction strength; this "frequentist" approach, however, may miss important aspects when the outcomes of an interaction are measured in relation to an specific ecological service.

Sp.12-12-Oral

Similarity in gene expression predicts species interactions, coexistence and ecosystem functioning

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Phenotypic variation controls the nature of species interactions, which in turn determine whether or not species coexist, and how they influence ecosystem functioning. We tested the hypothesis that as phenotypic similarity in patterns of gene expression across an organism's entire transcriptome declines across species, they will be more likely to experience weaker competition, and will therefore be more likely to coexist and increase ecosystem functioning. To test this, we grew eight species of freshwater green algae in monocultures and bicultures for 46 days in a lab microcosm experiment. We quantified the strength of species interactions and coexistence by: 1) fitting Lotka-Volterra models to time-series densities and estimating interaction coefficients, and 2) calculating relative densities that compare species' steady-state densities in biculture to those in monoculture. We used Illumina sequencing to quantify the expression of 1,253 families of homologous genes, including a set of 17 candidate genes that we hypothesized a priori to be involved in competition or facilitation. To assess levels of ecosystem functioning, we measured the community total biovolume, primary production, respiration and nutrient uptake. Counter to our hypothesis, we found that as gene expression similarity among species increased, species experienced weaker competition and greater facilitation, and were more likely to coexist. These species also tended to increase levels of all ecosystem functions measured. These results run contrary to common thinking in ecology and evolution, and suggest that similarity in the expression of commonly-expressed genes promotes coexistence and ecosystem functioning.

Sp.12-13-Poster

Plant facilitation promotes ecosystem functions by maximizing phylogenetic diversity in mine tailings

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Facilitation assembles plant communities in abiotically stressfull ecosystems across the world. Nurse plant species usually shape patches of increased biodiversity by alliviating estress factors and promoting niche complementarity among species as a way to a better explotation of limited resources. In some cases the nurses promote soil fertility also. However, the role of the facilitation as a driver of the community assembly and ecosystem functions in extreme anthropogenic environments has been rarely reported and hardly thought as a practical tool for restoration. We hypothesized that the high soil toxicity, barren soil conditions and water and temperature stress determine a plant facilitation-driven community assembly in abandoned metaliferous mine tailings from semiarid Mediterranean areas in Spain. We expected that patches with higher phylogenetic diversity have also higher contribution to ecosystem functions related to the soil productivity and fertility. To test these hypotheses we sampled the plant and soil microbial communities and soil properties in 12 mine tailings. We identified three main functional types of species: 13 nurses, 94 beneficiaries and 30 pioneers. The nurses shared some differential traits compared to the pioneers and beneficiaries: they were higher plant species with lowest deep/laterality and length/weight root ratios. They had also lesser specific leaf area. These nurses shaped patches with higher richness compared to the adjacent sites in the tailings. Nevertheless, only some of the nurses also improved the phylogenetic diversity. Similarly, several nurses promoted the soil microbial activity in the patches but only four species increased the soil fertility in the tailings.

Sp.12-14-Oral

Herbivores hosting hosts: can hyperparasitoids cause large-scale insect outbreaks?

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Many causes of synchronous population fluctuations of species, such as large-scale insect outbreaks, have been proposed. Here we investigate if natural enemies may cause landscape-scale changes in densities of herbivorous insects and thus forest defoliation. Biodiversity, i.e. natural enemies of herbivorous insects, could provide an ecosystem service through increasing biological control. One of the most common and effective natural enemies of herbivorous insects are parasitoids that lay eggs in hosts, and high parasitoid-caused mortality has been observed during endemic host periods. However, observed parasitism rates cannot be compared to theoretical expectations from the classic modelling approaches towards host-parasitoid dynamics. To develop a landscape-scale approach to study how natural enemies affect outbreaks, we construct a novel metacommunity model from an observed host-parasitoid-hyperparasitoid networks with 89 species. In this model, colonization and extinction of species are determined by the interactions between hosts, primary parasitoids and their parasitoids (hyperparasitoids). Hyperparasitoids are important because they simultaneously decrease host and parasitoid densities which disrupts its own potential to reproduce, and ultimately leads to the collapse of natural enemy densities and host density explosion. Results show that the quantitative implementation of these observed processes reproduces observed outbreaks. The model also identifies a testable prediction that the proportion of hyperparasitoid-caused host mortality should increase just before a host outbreak because its instability leads to outbreaks. If verified empirically, the metacommunity model indicates the hyperparasitoid dominance could provide a biotic early-warning signal that an outbreak is approaching.

Sp.12-15-Oral

Pest regulation by insectivorous birds in Mediterranean woody crops

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Regulation of agricultural pests by their natural enemies is an alternative strategy to the use of chemical pesticides. We assessed the potential of insectivorous birds as pest regulators in woody crops located in central Spain. A total of 417 nest boxes installed in five field study sites (one vineyard, two fruit tree orchards, and two olive groves) were monitored for occupancy and breeding of insectivorous birds and predation experiments with sentinel caterpillars were conducted for three consecutive years. In addition, consumption rates by birds were estimated at all field sites. In the vineyard and two fruit tree orchards, occupancy by breeding birds increased with time since installation and averaged 58.5% per field site by the third year. There was a significant effect of habitat characteristics on both use of nest boxes and recruitment of birds. Predation rates of sentinel caterpillars were higher near nest boxes with breeding birds compared to paired controls (45% vs. 31%, respectively). Estimated consumption rates by insectivorous birds ranged between 0.89 kg ha-1 yr-1 in one fruit tree orchard and 4.94 kg ha-1 yr-1 in the vineyard by the third year. Nest boxes were not occupied by birds in the two studied olive groves probably due to long distance (>2 km) from suitable bird habitat and inappropriateness of nest boxes uncovered by natural vegetation. We conclude that ad-hoc installation of nest boxes in Mediterranean woody crops overall enhances pest regulation by insectivorous birds but that actual outcomes are moderate and highly context dependent.

Sp.13: Investigating ecological and evolutionary processes with NGS

Sp.13-1-Oral

Colonization history and further gene flow of the Galápagos Lantana peduncularis (Verbenaceae) using Sanger and Next-generation Sequencing

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The Galápagos archipelago, situated in the Pacific Ocean ca. 1000 km off continental Ecuador, has a singular flora with a high percentage of endemism (ca. 45% of native species). Nevertheless, few phylogenetic studies include Galapagos plant species, and even fewer address phylogeographic and population genetic questions. Lantana peduncularis is endemic to the Galápagos and broadly distributed across all 12 large islands of the archipelago. Besides, L. peduncularis is considered a hub in both pollination and dispersal networks of lowland communities, which indicate that active gene flow is occurring within each island. Here we address a population genetic study of to reconstruct historical gene flow among islands. Two genetic methods to infer population structure were employed: 1) Traditional Sanger approach was used to sequence five DNA plastid regions; and 2) Next-Generation Sequencing (NGS) allowed obtaining hundreds of restriction-site associated DNA (RAD) polymorphic markers distributed across the genome. Both methods turned out to be complementary and revealed high connectivity among populations and islands.

Sp.13-2-Oral

Exploring the genetic basis of heterostyly in the genus Linum (flax)

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Heterostyly is a fascinating plant mating system that involves multiple flower morphs with different spatial arrangements of male and female reproductive organs that simultaneously limit self-pollination while improving cross-pollination efficiency between morph types. In addition to different style and filament lengths in each floral morph, many heterostylous species also show extra floral morph differences including: self-incompatibility, different pollen and stigma morphologies, and repositioning of styles and filaments within the flower. Despite these complexities, classical genetic studies show that distyly is controlled by a single genetic locus (S), a biallelic supergene of physically linked genes that interact to build each flower morph. The evolution of the S locus is characterized by dominance interactions and balancing selection between the two alleles. We performed a gene expression study of heterostyly in Linum tenue, an endemic annual from the SW Mediterranean, to learn more about the genetic basis of heterostyly in this genus. The messenger RNA of flowers from multiple glasshouse-grown individuals of both morphs at different stages of bud development was sequenced on an Illumina HiSeq 2500. The combined sequence read data was de novo assembled into a floral transcriptome using Trinity software tools followed by scaffolding of resulting contigs against reference plant transcriptomes. Genes and functional groups showing significantly different expression between the two morphs during floral development have been identified. Some of these genes are S locus candidate genes that are being followed up with confirmatory quantitative PCR and floral RNA sequencing of nine more Linum species with and without heterostyly.

Sp.13-3-Oral

Refining a panel of intron markers to monitor the genetic diversity in small mammal communities by exploring different multiplexing strategies: a study from Doñana

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The plethora of novel and exciting perspectives opened up in ecology and evolution following the advent of NGS technologies has been widely addressed over the last decade. However, the impressive decrease of sequencing cost has only recently triggered the development of multilocus sequence-based nuclear DNA markers. Moreover, there is still ample room for investigations addressing the performance and comparability of different NGS approaches. In this study, a panel of 46 intronic markers primarily designed for rodents was tested on a total of 10 species found in Doñana National Park and encompassing the orders Rodentia, Eulipotyphla and Lagomorpha by sequencing PCR-based libraries on two different sequencing platforms (454 and Illumina). In order to enhance applicability of this approach across other biological systems, the ad-hoc bioinformatic pipeline for primer design was outlined and a coverage analysis performed to ensure genotype reliability. Expectedly, number of loci amplified and amplification evenness decreased as phylogenetic distance increased from the focal taxa, yet several loci still amplified and were variable across other orders. Genetic variability found at some loci looks promising in terms of population genetic analyses, as illustrated by variation in a common rodent. Others will deliver their utility for addressing phylogeographic and phylogenetic questions, which we illustrate by comparing phylogenies based on mitochondrial markers to those based on these nuclear loci.

Sp.13-4-Oral

The epigenetic basis of adaptation to environmental change in a pollinator model

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Biological diversity is fundamental for populations to adapt to changing environments. The evolvability and adaptation potential of species and populations depends on both genetic and epigenetic variation. Pollinators are key to ecosystem functioning but extremely vulnerable to the effects of pathogens, anthropogenic activities and climate change. In this study we investigated the effects of various environmental stressors on the extent and patterns of epigenetic variation, in the bumblebee Bombus terrestris. For this purpose we set up a novel epigenomic approach named bisulphite RAD- sequencing, which allows to study DNA methylation at the population level. Data will be presented in relation to the analysis of genome-wide SMPs (single methylation polymorphism) from several populations and developmental stages. We will discuss results in relation to levels of epigenetic diversity among populations . We will also discuss future directions in relation to the functional analysis of environmentally responsive epigenes, and the long-term modeling of epigenetic variation to predict consequences of climate change and other anthropogenic activities on B. terrestris.

Sp.13-5-Poster

A curated set of genome-wide SNPs for the conservation of Iberian lynx

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The Iberian lynx (Lynx pardinus) has been acknowledged as the most endangered felid species in the world. Its scientific interest, in combination with on-going in situ and ex situ measures which include the management of a captive population, place this species in a unique spot for the development of conservation-focused tools. Within the framework of the Iberian lynx genome project many resources have been generated, including a fully annotated draft reference genome and re-sequencing data for ten individuals that allowed the calling of more than 1.5 million single nucleotide polymorphisms (SNPs). Of these, 1,536 SNPs were selected based on minimum inter-SNP distance (> 0.6-1Mb), minor allele frequency in the global sample (MAF = 0.4) and predicted conversion rate probability (Illumina's ADT score = 0.8), and then genotyped in 384 Iberian lynx samples using Illumina's GoldenGate technology. 1494 markers rendered good genotypes (conversion rate = 97,3%), and were subsequently analysed for Hardy-Weinberg equilibrium, heterozygosity, linkage disequilibrium, and population structure. We also took advantage of this dataset to identify deviations from neutrality, to infer genealogical relationships among samples and to detect Mendelian inconsistencies. Finally, we selected optimal subsets of SNPs for specific interests, including individual identification, kinship estimation, parentage assignments, and admixture tests. These subsets of extensively curated SNP markers offer novel and more powerful genomic tools for the genetic management and non-invasive monitoring of Iberian lynx populations.

Sp.13-6-Poster

Lynx evolutionary genomics: An evaluation of functional variation and the role of balancing selection in declining populations

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Declining and isolated populations lose genetic diversity due to genetic drift, what could cause a reduction of fitness and adaptive potential. In functional areas of the genome, balancing selection, recombination and mutation could oppose the action of genetic drift by generating or maintaining diversity. The concurrent action between these forces and genetic drift may vary in different demographic scenarios and result in distinct diversity patterns across the genome. In this poster, we present our on-going research on these coexisting processes in Eurasian lynx (Lynx lynx) and Iberian lynx (Lynx pardinus), based on sequencing whole genome data from various contemporary populations with different demographic history, and exploring patterns of diversity and balancing selection across the genomes. Besides, we will assess diachronic changes in the Iberian lynx genome using ancient and historical samples. The history of the species and the availability of samples, knowledge, and resources, such as a fully annotated genome, make the system a perfect model for addressing these evolutionary questions using the latest sequencing technology.

Sp.13-7-Poster

Using targeted NGS to detect recent hybridization in plants

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Hybridization is considered one of the most important evolutionary processes in plants. It involves fertile crosses between distinct species, or between genetically differentiated populations of the same species. Although the actual role of hybridization in diversification remains controversial, some studies seem to indicate that evolution by hybridization is widespread in plants. Erysimum (Brassicaceae) contains more than 200 species. Some of these species are sympatric, share pollinators and have overlapping flowering times. Thus, prefertilization barriers to reproductive isolation could be porous allowing gene flow across species boundaries. Here we present preliminary results of a study of hybridization among three Ersysimum species: E.popovii - E.mediohispanicum - E. bastetanum. We amplified ribosomal spacer sequences (ITS) from sympatric and allopatric populations of each species and sequenced these DNA regions using the Illumina Miseq platform. We then analyzed ITS haplotypes using population genetics tools to detect hybrid populations and determine their origin. Results show a wide diversity of ITS haplotypes. The distribution of sequences among individuals and populations appear to indicate recent introgression, in particular in the sympatric populations. In conclusion, our work shows that hybridization seems to be frequent in Erysimum spp. and suggests this might have fostered the evolution of this group.

Sp.13-8-Oral

Genomics of niche evolution: tracking the emergence of plant parasitism

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Plants are characterized by photosynthetic nutrition; however, several plant species have lost or reduced their photosynthetic activity, and obtain nutrients and energy through direct connections to host plants or via fungi. Parasitism has appeared independently at least twelve times within plants, whereas mycoheterotrophy did so over 40 times. Currently, complete plastomes of non-photosynthetic plants have been sequenced only for some lineages, including just one or a few species per clade; a total of 25 parasitic and mycoheterotrophic species have been studied to date. This knowledge gap hampers disentangling selective pressures related to this trophic niche shift. Here, we investigate genetic changes on coding regions of the plastid genome related to the transition from autotrophy to heterotrophy. To do so, we build on an unprecedented genomic dataset that includes 150 parasitic and mycoheterotrophic species belonging to eight lineages, together with close autotrophic relatives. Specifically, we sequenced and assembled de novo the plastid genome of these species using a shotgun approach on genomic DNA, performed phylogenomic analyses, tested for relaxation or intensification of selective pressures in parasitic and mycoheterotrophic lineages compared to autotrophic relatives, and assessed the relationship between time since heterotrophy and plastome degradation. This study thus constitutes a significant advance on our understanding of the macroevolutionary context of the emergence of parasitic lifestyles.

Sp.13-9-Oral

Is phenotypic differentiation in common quail (Coturnix coturnix) populations due to divergent migratory patterns?: A genomic approach

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Ecology may play an essential role in speciation by the reproductive isolation of lineages in sympatry. Differentiation of migratory routes could be one mechanism promoting this kind of reproductive isolation. However, it is not always clear when intra-specific variation (i.e. in morphology or migratory behavior) is not just a stable polymorphism or could be leading to progressive differentiation by assortative mating. We have observed different morphological phenotypes in common quails (Coturnix coturnix) that tend to show spatial segregation in the Iberian Peninsula. This diversity also extends to Morocco, Canary Islands, Azores and Madeira. At the same time, fragmentary data suggest that some populations may have long migratory movements, while others may migrate short distances, and other populations are sedentary. We hypothesize that the phenotypic differences between populations could be related to differences in migratory patterns coupled with assortative mating between phenotypes. This could accelerate adaptation to different habitats and, potentially, lead to ecological speciation. We investigated this possibility by integrating ecological, phenotypic (pigmentation and wing morphology) and genomic data. We used Genotyping-By-Sequencing approaches to generate thousands of genome-wide genetic markers on a set of 95 samples distributed across the western limits of the species' distribution range. The integration of these data should allow us to identify fine-scale population structure, its association with phenotypic characters and correspondence with migratory patterns.

Sp.13-10-Oral

Comparison of amino acid replacement ratios in vertebrates: insights into life history traits of caecilian amphibians (Gymnophiona)

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Over the last few years, high-throughput sequencing (HTS) technologies and associated bioinformatics have revolutionised many areas of scientific research, including ecology and evolutionary biology. These technological advances enable studying and comparing genome-wide patterns and molecular variation in both model and non-model organisms in order to understand biological diversity. At the molecular level, variation is explained by the nearly neutral theory and predicts a faster accumulation rate of deleterious mutations in small populations. We have studied the pattern of amino acid replacement (KR/KC ratio) as a marker of selective pressure to analyse life-history traits as proxies of the effective population size. Our research compares 626,928 amino acid sites of 1955 orthologous genes for 56 vertebrates. These include newly-generated transcriptomic data for five species of caecilian amphibians that are representatives of 4 of the 10 families of the order Gymnophiona (Caecilia tentaculata, Microcaecilia dermatophaga, Microcaecilia unicolor, Rhinatrema bivittatum, and Typhlonectes compressicauda) and data from the 51 vertebrate species in the EggNOG database. The KR/KC ratios were correlated with the AnAge database variables available for the studied species. This approach can be used more generally to unravel important aspects of the life of other animals that, like caecilian amphibians, can also be difficult to study in the field due to their secretive habits and lifestyle.

Sp.14: Fire-driven evolution of MTE floras

Sp.14-1-Main talk

The role of fire in evolution of Mediterranean floras

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Most mediterranean regions are highly fire-prone: did fire-related traits arise with the advent of mediterranean climates (postulated at 20_10 million years ago, Ma, Rundel et al. 2016) or did they evolve earlier? Did fire precede the evolution of fire-related traits? (if not, then they cannot be considered fire adaptations). What role has fire played in the evolution of mediterranean floras? We consider the evolutionary history of fire-stimulated flowering in the Loranthaceae, Orchidaceae and Xanthorrhoeaceae, on-plant seed storage (serotiny) with fire-stimulated seed release in the Pinaceae, Proteaceae and Restionaceae, and fire-stimulated germination in the Fabales, Cistaceae (heat cracking of hard seeds), Haemodoraceae, and Poales (smoke-stimulated germination). We conclude that: 1) the origin of all three fire-related traits may be traced to at least the mid-Cretaceous, 90+ Ma, long before the advent of mediterranean climates; 2) fire-proneness preceded, or rarely coincided with, the appearance of fire-related traits and their continuous association with fire-prone habitats confirms that they are fire adaptations. At best, drought-related traits are exaptations to fire; 3) the Cretaceous was marked by the slow evolution of fire-adapted lineages with novel fire-related traits, whereas the Cenozoic was marked by a 2.5 times increase in the evolution of lineages with novel fire-related traits and a 23 times increase in lineages with conserved fire-related traits (despite a hiatus at 40_30 Ma) – once adapted to fire, other constraints, such as drought, pollinators and granivores, triggered further evolutionary events; 4) the advent of mediterranean climates appears to have further promoted the initiation of fire-adapted lineages.

Sp.14-2-Oral

Germination behavior of Sarcopoterium spinosum indicates anthropogenic-fire-driven selection in the southeast Mediterranean

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The long history of human activity in the southeastern Mediterranean region had a strong impact on the vegetation in the region. In order to determine whether human activity also influenced plants' adaptive traits we tested the germination ecology of the widespread shrub Sarcopoterium spinosum as it responded to post-fire cues. As wild-fires in this region occur mainly during the long dry season, but are not ignited by natural causes such as lightning strikes, we hypothesized that post-fire-stimulated germination evolved in response to human activity. Emergence experiments were conducted on 10 populations from productive, fuel-rich and fire-prone mesic Mediterranean populations, as well as from those in arid and fuel-poor environments. Our results indicate that post-fire cues induced germination of S. spinosum only among populations that originated from sites that are prone to wild fires, indicating on selection driven by anthropogenic factors in natural populations of the southeastern Mediterranean environments.

Sp.14-3-Oral

Fruits from the fire? Conflicting pressures for the evolution of woody-fruited hakeas in Western Australia

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Nutrient-impoverished soils, severe summer drought, and frequent fire typify many Mediterranean-type regions of the world. Such conditions limit seed production and restrict opportunities for seedling recruitment, making seed protection paramount. Our focus was on Hakea, a diverse genus of shrubs (Proteaceae) which frequently display long-term on-plant seed storage (serotiny), but whose nutritious seeds are also targeted by cockatoos (Calyptorhynchus spp). Working with 56 species from populations located throughout southwestern Australia we examined how fruit defence characteristics varied according to a) pollination syndrome (bird vs insect), b) fire regeneration strategy (killed vs re-sprouting), and c) on-plant seed storage (degree of serotiny). Around 40% of species showed substantial seed loss from cockatoo granivory, but species with large woody fruits (>1 g) were rarely attacked. In addition, species lacking protective spiny foliage (bird-pollinated) had much larger (4?5 times) fruits than those with spiny leaves and cryptic fruits (insect-pollinated). Fire-killed species were just as resistant to granivores as re-sprouters but with much greater seed stores. The large, clustered fruits of species with prolonged seed storage (serotiny) were rarely attacked. We conclude that the evolution of large woody fruits in Hakea is contingent on several selective agents; pollinator syndrome (bird pollination dictates flower/fruit location, thus apparency to granivores); fire (serotiny ensures post-fire recruitment but requires long-term defense); and the presence of a formidable granivore (that promotes strong defense).

Sp.14-4-Oral

Baptism by fire: the pivotal role of ancient conflagrations in evolution of the Earth's flora

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Fire-prone landscapes in MTEs have historically been interpreted in terms of climate and anthropogenic disturbance. Fire became a defining feature of Earth's processes as soon as land plants evolved 400 million years ago and has shaped the structure and function of major global biomes ever since. However, there remains a general lack of appreciation of the roles of fire in the origin, evolution, ecology and conservation of the Earth's biodiversity. We review the literature on the presence of fire throughout the Earth's history following the evolution of land plants and examine the evidence for the origin and evolution of adaptive functional traits, biomes, and major plant groups in relation to fire. We show that: 1) fire activities fluctuated throughout geological time due to variations in climate, and more importantly in atmospheric oxygen, as these affected fuel levels and flammability. 2) fire promoted the early evolution and spread of major terrestrial plant groups (both gymnosperms and angiosperms; 3) fire shaped the structure and function of major global biomes; 4) fire has initiated and maintained the evolution of functional traits as an adaptation to fire since the evolution of land plants. We conclude that fire has been a fundamental agent of natural selection on terrestrial plants throughout the history of life on the Earth's land surface. We suggest that a paradigm shift is required to re-assess ecological and evolutionary theories that exclude fire, and also the need to review fire-suppression policies on ecosystem management and biodiversity conservation in MTCs and fire-prone regions globally.

Sp.14-5-Oral

Fire as a selective force in the evolution of the Cistaceae (Europe/USA) and Xanthorrhoeaceae (Australia/South Africa)

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It is likely that Mediterranean-type environments (MTEs) first established during the mid-Miocene, ~20–10 Ma (Rundel et al. 2016). Since fire is a key feature of MTEs, is the presence of species with fire-related traits a response to fire (adaptation) or drought (exaptation) from a Mediterranean-type climate or did these traits arise earlier? If fire was essential for their evolution, then 1) fire-proneness must predate the appearance of fire-related traits and 2) fire-proneness and fire-related traits will be correlated through time. These hypotheses were tested on Cistaceae and Xanthorrhoeaceae, two families that persist in fire-prone MTE habitats via contrasting survival strategies. We re-analysed an existing molecular phylogeny for each family, then used trait-assignment techniques to trace fire-related traits and habitat fire-proneness back to their origin. Hard-seededness (fire-stimulated germination) in Cistaceae first appeared 24 Ma with the crown 14.2 Ma (Guzmán and Vargas 2009), as the family differentiated in the already fire-prone Mediterranean Basin. Xanthorrhoeaceae arose in already fire-prone Australia 75 Ma (Crisp et al. 2014) from non-fire-prone ancestors. By 70 Ma, one subclade had developed fire-stimulated flowering (FSF). By 65 Ma it had split into Xanthorrhoea, speciating strongly in SW Australia 30 Ma, (universal FSF), and Asphodeloideae in South Africa, with Kniphofia (FSF) arising 34 Ma and the succulent-leaved group (Haworthia, Aloe – some FSF) 19 Ma. These findings support the view that fire helped shape the floras of the Mediterranean Basin, South Africa and southern Australia during and before their subjection to Mediterranean climates, independent of drought.

Sp.14-6-Oral

Heat, smoke and postfire temperatures control seed germination in the South African genus Leucadendron

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Fire is a major driver of ecological processes in fynbos vegetation. With almost 100 species/subspecies, Leucadendron (Proteaceae) is a prominent shrub genus in fynbos. Seeds are either stored on the plant (serotiny) or in the soil, a dichotomy unknown in any other genus, thus making it an ideal group for comparative germination studies. Serotinous species release their seeds from cones in response to fire heat, ensuring germination in the post-fire environment that is optimal for seedling recruitment. In contrast, germination of soil-stored seeds is promoted directly by heat and/or chemicals in smoke that also cues germination to the post-fire environment. Increased diurnal fluctuations of temperatures at the soil surface following vegetation removal by fire is an indirect cue that promotes germination in some fynbos species. In addition, fruit morphology can be divided into nutlets (serotinous and non-serotinous species, another unique dichotomy) and winged (serotinous only). Our study investigated the role of direct (heat and/or smoke) and indirect (fluctuating temperatures) fire-related cues on seed germination for 40 species of Leucadendron with contrasting fruit morphologies and seed storage. All soil-stored seeds showed a fire effect on germination as did (surprisingly) 23% of serotinous species, a similar pattern when only nutlets were used. Germination was stimulated by either smoke or, to a lesser extent, heat. All soil-stored species responded to smoke as did 17% of serotinous species. Seed morphology made no difference to the fire effect on serotinous species. Fluctuating temperatures sometimes supplemented the dominant smoke stimulation of germination among soil-stored species.

Sp.14-7-Oral

Lethal conditions of seeds; identifying lethal thresholds of seeds from Mediterranean ecosystems when exposed to extremely high temperatures

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Recruitment of new plants from seeds is a vital part of post-fire ecosystem recovery. In many Australian species, germination and recruitment are from smoke-generated germination cues and heat-induced release of woody fruit containing seeds. Both soil and canopy-stored seed banks are somewhat insulated from heat effects of fire, but particularly intense fires, or spots in fires, may result in temperatures that are lethal to seeds. Heat interactions with seed tissues are influenced by seed hydration status, and thus heat impacts are potentially related to seasonal patterns in soil moisture content. Here we examine the lethal temperature thresholds of 15 Banksia woodland species encompassing both soil and canopy stored seeds across a range of temperatures and different seed hydration states. Seeds hydrated to 15%, 50% and 95% relative humidity were exposed to a range of temperatures between 100°C- 180°C. Most native seeds survived exposure to 120°C while dry (15% RH), but at higher levels of moisture, mortality generally increased. At 140°C, seeds of most species died, regardless of hydration status. Seeds from non-native invasive species showed a reduced tolerance to high temperatures, with most being killed after exposure to 120°C under any moisture condition. Interestingly there was no difference between survival of canopy v soil-stored seeds at temperatures = 120°C. The results may inform the timing of prescription burns by taking into account seed hydration state to minimise seed mortality. In order to minimize seed mortality, effects of fuels, soil wetness and exposure time on seed survival should be considered.

Sp.14-8-Poster

Response of different woody species to fire severity conditions, and their interaction with nitrogen depositions

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The underground of Pinus pinaster forest in northwest of Spain is dominated, among other species by Pterospartum tridentatum. These pine forest are subjected to wildfires frequently; so, both species, Pinus and Pterospartium showed specific adaptations to regenerate after fire. The strategies for the regeneration of these species are germination and vegetative regrowth. The characteristics of fires, mainly the severity and characteristics of the seeds can condition their capacity for regeneration. The objective of the present study is to analyse the germinative response and development of plants, Pinus pinaster and Pterospartum tridentatum when they are subjected to high temperatures and nitrogen deposition. Seeds from Sierra del Teleno (León) have been subjected to the experimental treatments: (1) thermal shocks (60° C and 120° C for 5 minutes), (2) addition of nitrogen and (3) thermal shocks plus nitrogen addition. We evaluated the percentages of seeds germination, seedlings establishment, aerial/subterranean seedlings growth and (3) the seedlings competition effects between both species. The results have shown that thermal shocks produced an increase in the percentages of germination of Pterospartum tridentatum but did not affect to Pinus pinaster. The addition of nitrogen negatively affected germination of Pinus pinaster. The seedlings of Pinus pinaster showed the longest aerial and subterranean growth. There were significant influence of competition among seedlings of Pinus pinaster and Pterospartum tridentatum.

Sp.15: Plant reproductive ecology and evolution in a changing Mediterranean climate

Sp.15-1-Main talk

The role of historical and biogeographical constraints on Chilean plant-animal interactions

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The idea of specialization has been a cornerstone in studies on the ecology and evolution of plant-animal interactions. In the last decades, however, a paradigm shift from specialization to generalization has occurred, in part, because most evidence indicates that multiple and often weak interactions provide a better characterization of interactions in a variety of ecosystems. In this way, the initial idea of tight and specialized interactions has been replaced by one that emphasizes the generalized, labile and weak nature of plant-animal relationships. In this contribution I will put forward the idea that generalization of interactions is not necessarily the norm in Mediterranean ecosystems. In doing so, I will provide examples of highly specialized plant-animal relationships found in central Chile, stressing that such specialization results as by-product of historical and biogeographic constraints. Unlike most Mediterranean ecosystems, the Chilean one can be depicted as a continental island with geographical barriers that reduced colonization from tropical and sub-tropical latitudes, resulting in depauperate species assemblages and high levels of plant endemism. Such historical constraints provided a limited pool of plant and animal species, currently represented by low pollinator/plant ratios, similar to those found in oceanic islands, and a relatively high prevalence of specialized interactions. Unlike other Mediterranean ecosystems, and against the current generalization paradigm, specialization is not an unusual finding in the Chile, which provides unusual opportunities to inquire into the properties that make possible the maintenance of subtle and fragile plant-animal interactions.

Sp.15-2-Poster

Cytogenetic diversity in the diploid-polyploid complex Linum tenuifolium s.l.

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Polyploidy is widespread in angiosperms and has long been considered as an important mechanism of speciation. Genome duplications bear broad-scale consequences on gene expression and developmental processes, potentially leading to immediate morphological, reproductive, physiological and ecological shifts. Linum tenuifolium s.l. is composed by perennial plants with monomorphic (L. tenuifolium) and dimorphic (L. suffruticosum) populations, the latter species presenting a heteromorphic self-incompatibility system. Additionally, these species form a polyploid complex and preliminary data have shown cytogenetic diversity in east Spain and south-east France. Still, most of the distribution range of the group remains largely unexplored. Our objective was to determine the cytogenetic variation for the entire range of Linum tenuifolium s.l. For that, we investigated 172 populations from Iberian Peninsula, south-east France and north-west Italy. A high cytogenetic diversity was found in the complex with five cytogenetic entities being detected. The cytogenetic diversity was observed in the dimorphic L. suffruticosum and concentrated in the Iberian Peninsula, while the monomorphic L. tenuifolium resulted to be homogeneously diploid through the entire range surveyed. Most of the populations were pure-ploidy populations, but we also found a few mixed-ploidy populations suggesting that cytotypes might co-occur. Still, a clear spatial aggregation of cytotypes was observed, despite the low habitat specificity that could promote population dynamics in cytotype contact zones. Study funded by a CONFLISEX research grant (Spanish MINECO CGL2013-45037-P) and by the Portuguese Foundation for Science and Technology (grant SFRH/BD/108451/2015 and project IF/01267/2013).

Sp.15-3-Poster

The role of herkogamy in controlling self-pollen deposition in two floral colour morphs of Lysimachia arvensis in the Mediterranean Basin

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Given that most plant species are hermaphrodites, traits that limit selfing when inbreeding depression is high are expected to be important targets of selection. Herkogamy is the spatial separation of male and female reproductive functions and it is regarded as a mechanism to avoid selfing. We evaluated the effectiveness of herkogamy in controlling self-pollen deposition in the annual Lysimachia arvensis, a species with two colour floral morphs suffering inbreeding depression in the Mediterranean area. Flowers of this species last three days and show nystinastic movements. The first day of anthesis, style is placed laterally and forms an angle with the stamens, and then it moves upwards approaching the stamens. The style gets placed between or above the stamens, depending on their relative lengths, and delayed selfing can occur during anthesis or when corolla abscised. We studied the style-stamen angle and differences in style-stamen length in both colour morphs, and estimated the levels of self-pollen deposition. Both traits were highly variable among plants but not within plants. Preliminary results showed that flowers of the blue morph had lower style-stamen angles but higher style-stamens length. Self-pollen deposition increased along the flower anthesis and was always higher in the red morph than in the blue one (1st day: 23 vs 18, 2nd day: 61 vs 43, 3rd day: 110 vs 81). Differences in style-stamens length were more effective than the style-stamen angle in delaying self-pollen deposition. The importance of herkogamy in the rates of selfing of both morphs in the Mediterranean is discussed.

Sp.15-4-Oral

Deterministic and stochastic processes on morph-ratio variation across the range of four stylar-dimorphic Narcissus species

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Style polymorphic Narcissus species often display spatial variation among populations in morph-ratio and perianth traits. Deterministic and stochastic processes may play a role in this variation. For example, morph-ratio variation in Narcissus may result from morph-specific differences in the rates of selfing, and assortative and dissasortative cross-pollination in populations. All of these crosses are possible because polymorphic species are characterized by the absence of an intra-morph incompatibility system and some are also self-compatible. Pollinator shifts have also been useful to understand variation in morph ratio across populations. Furthermore, historical stochastic factors (i.e. founder events, drift) can account for population structure. Detailed understanding of the maintenance of morphs requires thorough investigation across the species' range, which is rarely achieved in widespread species. Here we analysed the influence of historical stochastic factors, pollinators and incompatibility systems on the morph-ratio variation among populations of four Narcissus species (N. assoanus, N. dubius, N. rupicola and N. cuatrecasasii).The historical factors were determined through phylogeographical analyses. We used plastid sequences (trn T-L, trn L-F and ndhF) from a total of 193 populations. Pollinator environment was studied by means field observations.We determined visitation rates of pollinators in two representative populations of each species which have differences in the morph-ratio. Finally, the incompatibility system was determined from published data. This work shows the relative relevance of different factors (i.e. historical, ecological and genetic) on the stylar-polymorphism maintenance and morph-ratio variation across populations.

Sp.15-5-Oral

Uncertain pollination environment promotes the evolution of a stable mixed reproductive system in the self-incompatible Hypochaeris salzmanniana DC (Asteraceae)

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According to general theory, reproductive systems in plants should evolve to complete selfing or complete outcrossing. However, a large proportion of flowering plants show mixed reproductive systems, even suffering inbreeding depression. Some models have proposed conditions to explain its evolutionary stability, although empirical studies are still scarce. We studied Hypochaeris salzmanniana, and endangered annual plant species with populations differing in their self-incompatibility expression, to assess the stability of its mixed reproductive system. We combined a study of the pollination environment with experimental measurements of the stability of the self-incompatibility system, outcrossing rate, reproductive assurance and inbreeding depression in four populations for two consecutive years. Self-incompatible plants decreased as the pollination environment was less favourable. After selfing, progeny was mainly self-compatible, while after outcrossing both self-incompatible and self-compatible plants occurred. Reproductive assurance and high inbreeding depression were found in the studied populations and years. The lowest values of inbreeding depression were found in 2014 in two populations, which experienced a marked increase in self-compatibility in 2015. The mixed reproductive system of H. salzmanniana seems to be evolutionarily stable. Year-to-year changes in the frequency of self-incompatible individuals are directly derived from the balance between reproductive assurance and inbreeding depression

Sp.15-6-Poster

Assessing regeneration of Eucalyptus globulus Labill. with the Portuguese National Forest Inventory

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Forest inventories are tools for assessing several forest features in order achieve sustainable forest management. National forest inventories (NFI) which have data on forest vertical structure provide information about plant size of individual species and cover percentages per height class. Eucalyptus globulus Labill. is broadly cultivated in Portugal, where it is exotic and probably naturalized. This species regenerates through both resprouting and germination. This study aimed to assess the geographical distribution of E. globulus regeneration in Portuguese forests, using the data of forest vertical structure obtained by the 5th Portuguese NFI (2005/06). Data from all forest plots of the 5th Portuguese NFI were analysed. Information about each plot was drawn from the database: dominant species; height class; and occurrence of E. globulus regeneration and other plants of this species. Regeneration was defined as the plants shorter than 1 m. Almost all E. globulus plants in the database occur in eucalypt dominated forests, some occur in Pinus pinaster dominated forests, and a residual number in other forest types. In line with this, the same trend is observed with regeneration. Although this inventory was not prepared to specifically assess tree regeneration, it proved to be a useful contribution to assess the geographical distribution. Moreover, it has the added value of accomplishing this objective systematically across the whole country. Many countries make periodical NFI nowadays, enabling the monitoring of regeneration distribution of forest species along time. This is especially valuable in contexts of species introductions and environmental changes.

Sp.15-7-Poster

Germination sensitivity to water stress after exposure to smoke in nine woody species of the Mediterranean shrubland

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Mediterranean shrublands are water-limited and fire-driven ecosystem. Post-fire regeneration often depends on germination from seeds. Changing precipitation total and patterns due to climate variability and change could differentially affect species depending on their sensitivity to germinating under water stress. It has been shown that smoke can alter germination performance in a number of species, but little is known about its role during germination under water stress. Here we studied the germination response to water stress in interaction with smoke in nine abundant species in Mediterranean shrublands. Seeds of six species with a hard coat (three Cistaceae and three Fabaceae) and three with soft coat (Lamiaceae), were exposed or not to smoke and set to germinate under four levels of water stress (0; -0,15; -0,30; -0,45 MPa). Seeds of hard-seeded species were previously mechanically scarified. Final germination percentage and germination speed were recorded. Water stress only decreased final germination in five of six hard-seeded species, and reduced germination speed in both hard- and soft-seeded species. Smoke was found to reduce germination speed in one soft-seeded species. Moreover, an interaction between smoke and water stress was found in germination speed of one hard-seeded species, whereby smoke increased sensitivity to water stress. In conclusion, the species studied differed in germination sensitivity to water stress and, generally, hard-seeded species were more sensitivity to water stress than soft-seeded species. Furthermore, smoke did not change this sensitivity except in germination speed of one hard-seeded species.

Sp.15-8-Oral

Global patterns of floral morph variation, ploidy level and sexual reproduction in the clonal invasive Oxalis pes-caprae

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Reproduction is the key factor involved in the successful establishment and spread of organisms after long-distance dispersal. Introduction of plants into new ecosystems may involve changes in reproductive system, offering an opportunity to investigate contemporary shifts occurring during colonization. Oxalis pes-caprae, a tristylous invasive weed, has been described as reproducing solely by clonal propagation in introduced Mediterranean areas worldwide due to the loss of mating types and sterility after introduction of the 5x short-styled morph. Recent studies revealed variation in floral morph and cytotype composition with sexual reproduction occurring in several locations across the Western Mediterranean Basin. However, morph and cytotype composition in other introduced areas has not been investigated in detail. In this study we recorded the patterns of floral morph, cytotype distribution and potential for sexual reproduction of O. pes-caprae throughout its entire range. This was accomplished by sampling a total of 106 populations in the native area, South Africa, and in introduced California, Australia and Chile. Populations in South Africa were trimorphic and mostly tetraploid; the presence of very few 5x individuals was recorded. Diverse floral morphs and cytotypes were observed in Australia, with the 5x form being dominant; in California and Chile only 5x individuals were recorded. Our results indicate heterogeneity among introduced regions in the potential for sexual reproduction with clonal propagation being prevalent. Nevertheless, the occurrence of morph and ploidal-level diversity in some regions may provide opportunities for on-going evolutionary changes and the possible evolution of local adaptation over longer time scales.

Sp.15-9-Oral

Plant-animal mutualism effectiveness in native and transformed habitats: an assessment of the coupled outcome of pollination and seed dispersal

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Most flowering plants depend on biotic pollination and seed dispersal for successful reproduction. Pollination and seed dispersal are diffuse mutualistic interactions, in which many species with different effectiveness levels participate. However, anthropogenic habitat disturbance may hamper the impact of mutualists, jeopardizing plant recruitment. Important as it is, the effect of habitat transformation on the simultaneous contribution of pollinators and seed dispersers to plant reproduction remains little explored. Aiming to assess the effects of habitat transformation on the effectiveness of pollination and seed dispersal mutualisms, we studied a highly specialized system (a mistletoe interacting with one pollinator and one seed disperser), in native and transformed (abandoned Eucalyptus globulus plantations with native understory) habitats. Pollination and seed dispersal effectiveness landscapes were highly variable and did not differ between native and transformed habitats. Pollinator visitation and fruit removal, however, were higher at the transformed habitat probably favoured by a thick understory vegetation of shrubs and bamboo that provided additional resources to consumers. The resulting plant fitness was higher at the transformed habitat. Contrary to expectations, mistletoe reproduction was higher in the transformed habitat, suggesting that persistence of a highly specialized mutualistic is benefitted from the presence of a native understory vegetation that attracts mutualists and compensates for the often detrimental effects of habitat transformation.

Sp.15-10-Oral

Selfing and allogamy in Rosmarinus officinalis: the role of seed abortion, phenology and environmental variation

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Self-fertilization is likely in plants with hermaphrodite flowers like Rosmarinus officinalis that simultaneously expose many flowers to pollinators. However, despite favoring high levels of self-fertilization and mating among relatives, this species holds very high levels of genetic diversity within populations. To understand how this species maintain such high levels of genetic variation, we performed pollination experiments and observation in wild populations living at the extremes of its altitudinal range along two reproductive seasons. Seeds from cross-pollination experiments germinated four times more than those from self-pollination, largely as the consequence of reduced seed viability. Wild populations consistently showed low seed germination and high allogamy rates during the two seasons. Germination rates were positively influenced mostly by flowering synchrony, the number of days that plants flowered and plant density within populations, but their relative importance depended on the altitude and the reproductive season. Allogamy was positively related to the ratio of male-sterile flowers of individuals but was negatively related to the number of simultaneously open flowers. Seedlings of wild rosemary plants are mostly outcrossed because plants purge most of the inbreeding produced by self-fertilization prior to germination. Male sterility, length of the flowering season and flowering synchrony within populations all favor allogamy and high seed viability. However, they cannot be considered as adaptations to reduce self-fertilization because they varied with local environmental conditions. This plasticity combined with high levels of gene flow among populations contribute to maintain the high levels of genetic variation in populations.

Sp.15-11-Oral

Disentangling reproductive strategies in the Mediterranean: The evolution of floral and vegetative traits in Centaurium (Gentianaceae)

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The shift from outcrossing to selfing has been associated to a set of flower changes so-called “the selfing syndrome”. The occurrence of this transition has been mainly explained within the “reproductive assurance” theory in scenarios under mate limitation. It is expected that “the selfing syndrome” evolves in short-lived, colonizing lineages. We explore the evolutionary trajectories of flower and vegetative traits tipically related to mating system along the phylogeny of Centaurium, a mostly Mediterranean genus typical to open habitats. Our goal was to evaluate if patterns associated to evolution of “the selfing syndrome” occur along the phylogeny of this genus. We first clarified the phylogenetic relationships and timing of diversification among 30 taxa using nine plastidial and nuclear DNA regions. Ancestral state reconstruction and phylogenetic signal were estimated for traits treated as binary characters. Finally, we tested the correlative evolution of traits that are expected to change altogether during “ the selfing syndrome” evolution. Our results showed a tree topology with two distinct diversification periods: onset of Mediterranean climate and glacial-interglacial Quaternary events. The ancestral state reconstructions were not clear for all traits, specially those expected to change during selfing transition. Phylogenetic signal was not detected for anther, flower size and herkogamy, suggesting an adaptive value during their evolutionary history. We did not find evidence that the pattern of flower evolution that predicts “ the selfing syndrome” has occurred along Centaurium history. Instead, traits seem to have evolved in an independent manner.

Sp.15-12-Poster

Effects of water stress, heat-shock and hydration-dehydration cycles on seed germination of Lavandula pedunculata (Mill.) Cav.

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In Mediterranean ecosystems, many plant species regenerate after fire by germination. Water is a limiting factor and water availability can control germination timing and rate. Tolerance to water stress can be affected by seed exposure to fire-cues, such as a heat shock, or by fluctuations in soil water content. However, the interactions among these factors are little known. This is important in these environments due to the high variability in rainfall patterns. Moreover, reduced rainfall and increased drought are projected to occur due to climate change. Here, we studied the effect of water stress, heat-shock and hydration-dehydration cycles on seed germination of Lavandula pedunculata (Mill.) Cav., a typical species from Iberian Peninsula shrublands. Half of the seeds were exposed to a heat-shock (90 ºC for 10 minutes), then they were hydrated-dehydrated for two periods (12 and 24 hours). Finally, seeds were germinated under three different water stress conditions (0, -0.2 and -0.4 MPa). Hydration-dehydration cycles increased germination under -0.2 MPa, but only in unheated seeds. Without hydration-dehydration cycles, a heat-shock also increased germination at -0.2 MPa. However, germination under -0.4 MPa was not improved by any treatment. In conclusion, germination decreased with water stress and each one of heat-shock and hydration-dehydration cycles improved germination tolerance to moderate water stress, but not when they acted together.

Sp.15-13-Poster

Landscape genetics: Fragmentation effects of a highway in Lepidium subulatum, a specialist gypsophile

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Landscape genetics studies how population genetics could be modified by landscape features, habitat loss, fragmentation and potential barriers. Fragmentation is one of the main threats to biodiversity since it might trigger genetic erosion in the affected populations by decreasing population size, modifying dispersion patterns or increasing inbreeding effects. Lineal infrastructures are one of the main causes of fragmentation, although their effect is still controversial. Gypsum ecosystems showed a patch distribution, surrounded by a matrix which gypsophiles cannot colonise and developing a natural fragmentation. For some decades, these vegetal communities have been shaped by strong anthropic pressures (e.g.: agriculture, cattle, infrastructures, etc.) which are threats to this biodiversity hotspot. In this research, we chose Lepidium subulatum as study species to evaluate the populations' genetic condition and to study the fragmentation effects caused by cereal crops and a highway with heavy traffic volume. We calculated different parameters of genetic diversity and differentiation, we tested if isolation by distance and bottlenecks would exist in the populations and we studied the genetic structure of the area. It was obtained that genetic flow existed among populations because of the species' mating system. Nevertheless, populations might be suffering the first fragmentation effects. The populations situated at different road edges showed small differences in their genetic state due to the presence of the highway, but this may have potential consequences in the future.

Sp.15-14-Oral

Patterns and drivers of tree fecundity in Pedunculate oak (Quercus robur) refugial populations at the species' southern range margin

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Low-latitudinal range margins of temperate plant species typically consist of scattered populations that persist locally in microrefugia. A better understanding of how species achieve this resistance under conditions close to their tolerance limits can provide insights about their perspectives in a future warmer climate. Yet we know little about how the refugial habitat of such populations affects their patterns of fecundity, a key component for their recruitment, long-term resilience and evolution. This study examined landscape-scale patterns of female and male fecundity in refugial populations of the widespread European forest tree Pedunculate oak (Quercus robur) from the species' southwestern range limit. These populations had previously been shown to exhibit a strong genetic structure suggestive of limited gene flow. Our aim was to identify major drivers of variation in flower and seed production among forest stands and individual trees. We surveyed a total of 159 trees from 12 stands over two years and assessed the relative importance of various tree, stand and habitat related drivers on reproductive effort and success. We detected no noteworthy effects of stand size or isolation but of individual trees' neighbourhood on reproduction. Results further suggest that populations seem to suffer little from inbreeding despite their history of long-term isolation. Our findings suggest that flowering and fruiting do at present not represent a major constraint for their regeneration and viability within the refugial environment.

Sp.15-15-Poster

Ecological barriers may constrain hybridization between two closely related Linum species

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Hybridization is a major evolutionary force in plants. It can be a reproductive isolating barrier and thus a driver for differentiation (i.e. homoploid hybrid speciation or allopolyploidization). However, the homogenizing effects of gene flow and outbreeding depression can also slow or reverse speciation process. Yet, hybridization can be avoided by different constraints such as ecological barriers. Thus, niche differentiation between potentially hybridizing species might result in an important pre-zygotic isolating barrier. Two sister Mediterranean species (Linum tenuifolium and L. suffruticosum s.l.) have been suggested that hybridize in their extensive contact zone of 500 km in NW Mediterranean Basin, from north-east Spain, across southern France to north-west Italy. In this study we characterize the ecological niche of each species and investigate its potential role as a prezygotic reproductive isolating barrier. First, we built a database of population occurrences, and fitted species distribution models to assess climatic niche. Second, we collected field data on 96 populations located throughout the contact zone to quantify niche differentiation. Species niche tend to exhibit differences in terms of successional habitat stage and soil characteristics. However, due to spatial complexity and short-scale variation of Mediterranean landscape, these species display somewhat sympatric distribution, creating a mosaic of populations that allows hybridization (morphologically intermediate forms have been found). The genetic analysis of hybridization, introgression rates and pollinator-mediated contemporary gene flow is now planned.

Sp.15-16-Poster

Do pollinators exert selection against plants of Lysimachia arvensis with intermediate flower colours?

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Pollinators can discriminate between flower colours and associate them with rewards; thus it is assumed that the colour acts as a selective target for flower visitors. Directional selection exerted by pollinators could lead to the loss of floral colour polymorphisms, but spatial or temporal variations of pollinator arrays could maintain colour polymorphisms through divergent selection. Lysimachia arvensis is an annual herb with two distinct floral colour morphs, red and blue, those frequently co-occur in Mediterranean populations. In that region, it has been reported that blue-flowered plants of L. arvensis are selected by small bees, their main visitors. In greenhouse, hand-crosses between both colour morphs originate a different flower colour phenotype (salmon) that is rarely found in the wild. This raises the questions of how this new phenotype, compared with the blue or red one, is perceived by pollinators, and if they could exert some kind of selection on it. To answer the first question, reflectance spectra of petals (blue, red and salmon) were measured, and then constructed in the hexagon model based on the bee colour perception space. Preliminary results showed that salmon flowers are close to red ones in the hexagon model and probably they are not clearly distinguishable by pollinators. To answer the second question, artificial stands with similar proportions of the three types of flowers were set in field conditions, and pollinator attendance was monitored. Blue flowers were preferred by bees compared with both salmon and red ones. Reproductive, ecological and evolutionary implications are discussed.

Sp.15-17-Poster

Effects of drought on the phenology and reproductive effort of Cistus ladanifer L. shortly after fire

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Climate change is projected to increase temperature and reduce precipitation in the Mediterranean, thus producing a pronounced summer drought. These changes can affect plant phenology and reproductive effort which could lead to altering vegetation composition and functioning, especially in recently burned areas in the case a new fire would occur. Here, we analysed the effects of experimental post-fire drought on phenology and reproductive output of Cistus ladanifer L., a dominant species in the Mediterranean shrublands of the Iberian Peninsula. To this end, a shrubland in central Spain was experimentally burned and subjected to various levels of drought by a system of automatic rainout shelters with irrigation facility. During the fourth post-fire year, we monitored the phenology in the different treatments, as well as the production of flower buds, flowers and fruits, and the functional characteristics of fruits and seeds. We found that the burned plants had a production of buds, flowers and fruits much lower than those of unburned plants four years after fire. Furthermore, the plants under drought treatments showed a slight delay in phenology relative to the control treatment. No significant effects of drought on reproductive effort (number of buds, flowers, fruits, fruit and seed size, number of seeds, viability, etc.) were observed. In summary, C. ladanifer appeared as a very drought resistant species in terms of reproductive capacity. However, given the much lower production of seeds four years after fire, its persistence could be compromised in case of enhanced fire frequency due to climate change.

Sp.15-18-Oral

Long-legged bees make adaptive leaps

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Adaptation is evolution in response to natural selection. Hence, an adaptation is expected to originate simultaneous with the acquisition of a particular selective environment. Here we test whether long legs evolve in oil-collecting Rediviva bees when they enter the selective environment imposed by long-tubed, oil-secreting flowers. To quantify the selective environment, we drew a large network of the interactions between Rediviva species and oil-secreting plant species. The selective environment of each bee species was summarized as average tube length of the interacting plant species weighted by interaction frequency. Using the method of phylogenetically independent contrasts, we calculated divergence in selective environment and evolutionary divergence in leg length between sister species (and sister clades) of Rediviva. We found that change in the selective environment explains 80% of evolutionary change in leg length, with change in body size contributing an additional 6% of uniquely explained variance. The result is one step towards testing for coevolution.

Sp.15-19-Oral

Plant-pollinator networks in fragmented habitats: a case study from a Mediterranean gypsum steppe

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Fragmentation is known to alter mutualistic relationships specially in small or/and isolated habitat remnants were some species are not present or can became scarce. However till now the effects of fragmentation on mutualistic networks has been poorly studied. Here we analyzed the structure of twelve plant-pollinator networks corresponding to twelve gypsum steppe habitat fragments in Central Spain, differing in size, conectivy and perennial cover. Network structural properties (number of plants, pollinators, interactions and visits; interaction evenness; and network specialization, connectance, asymmetry, modularity and nestedness) were modeled in relation to the two fragmentation descriptors, size and connectivity, and also in relation to habitat quality expressed in terms of perennial vegetation cover. Year was also considered as a repeated measure factor as the networks were constructed twice based on field work in two consecutive springs. Habitat size, connectivity and perennial cover deeply influenced network size and structure. The important differences observed in network structure between years stress the need of long term data to conclude on the effect of fragmentation on mutualistic networks, specially under variable and unpredictable climates.

Sp.17: The role of ecological interactions in recovering self-regulating and diverse MTE

Sp.17-1-Main talk

A deep-time perspective on ecosystems and rewilding in the Mediterranean region

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Trophic rewilding is an ecological restoration strategy that uses species introductions to restore top-down trophic interactions and associated trophic cascades to promote self-regulating biodiverse ecosystems. Trophic rewilding is often focused on megafauna due to their large potential ecological impacts and the widespread, strong historical losses of megafauna in most regions around the world. It is receiving increasing interest in the Mediterranean region, at least in part due to its broad applicability due to widespread land abandonment. In this presentation, I will outline the general background for trophic rewilding, the specific applicability to the Mediterranean region, integrating paleoecology (the region's Quaternary and Neogene faunal and ecosystem history)and ecology (current functioning and dynamics of Mediterranean ecosystems), its relation to other forms of rewilding (notably passive rewilding or passive management) and landscape management more generally, as well as key research needs for developing the scientific basis for trophic rewilding in a Mediterranean context.

Sp.17-2-Oral

Effects of non management practices on the biodiversity and ecosystem functioning of a Mediterranean ecosystem

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Mediterranean ecosystems have been shaped by humans throughout millennia. In some cases, human use generated socio-ecological systems of high conservation value. Maintenance and conservation of these systems depends on proper management and use. Here we summarize results about the effects of no management on the biodiversity and ecological functioning in Mediterranean cork (Quercus suber) and holm oak (Q. rotundifolia) woodlands of southern Portugal. Halting grazing and vegetation clearing for 12 years led the system to accumulate six time higher shrub biomass in unmanaged plots, substantially increasing the risk of severe wildfire in these plots as compared to managed plots. Oak trees growing in managed sites (vegetation cleared) were more resilient to extreme drought events than oak trees growing in non-managed sites. Non management may lead these systems to fall into a shrub encroached state of arrested succession not progressing into woodland or forest. Conversely, promotion of coexisting managed and unmanaged sites promoted habitat heterogeneity and increased plant and invertebrate diversity at the local level in these systems. Abandonment and no management of cork and holm oak woodlands may lead to unexpected or even undesirable conservation outputs in these systems. We suggest that conservation aims must be cleared defined and stated and potential outputs carefully considered, before adoption of non-management options in Mediterranean socio-ecological systems. Sustainable management options may better contribute to achieve biodiversity and ecosystem services conservation aims and work as "self-regulatory" mechanisms in these ecosystems.

Sp.17-3-Oral

Potential cascading effects of trophic and passive rewilding in Mediterranean ecosystems

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Trophic and passive rewilding are occurring along the north fringe of the Mediterranean basin potentially leading to multiple and unexplored ecosystem effects such as trophic cascades from apex predators to plant regeneration dynamics. Preliminary data for southern Iberia show that lynxes modified the community structure of the mesocarnivore guild. Specifically, the relative abundance, richness and biodiversity of medium-size carnivores were significantly reduced in the presence of lynxes. As a result the abundance of rodents increased which may trigger additionally effects to important resource species, such as oaks, by means of modifying acorn dispersal distance and the balance between dispersal and predation resulting from scatter hoarding. The mesocarnivore species, red fox and stone marten, are known to be effective seed dispersers driving the regeneration dynamics of several endzoochorus Mediterranean species, especially in areas currently subjected to passive rewilding. According to the obtained results, this tendency of recovery of fleshy fruited plants may be disrupted or modified. Additionally, data obtained in northern areas of Iberia showed the community structure or the abundance of the mesocanivore community was not affected by the presence of wolf packs but instead scent marking of mesocarnivores was lower. In seed dispersal terms, a reduction in scent marking may lead to similar effects than dispersers abundance decrease. Overall, the results presented, even if preliminary, show there might relevant ecosystem effects derived of current apex predators' expansions, i.e. trophic rewilding, that may generate a cascade effect on the regeneration dynamics of plants, especially under passive rewilding.

Sp.17-4-Oral

Ecological rewilding and the passive restoration of self-regulating ecosystems

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While agricultural areas are expanding in developing countries, an opposite trend is observed in high-income countries, where low-intensity agriculture is increasingly becoming less economically competitive. This is for instance the case in the Mediterranean basin, which is also qualified as one of the severely endangered biodiversity hotspots. The abandonment of anthropogenic landscapes with high nature value is believed to negatively impact farmland biodiversity, hence the predominant conservation strategy in Europe of maintaining and subsidizing low intensity farming practices to preserve these landscapes. An alternative approach that has recently been gaining momentum is to restore natural ecosystems via rewilding. In Europe, both ecological rewilding, i.e. the passive management of ecological successions, and trophic rewilding, i.e. the restoration of trophic cascades via species reintroductions, are being discussed and implemented. In this context, we will focus on the former approach and discuss how the availability of land resulting from farmland abandonment can become an opportunity for the restoration of ecosystems when implementing ecological rewilding. In particular, we will address past and projected trends in land cover changes, their impact on populations of megafauna, and the ecological role that those play in abandoned landscapes. Particular attention will be given to the role of grazers and browsers in influencing secondary succession and maintaining specific landscapes. We will also discuss the potential benefits of rewilding for society via the supply of certain bundles of ecosystem services.

Sp.17-5-Oral

Rewilding Mediterranean ecosystems with large herbivores: The use of woody plants and vegetation dynamics to assess the suitability and sustainability of wild ungulate introductions

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Passive and active rewilding with large herbivores have increased in recent times, with numerous (re)introductions inside and outside their actual native range. However, the long-term ecological and conservation implications of introducing large dominant herbivores are still far from clear. This study aims to analyze the use of woody plants (threatened and widespread taxa) and vegetation succession as possible ecological indicators to assess the suitability and sustainability of large herbivore introductions in Mediterranean-type ecosystems. We summarize the effects of wild ungulate populations (red deer, Iberian ibex, Barbary sheep) on woody plants and vegetation dynamics 25-45 years after being (re)introduced in Mediterranean ecosystems. The use of woody taxa through ecological indicators (e.g. herbivore damage, habitat use, plant preferences and regeneration success) represents a useful tool not only to assess the ecological sustainability of large herbivores populations but also to establish a priority conservation ranking for protected habitats and threatened taxa in ungulate-dominated environments. Monitoring herbivory damage and regeneration success in threatened taxa is probably more challenging and costly but may provide more conservative and reliable indicators of the actual suitability for rewilding. We highlight the need of considering woody vegetation conservation and dynamics to better estimate the suitability and sustainability of large herbivore introductions rather than focusing exclusively on animal health and population dynamics. A management plan considering population control or introduction of large predators seems essential.

Sp.17-6-Poster

Edafic microbiota effects in the establishment of Scots Pine in an ecotone

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Although there is a growing amount of evidence that soil microbial influence plant performance an hence, forest community development, the extent of their involvement remains unclear. We hypothesise that competition and facilitation interactions occurring in Scot Pine forest are modulated by the edaphic biota and are directly related with the biota provenance. Therefore, we investigated the influence of natural soil microbial communities on the establishment on Scot Pine seedlings and further plant performance, and how these effects changed over time. Using a microcosm Scot Pine seedlings were either allowed access to grow in the presence and absence of complex soil microbial communities extracted from natural soils of Scot Pine. Microbial communities came from soils along a gradient from Tundra, Tundra-Forest, Forest-Tundra and Forest ecosystems were tree density proved to determine microbial diversity richness. The experiment ran for five months, with destructive harvest at 30, 90, 120 and 150 days. For each harvest we measured, soil nutrients, soil microbial biomass-C,-N and –P, soil respiration, root and shoot biomass, and construction cost, from day 90 till the end of the experiment in all treatments, and the soil available P was significantly lower in those treatments with high microbial added as inoculant. Soil microbial biomass and respiration were variable in all treatment, with a neat decreased in C values in those microcosm treated with microbial communities have the capacity to influence the rate of plant performance, not only by influencing the plan growth rate, but also by enhancing the rates of microbial activities.

Sp.17-7-Poster

Biodiversity responses to land abandonment over different lithologies in semiarid Mediterranean areas

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Land abandonment has been a common phenomenon in Mediterranean areas. In the case of the Iberian Peninsula, it has been encouraged by socioeconomic factors such as the rural exodus to cities and coastal areas occurring in the 60´s and 70´s of the XXth Century, and more recently by subsidies for land set-aside from the European Union´s Common Agricultural Policy (CAP). The aim of the study was to determine the evolution of the biodiversity when land abandonment occurs over different lithologies. Three biodiversity groups were assessed: birds, woody flora and land snails, of which conservation, diversity and richness indexes were calculated. A total of 23 plots were sampled, including recent and old abandoned lands, and unploughed areas close to these that can be interpreted as final succession endpoints (as well as colonization sources). Classification analyses were developed to group the areas by their plant and bird communities. Indicator species for these groups were obtained through IndVal analyses. Partial Least Square Regressions (PLSR) with geomorphological and ecological variables as predictors, revealed that the biodiversity of the studied fields is heavily influenced by erosion variables and slope. Regarding ecological variables, the abundance of herbivores exterted a negative influence on the three biodiversity groups. However, for birds and land snails, the presence of facilitator elements (nurse plants/fertility islands) improved their conservation value. The results should be taken into account in management plans, to enhance the biodiversity performance of these key areas of the Mediterranean mosaic landscapes.

Sp.18: Origin of the Mediterranean Climate

Sp.18-1-Oral

Did Cape Mediterranean-type vegetation predate a Mediterranean-type climate?

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Oceanographic, phylogenetic and fossil evidence indicate a middle Miocene emergence of mediterranean-type climate (MTC) in the Cape region. However, there have been suggestions that fire-prone mediterranean-type vegetation (MTV) – in this case fynbos – predated the onset of MTC. Evidence in support of this hypothesis is weak, based as it is on the Oligocene diversification of some Cape clades, a temperature regime broadly similar to the late Neogene, and the presence of infertile sands on both the Cape uplands and lowlands. Recent research on terminal Oligocene sediments from the Cape west coast shows the widespread presence of charcoal, and pollen representative of MTV. While the predominant vegetation of the region was a diverse warm temperate rainforest, proto fynbos likely occupied dry slopes and sandplains where it coexisted with savanna/thicket elements. Today, the latter are strongly associated with summer rainfall environments. It is possible that the high diversity of the Cape (and southwestern Australian) MTC is a consequence of long evolutionary histories in fire-prone environments under both summer and winter-rainfall regimes. Adaptations such as obligate post-fire reseeding would have been important drivers of diversification in many lineages.

Sp.18-2-Oral

When did a Mediterranean-type climate (MTC) originate in southwestern Australia (SWA)?

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Opinions are divided on when a MTC first arose in SWA, ranging from Beard (1977) at 30 Ma (in NW-WA) to Byrne (2014) at 3 Ma. Clues to the time of change can be sought in the time of origin of plant adaptations to hot, dry summers and intensified fire. Thus, Hakea (Proteaceae) arose 18 Ma in SWA with resprouting and serotiny from non-fire-prone, rainforest ancestors, and by 14 Ma, a thick/needle-leaved subclade with nonsprouting had evolved. Acacia (Mimosoideae) arose 18 Ma (500 species in SWA) and is essentially phyllodinous, but it is unknown where this Australia-wide genus originated. Drosera is a geophytic genus best represented in SWA but was already fire-prone 41 Ma. Serotinous Banksia arose 62 Ma but its sister, Dryandra, at 23 Ma, is a much more drought-adapted subclade. There was also retention of highly combustible, dead foliage in banksias by 26 Ma. Blancoa (Haemodoraceae), with fire-stimulated flowering and endemic to SWA, arose 18 Ma from an ancestor without fsf. In addition, there was a sharp increase in speciation of the strongly drought-adapted peas, Daviesia 27 Ma and Bossiaea 11 Ma in SWA. Collating existing data over the last 40 My gives: 40?30 Ma: 5 events, 30?20: 13, 20?10: 19 and 10?0, 3. It seems therefore that a MTC may have originated in SWA in the 20?10 Ma period, and possibly as far back as 30?20 Ma. Other approaches worth exploring include: exclusion of C4 grasses, presence of carbonates in paleosols, and chemical composition of offshore corals.

Sp.18-3-Oral

Origin of the Mediterranean climate in California and its role in fire-prone ecosystems

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The mediterranean-type climate (MTC) is widely agreed to have been in place in all five MTC regions since the late Pliocene, however, there is less agreement on: (1) The timing of the origin of the MTC, (2) the timing of and factors responsible for the origins of mediterranean-type vegetation (MTV), and (3) the paleo-history of fire and extent to which it has played a role in the origins of MTV. Ample evidence exists to suggest a much earlier origin of MTC and an even earlier origin of MTV. In western North America macrofossils indicate an early Cenozoic origin for many chaparral shrub genera, all of which are obligate postfire resprouters. These shrubs persisted on marginal sites with soil drought at some time of the year and it is likely many of these persisted through the Oligocene and Miocene in the present day southwest US and northern Mexico, but fossil floras are scant in the region. Where Oligocene and Miocene fossil floras are present they may be highly biased against arid and fire-prone vegetation. Several lines of evidence point to an early mid-Miocene origin of the MTC and this would have contributed to much greater connectivity of drought prone shrublands, greatly increasing predictability of fires and evolution of postfire seeding.

Sp.18-4-Oral

Origins of Mediterranean climates, vegetation and flora in central Chile

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The appearance of a proto-mediterranean-type climate (MTC) in Chile with summer drought was influenced by the uplift of the Andes beginning about 15 Ma, although key floristics elements appeared earlier in the Oligocene. Overall plant species richness in central Chile is modest in its relatively small flora of 2,900 species and comparatively low species- and generic-richness on an equal area. Two factors limit species richness in Chile compared with other MTC regions. First is the strong biogeographic isolation produced by the hyper-arid Atacama Desert and the high Andes. Numerous herbaceous lineages present east of the Andes and north of the Atacama Desert failed to reach Chile. Second, fire as a stimulus for diversification has been virtually absent since the Miocene uplift of the Andes. Nevertheless, many woody clades predate the establishment of the MTC, with the moderate oceanic climate of Chile allowing the persistence of paleo-endemic woody lineages and contributing to a woody flora proportionately larger than that of California. Legacies of additional woody clades in the past are evident in generic disjunctions to summer rainfall ecosystems in southeastern Brazil. Radiations in herbaceous clades dating to the Miocene are present as well as younger clades.

Sp.18-5-Oral

Origin of plant diversity in the Mediterranean Basin

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The Mediterranean Basin (MB) harbors a rich flora of approximately 25,000 species distributed across 75% of the global MTE land area, combining numerous floristic clades of Pliocene and Quaternary origin coupled with a few ancient lineages from pre-Mediterranean epochs. On the one hand, the fossil record from the MB indicate that four waves of extinction during the Cenozoic and Quaternary took a toll on many lineages: tropical elements by emergence of strong seasonality in the middle Miocene (16-14 Ma); tropical and subtropical elements by aridification during the Messinian Salinity Crisis (6--5 Ma); and mesic elements by cool temperatures and drying during Quaternary glaciations 1 species Myr-1) in herbaceous and subshrub clades, rivaling or exceeding the fastest known global plant radiations [e.g., Centaurea and Tragopogon (Asteraceae), Cistus (Cistaceae), and particularly Dianthus (Caryophyllaceae)]. The influence of geographic restriction on diversification rates during differential clade ages and spatio-ecological isolation appears to have primarily been responsible for the high levels of plant diversity in the Pleistocene. In contrast, few ancient lineages survived in the MB since the Miocene. In addition, the flora observed today has been shaped by long-term human activity, more than in any other MTE region, by more than 10,000 years of domestication, plant cultivation, livestock spread, and fire.

Sp.19: Mediterranean High-Mountain habitats: challenges for research & a global conservation concern

Sp.19-1-Main talk

The unique environmental conditions of Mediterranean mountains and their consequences for interactions among plants

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Plant–plant interactions are an important structuring force of plant communities. The stress gradient hypothesis predicts an increasing frequency of facilitative interactions with increasing stress, while competitive interactions among plants dominate under mild environmental conditions. Altitudinal gradients have often been used to test the stress gradient hypothesis, assuming increasing stress (e.g. cold) with increasing elevation. However, in Mediterranean and dry mountains altitudinal gradients are complex since both high and low elevations are stressful due to decreasing temperatures at the high end and increasing drought at the low end. Therefore, assuming two crossed stress gradients of temperature and drought in the Sierra Nevada Mountains in south-eastern Spain we hypothesised an increasing frequency of facilitative interactions towards high and low elevations. We studied plant association patterns along altitudinal gradients and for different cushion and shrub species and found indeed more positive effects at the most extreme sites. In addition, by studying interactions of a single nurse plant species with their neighbours along the same altitudinal gradient we could also show that nurse plants themselves change their morphology in line with changes of the environmental conditions. These changes in plant morphology then had a strong impact on their capacity to ameliorate stressful conditions and therefore facilitate other species. Our research highlights that Mediterranean and other dry mountains are characterised by unique environmental conditions, with extreme conditions both at high and low elevations, that have consequences on the prevailing plant interactions and their effects on plant community structure and composition.

Sp.19-2-Oral

Epigenetic regulation in Mediterranean mountain plants: a comparison between two violets with contrasting habitats

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Growing evidence suggests that, fast phenotypic changes in response to environmental stress are frequently due to epigenetic modifications that affect chromatin structure and modify phenotypes without changing the DNA sequence. In plants, DNA cytosine methylation/demethylation are key epigenetic responses to environmental stress that can be transferred to offspring, and revert to the original state when stress fades away. Harsh, unpredictable Mediterranean mountain habitats should provide a good scenario to address the role of cytosine methylation in wild plant populations' adaptation. We investigated global DNA cytosine methylation in three populations of two violet species with contrasting distribution ranges and habitat requirements: the habitat specialist narrow endemic Viola cazorlensis from rocky-sandy dolomitic soils presumably subject to intense water stress; and its widespread congener V. odorata from mature forest understory on deeper soils with high water retention capacity. We found that total genomic cytosine methylation was remarkably lower in V. cazorlensis (7.5 ± 0.2 % of total cytosines methylated) than in V. odorata (20.1 ± 0.2 %). In both species, variation across individual plants within populations was a major source of variation in cytosine methylation (> 66 % of total variance). Differences among populations were statistically significant only in V. cazorlensis, methylation being higher at the highest elevation site. Our results suggest that ecological factors, particularly the magnitude of environmental stress, may underlie interspecific differences in genomic methylation levels, and that greater spatial differentiation in global methylation is to be expected in plants restricted to stressful fragmented habitats characteristic of the Mediterranean mountains.

Sp.19-3-Oral

Mapping habitat distribution in complex Mediterranean High-Mountain systems: A novel approach for evaluating the conservation status based on remote sensing

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The conservation interest of some areas has led European governments to protect certain habitat types under environmental policies. This requires not only attributing landscape patches to plant communities in a particular point in space, but also updating the ecological status through time across geographical ranges. Since the initial steps of implementation of the Habitats Directive (92/43/EEC), habitat mapping has been linked to field-based vegetation surveys and aerial photointerpretation. Recent developments in data availability and processing methods have linked this monitoring task with ecological modelling (EM) and remote sensing (RS) techniques. These methods offer multiple advantages such as faster map production, insight into inaccessible terrain and repeatability of the mapping process, providing an opportunity for harmonizing habitat mapping throughout Europe. However, EM and RS-based analyses of vegetation are hampered by the complexity of natural systems due to environmental or successional gradients as occur in many Mediterranean High-Mountain systems, avoiding easy classification processes typical of more homogeneous environments. In this presentation, using as case study the Cantabrian Mountains of NW Spain, we developed an integrative approach to combine traditional vegetation surveys for training and validation, environmental limiting factors and RS (multiespectral imagery and LiDAR data) for mapping the spatial distribution (extent and area of occupancy) of 24 forest, shrub and grassland habitat types. We evaluated the conservation status following Natura 2000 guidelines and developed a novel GIS-based methodology for designing locally-tailored management and convervation strategies for each habitat type in the base of diagnostic indicators and the current effects of Global Change.

Sp.19-4-Oral

Study of alpine dwarf shrub responses to environmental change through temperature, CO2 and precipitation manipulations

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High-elevation and high-latitude ecosystems are expected to be especially vulnerable to global change. Dwarf shrub species cover extensive areas in alpine ecosystems, and warmer temperatures and land-use change have favoured their expansion. Co-occurring dwarf shrub species may respond differently to environmental change, which can have major effects on their interactions, growth and performance, and ultimately lead to drastic changes in plant communities. We have carried out warming, CO2 enrichment and drought experiments at different study sites across the Pyrenees and the Alps to understand how these factors may influence dwarf shrub species interactions, growth, wood anatomy and C allocation. Our results show species-specific responses to the treatments, and these responses differed in magnitude and direction depending on the treatment applied. Vaccinium myrtillus responded positively to increased temperatures, whereas the co-occurring Vaccinium uliginosum and Empetrum hermaphroditum showed no response. We did not find any evidence of alterations in shrub-shrub interactions with warming. Vaccinium myrtillus responded positively to CO2 enrichment with a lagged increased hydraulic efficiency, but vessel lumen size and hydraulic conductivity decreased with warming during the first treatment years. We did not find major effects of the summer drought simulation on the allocation of newly assimilated C neither in V. myrtillus nor in V. uliginosum. Our results indicate that environmental change may benefit some species at the detriment of less responsive co-occurring species. While temperature seems to be the most influential factor, summer drought does not seem to have major implications on the dwarf shrub species studied at the short-term.

Sp.19-5-Oral

The shape is more important than we ever thought: plant to plant interactions in a high mountain community

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Working with fully mapped communities provides the ecologist the opportunity to estimate precisely who interacts with who, how frequently and which of those interactions are important for the assembly of the community. Most analyses of fully mapped communities have employed point pattern analysis techniques, as these extract the maximum information available in the dataset. However, when dealing with high mountain communities, an important part of the spatial structure of the community is lost by approximating plant individuals as points when most chamaephyte and hemicryptophyte individuals have non-symetric, irregular sizes that are best represented by planar shapes. Based on this, we have developed a new method to test for the existence of interactions between individuals. Shapes of the individuals are mapped in the field and intersections (i.e., interactions) between them are quantified and tested against the expectations of a null model of spatial configuration of shapes (e.g., random rotation). We applied our new method to study community assembly in a two-phase pasture-like alpine Mediterranean community in central Spain analysing pair-wise interactions between the 11 most abundant species and compared the results to those obtained by a traditional point pattern analysis (ppa). We found that our new method increased the number of significant interactions from 21 % (ppa) to 55 % and changed the sign of around half the interactions detected with ppa. Most significant interactions were negative. Therefore, our method provides a new efficient tool to study community assembly in alpine communities.

Sp.19-6-Oral

Alpine research in central Spain: from plants to soils

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In 2001 we started alpine research studies in Central Spain. The first data recorded in Sierra de Guadarrama (Spain) was analyzed to know some general features of Mediterranean high mountain vegetation: distribution patterns of species that occur at definite spatial scales, interespecific species associations and ecological factors that structure such communities. Then in 2006 we initiated sampling for implementing the GLORIA Initiative protocols in Central Spain. Two areas were sampled in the Sistema Central: Sierra de Guadarrama and Sierra de Gredos, four summits in each one. They were resurveyed in 2015. After this two starting points we have developed other research that include not only plants but soils. In this presentation we will show some results from our research related to plant diversity, richness and distribution patterns. Northern and western exposures showed a similar plant community pattern, different to eastern and southern exposures. Northern and eastern slopes showed a higher spatial heterogeneity but for different causes: extreme situation or disturbance environment. We have also found a frequent aggregated pattern of some species that is related to facilitation processes. The relationships between the plant cover and the soils and the dynamic of the microbial community during the growing season is driving by the content of water in soils showing the drought resistance of such communities. They are also related to plant biomass since plant roots exert as a driver on soil microbial biomass.

Sp.19-7-Poster

Elucidating the triggering factors in current Spartocytisus supranubius mortality: Who´s guilty?

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The combination of a high degree of endemicity, reduced population sizes and spatial isolation makes the effect of climate warming on oceanic islands a matter of serious concern. High mountain ecosystem in Teide National Park (Tenerife, Canary Islands) is dominated by the leguminous shrub Spartocytisus supranubius. This species is suffering episodes of high mortality combined with systematic recruitment failure associated to herbivory by introduced mammals, altogether driving to a rapid decline in its population. We applied dendrochronological techniques to reconstruct mortality episodes and explore the potential effect of climate as a trigger of mortality episodes. Preliminary results indicate that S. supranubius secondary growth is extremely dependent on rainfall. Residual chronology showed very strong correlation with October prior to growing season to February accumulated rainfall (r=0.8; P

Sp.19-8-Poster

Functional and phylogenetic dispersions are driven by biotic interactions across multiple stress gradients. Insights from Mediterranean high mountain grasslands in central Chile

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1. Quantifying the similarity of species using phylogenetic and functional trait approaches and identifying it variation across environmental gradients to disentangle the key underlying drivers that determine patterns of community assembly remains as a critical topic in ecology. 2. Here we assess trait and phylogenetic dispersion across multiple gradients simultaneously and across multiple-spatial scales of three high mountain Andean areas of the Mediterranean-type climate zone of central Chile. 3. Our results show as functional and phylogenetic dispersions were influenced by solar insolation and the effect was different along elevation gradient acting both factors simultaneously. Overdispersion was found in the most stressful sites and clustering where the conditions were milder. 4. We also found no signal for the studied traits. Thus, the correlation between the functional and phylogenetic dispersions was indirect and the additional unmeasured traits with phylogenetic signal were likely important in determining the structure of the communities studied. 5. Our results evidence that biotic interactions modulated by environmental conditions are very important structuring the alpine plants community assembly.

Sp.19-9-Oral

Changes in the alpine flora of the Pyrenees over the last 100 years. A re-visitation of historical summit flora records

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Alpine ecosystems are among the most vulnerable to climate change. Species distribution models predict dramatic extinction rates in Southern European mountain ranges like the Pyrenees. However, long-term vegetation surveys report an impressive increase in species numbers in European alpine ecosystems. To contribute to the open debate on the fate of the alpine flora of Europe, we evaluated the changes in the alpine flora of 20 summits and two mountain passes of the Pyrenees over the last century. Changes in species composition were assessed by revisiting summits with historical botanical records. The effect of potential drivers of change such as increased frequency of human visitors or grazers was evaluated by general linear models. Our results indicate an overall increase in species numbers in Pyrenean summits over the last century. Similar to other mountain ranges in Europe, such increase has been followed by a floristic homogenization among summits. The frequency of summer visitors had a significant effect on the changes in species numbers recorded. Summits with a low frequency of visitors experienced the greatest increases in species numbers over time, while summits with moderately high or very high numbers of visitors showed much lower increases. Although the rise in average mean temperatures of the Pyrenees over the last century has been similar in magnitude to the increase forecasted for future decades, the alpine flora of the Pyrenees did not lose species richness. Rather, the flora of Pyrenean summits is more diverse (although also more homogeneous) today than one century ago.

Sp.19-10-Oral

Violet reproductive traits and strategies in response to different environments in the Chilean Andes

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Geographic differences in soil moisture and light conditions may lead to among-population differences in plant resources and in flower visitors' abundance, and thus in the reproductive strategies and phenotypic variation observed at each site. A particular environmental stress may initiate a suite of plastic changes, including physiological and reproductive adjustments that enhance function in those particular environments. Using two Andean violets (Viola maculata and V. reichei) as model species, we explored patterns in plant traits' variation and reproductive strategies in two contrasting environments (on the one hand, an altitudinal gradient, and on the other hand, an understory vs. alpine habitat comparison). Specifically, we measured in the field different: (1) ecophysiological variables (SLA, stomatal conductance, Fv/Fm) (2) reproductive traits (floral display, seed set, chasmogamous:cleistogamous flowers, selfing level), and (3) performance traits (leaf area and various flower measurements) in both species. Plants were less stressed physiologically at high than at low altitudes and less in understory sites than in open areas. Interestingly, the correlation between flower and leaf traits is stronger in resource-poor than in resource-rich environments, and indeed such traits are more conserved in the former. No clear evidence of pollinator-mediated natural selection was detected, as there were neither differences in pollinator visitation rates nor in floral investment into chasmogamy vs. cleistogamy and success among sites. Our results suggest that under more physiologically stressful conditions, phenotypic plasticity is lower as traits have been under stronger selective pressures compared to favorable sites.

Sp.19-11-Poster

Silvicultural management models for the improvement of the conservation degree of Olympus national park's Mediterranean forest habitat types

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The "Natura 2000" network is an ecological network for the conservation of special areas, created for the maintenance of biodiversity, through natural habitats in the European Union member states, in accordance to the Habitats Directive 92/43 EEC. In Greece, in the protected area of Olympus National Park which is part of this network, two assessments have occurred, in 2000 and 2015, during the program "Monitoring of species and habitat types" based on the Habitats Directive 92/43 EEC. The purpose of this paper is to compare the conservation degree of the Mediterranean high mountain forest habitat types (codes 9130, 9150, 9180*, 9250, 9270, 92C0, 9340, 9530*, 9540), between the two assessments, as resulted from typical species, structure and their functions. The results of the research found that almost in every habitat the typical species had stable abundance. Also, the conservation degree is favourable "A" for all the forest habitats, regardless their extent, with the exception of the habitat Platanus orientalis and Liquidambar orientalis woods (Plantanion orientalis) (code 92C0), which displays conservation degree "B", due to its structure: fragmented stands and tree groups in small patches along the streams. Therefore the silvicultural measures taken so far are the appropriate ones, and as long as they continue to be taken, the conservation degree of the Mediterranean forest habitats in Olympus National Park will be favourable and the protection of the area efficient. *priority habitat in accordance to the Habitats Directive 92/43 EEC.

Sp.20: Seed dispersal and frugivory in changing Mediterranean landscapes

Sp.20-1-Main talk

Causes and consequences of seed dispersal disruptions in Mediterranean Ecosystems

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Seed dispersal processes are influenced by different drivers of global change in a variety of ecosystems worldwide. Among such drivers, habitat loss and fragmentation, defaunation (hunting), and species invasions appear as the most important. Disruptions in the seed dispersal process is increasingly being documented as populations of legitimate animal dispersers decrease or even disappear, although the ecological and evolutionary consequences for plant reproduction are still largely unknown. Little is also known about the patterns of such mutualistic disruptions. Are the disruption consequences occurring mostly at the population level or at the level of the entire community? What are the evidences of community collapse? Is this most likely to happen in simple communities like islands than in mainland systems? How frequent is functional redundancy, i.e. to what extent lost seed dispersers can be replaced by other (native or alien) frugivores that act as effective dispersers? Can a network approach help us to understand community impacts of seed dispersal disruptions? My talk will address all these questions, and I will present several case studies to illustrate both demographic and evolutionary consequences of disrupted seed dispersal mutualisms in the Mediterranean region.

Sp.20-2-Oral

Seed dispersal of fleshy fruited shrubs in semiarid landscapes: the role of plant-bird interactions in restoration of abandoned agricultural fields

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Currently, Mediterranean semiarid landscapes face important transformations as a result of changes in land uses. The abandonment of agricultural fields is increasing globally and it is associated with erosion, reduction of water availability and biodiversity loss. In this context, seed dispersal is considered an important ecosystem service, that promotes the recovery of vegetation, being avifauna the principal vector involved in this process. Thus, it should be considered a key goal in conservation strategies. In this work, we assessed bird-mediated seed dispersal patterns of endozoochory shrubs fleshy fruits and the involvement in passive restoration of disturbed habitats. Attractors elements for birds (perches and water troughs) and seed traps under perches for collecting droppings were installed in the study area. Vegetation and avifauna samplings were performed in abandoned field plots and in the nearby pineforest, in order to identify sources of seeds propagules and characterize the community of potential dispersers. Moreover, feces were collected and the seeds found were analyzed by DNA-barcoding molecular technique. The results showed that perches had an attraction effect on birds, acting as an important element on seed dispersal. Although results were not significant, it had been reported that the water troughs had and attract effect on birds. The scarcity of fruits may limit the seed dispersion in the study area. Such researches can be very useful in territory management plans; however, long-term studies are needed to obtain more conclusive results.

Sp.20-3-Oral

Complex effects of competition and predation risk on foraging behaviour and acorn dispersal by Algerian mice in scattered oak woodlands: an experimental approach

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Acorn dispersal by Algerian mice (Mus spretus) is essential for solving the lack of natural regeneration in savanna-like holm oak woodlands (dehesas). Perceived risks of predation and cache pilferage by conspecifics and other competitors seem to drive seed dispersal by mice in oak forests, as shown by agent-based model simulations. We performed a field manipulation of both factors by means of predator scents (Genetta genetta) and ungulate exclosures to test whether ungulate and/or predator management could enhance oak regeneration in dehesas through cascading effects on mice responses. Foraging behaviour and acorn dispersal were analysed with automatic video cameras. Presence of predators, ungulates and conspecifics modulated the effects of previous experience on foraging and caching decisions, and these processes acted at different scales (tree and plot) that were integrated by foraging individuals. Removal rates were largest when both ungulates and prededators were present under low levels of indirect predation risk (new moon), whereas increased direct risk by means of addition of predaror scent resulted in increased vigilance and recuced dispersal under high levels of indirect risk (full moon). Results obtained suggest that these three types of animals (predators, prey and competitors) are inmersed in a complex interaction web that also relies on the effects of conspecifics, as well as on other indirect factors such as moonlight or acorn availability. Thus, dehesa recruiment may be enhanced by the restoration of the overall functional diversity of open oak woodlands, including mouse dispersers but also carnivore predators and ungulate competitors.

Sp.20-4-Oral

How best can we assist seed-dispersers to restore old-fields? A spatially-explicit simulation model

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Whether and how old-fields are effectively recolonized depend first on the seed arrival which, in turn, is contingent on the abundance and identity of seed vectors (mammals, birds, etc.). Nonetheless, for a given guild of seed-dispersers, habitat management could alter (assisting or hampering) such “natural restorers”. Because of logistic limitations of empirical approaches, modeling is an efficient approach to address this sort of questions especially when in combination with a profound field-knowledge of the study system. We asked whether and how different ways of planting Pyrus bourgaeana trees in an old-field alter the seed rain and efficiency as natural restorers of red foxes Vulpes vulpes and badgers Meles meles in the Doñana National Park (SW Spain). Based on large sets of field data, we built, calibrated, and validated an individual-based spatially explicit model that satisfactorily simulates P. bourgaeana seed dispersal by foxes and badgers into the old-field. Then, by means simulation experiments, we evaluate the effect of contrasting strategies (e.g. spatially aggregated, regular) of planting trees on the mammal-generated seed rain. Preliminary results indicate that whereas planting trees in regular and random distributions augmented by 20% the proportion of old-field that received seeds, planting fruiting trees in an aggregated fashion only increased such proportion by 5%. Also, number of fox and badger seed-deposition sites were higher for regular (80.1 and 62.0, respectively) and random (81.6 and 60.4) as compared to aggregated (69.0 and 54.3) tree distributions as well as compared to a scenario of no plantations (64.2 and 55.0).

Sp.20-5-Oral

The role of dispersal by granivorous and omnivorous waterbirds in MTEs

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Whereas most attention is paid to frugivory, we must not overlook the importance of omnivorous, granivorous and herbivorous waterbirds as vectors of a broad range of native and alien plants in natural and artificial Mediterranean ecosystems. We exemplify their importance by illustrating the role of ducks, geese, shorebirds and gulls in dispersing terrestrial and aquatic plants within and between ricefields, salinas and natural wetlands. Endozoochory is more important than epizoochory, and is a dispersal mechanism for plants classically assumed to have no or other means of dispersal (i.e. for plants not assigned to the "endozoochory syndrome"). Hence the capacity for long-distance dispersal is widely underestimated for these plants. The role of migratory granivorous waterbirds is likely to be extremely important both in the spread of alien plants within MTEs and in allowing native plants to keep pace with climate change. Seed dispersal disruptions are occurring in MTEs through the loss of natural wetlands, declines of vector populations and short-stopping (contraction of migration routes) in response to global change.

Sp.20-6-Oral

Choose your oak wisely: drivers of tree selection by acorn-harvesting jays

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Seed-dispersing animals can strongly influence plant reproductive success and resulting population structures. Few studies have disentangled different drivers of disperser foraging behaviour in natural settings and their actual relevance for plant fitness. Here we adopt a novel approach to investigate which tree features guide foraging decisions of the principal disperser of acorns in a mixed oak stand and resulting tree reproductive success. We genotyped a seedling cohort (n = 825) and performed Bayesian parentage analysis to estimate the acorn dispersal success of all trees in the stand (n = 254). We then modelled this estimate as a function of several tree characteristics. Individual dispersal success was best predicted by fruit crop size and to a lesser extent by the abundance of adult oaks in the neighbourhood, whereas neither the oak species nor acorn size or shape played a role. Our findings contrast with results from experimental studies and suggest that jays, despite being scatter-hoarders, behave much like frugivores of fleshy-fruited species. Their foraging behaviour should exacerbate the relevance of large, prolific trees for the dynamics and genetic composition of naturally regenerating oak stands.

Sp.20-7-Poster

Differences in seed fate according to simulated differences in seed drop timing in Quercus ilex and Quercus suber

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In the Mediterranean area of Southern Spain oaks seed rain lasts approx. from early October to mid February although there are variations among species. Previous studies carried out on Quercus ilex in Doñana Natural Park suggest that early acorn sowing during the seeding season is likely to improve seedling establishment comparatively to normal or late acorn sowing (sowing at peak or end acorn fall) by decreasing acorn predation by rodents among other mechanisms. To test this hypothesis we carried out a field experiment analyzing the acorn fate (I: depredated by rodents, II: rotted and/or exhibiting failures in seedling establishing; III: successfully established seedlings) from October to May 2015-16. We included two oak species (Q. ilex and Q. suber) and two moments of acorn placement in the field (October end = early acorn dropping and mid December= normal acorn droppings). Results indicated that the two species experienced the same temporal differences in predation by rodents: it was much lower (20-23% predation) for early acorns that for normal acorns (46-47% predation). However, there were differences among the two species for acorn and seedling failures due to other damages and for successful seedling establishment in the spring. As a result early acorn placement in the field enhanced seedling establishment in Q. suber but it had no effect on Q. ilex.

Sp.20-8-Oral

Shifting life-stage conflicts in a post-disturbance Mediterranean landscape

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Successional changes can alter the habitat preferences of seed dispersers. As subsequent plant demographic stages depend on the suitability of the habitat where seeds are dispersed, we asked whether shifts in the direction of seed dispersal could induce shifts in the success of life stages across successive seedling cohorts. We monitored the recruitment and performance of a major tree species (Quercus ilex) across seven cohorts in four kinds of post-fire habitat with different structure in a burnt pine stand of a Mediterranean mountain (Sierra Nevada, southern Spain). These habitats included patches of unburnt forest and three burnt-wood management treatments: logging, partial cutting, and non-intervention. Young, post-fire resprouting oaks mostly appeared near acorn sources. In contrast, post-fire recruits emerged chiefly in habitats with standing snags due to the positive selection of this habitat type by European jays (Garrulus glandarius) for dispersal. However, the dead trees progressively collapsed and reduced their attractiveness for dispersal, and subsequent seedling cohorts mainly recruited below unburnt pines. The pines, in turn, generated a life-stage conflict that was absent elsewhere: they increased oak survival but reduced their growth. Thus, as a consequence of the directional shift in the habitat where seedlings recruited –which was in turn due to the reduction in vertical habitat elements selected by jays for dispersal–, successive seedling cohorts experienced a gradual improvement in their likelihood of survival but a reduction in growth. Temporal changes in habitat structure can indirectly change the environment in which recruitment occurs by shifting the direction of seed dispersal.

Sp.20-9-Oral

Seeds that do not move and the fate of a critically endangered plant in Central Chile: It's not all bad news…yet

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Seed dispersal is a critical process in the reproductive cycle of plants because it determines the locations in which seeds and seedlings live or die. One of the benefits of seed dispersal is moving away from conspecific neighbours, where mortality rates are high due to density-dependent factors. In arid environments, however, remaining close to conspecifics may be beneficial because intra-specific facilitation can alleviate abiotic constraints on recruitment, particularly for plants with desiccation-sensitive seeds. Pouteria splendens is a critically endangered tree with large fleshy fruits and recalcitrant seeds; it has no legitimate dispersers and grows forming monospecific patches. Here, we examined the current assemblage of frugivores consuming P. splendens' fruits, determined the spatial patterns of seed dispersal generated by each frugivore and experimentally quantified seedling emergence and survival in the habitats where seeds are dispersed. We found that P. splendens is severely dispersal limited; frugivores visit plants less than once a day. Consequently, most seeds are either not removed at all, or not moved beyond the parent plant; very few arrive to other habitats. Seedling emergence and survival, however, was significantly higher under conspecifics than in other habitats and overall, the probability of establishment was higher in areas of high conspecific density. Our results suggest that P. splendens plants form high-quality habitat 'islands ', thus in the short-term the consequences of dispersal limitation may not be so dramatic for population persistence. As habitat quality changes, however, the lack of dispersal may have increasingly negative effects on this narrow endemic species.

Sp.20-10-Oral

How did I arrive here? Dispersal of holm oak (Quercus ilex) acorns by magpie (Pica pica) in a forest and farmland mosaic

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Magpies, the most common corvid in Eurasia, disperse acorns potentially contributing to tree recruitment in agricultural landscapes. We assessed the dispersal pattern of holm oak acorns, with emphasis on the preference of magpies for different environments and microsites in a forest and farmland mosaic to cache acorns. The study was conducted in Central Spain in a holm oak and almond-tree plantation surrounded by old-fields dominated by annual herbs. Acorn dispersal and caching was assessed by trail cameras and radio-tracking of transmitters inserted in the acorns. At least 79% of the removed acorns were cached. Dispersal distance ranged 1-112 m with a mean distance of 31 m. Acorn dispersal shadow overlapped magpie nesting territories, suggesting that they used these spring territories as feeding and caching territories during the fall and the winter. This pattern constrained the availability of environments and sites for dispersal. Magpies showed a higher preference for tilled sites than for the tree plantation and old-fields. In the tree plantation, magpies had similar preference for sites under tree canopy and gaps. In the old-fields, magpies frequently chose ant and rabbit pellet dumps to cache the acorns. Magpies used loose soil, small stones and litter for acorn caching. Acorn caching follows a hierarchical decision-making driven by magpie territories, and available environments and sites in them. Magpie territory properties and its position in the tree plantation drive acorn dispersal distance and caching sites. Understanding acorn dispersal pattern by magpies may be relevant for holm oak restoration of Mediterranean agricultural landscapes.

Sp.20-11-Poster

Climatic drivers of fruiting seasonality: consequences for frugivory

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Seed dispersal disruptions may arise not only by animal loss, but also when environmental changes produce a mismatch between the timing of activity of plants and their dispersers. As plant phenology is finely tuned to climate, understanding the main climatic drivers of fruit seasonality gives clues on potential phenological shifts mediated by climate change. This also helps in predicting the availability of resources to frugivores under future climatic scenarios. In this work, we aim to disentangle the climatic triggers that control the geographic variability and the degree of seasonality of fruiting phenology over large geographic scales and vegetation types in the Neotropics. We collated information from 110 study sites covering different Neotropical vegetation types and rainfall regimes, combining both published and unpublished data. We used circular statistics for extracting proxies of fruiting seasonality and we explored the relationship between fruiting and six environmental predictors by means of General Least Square models. Our results showed that fruit seasonality was dependent on climate, being the best environmental predictors of the length of the fruiting season the thermic amplitude, the seasonality of rainfall and the difference in day length between the shortest and the longest day of the year. Although these results were tropical, the same methodology can be easily applied to Mediterranean-type vegetation. As future climatic scenarios predict an increase of temperature range over the year, fruit seasonality will be presumably affected, with cascading consequences for interacting animals.

Sp.20-12-Poster

Seasonal dynamic interactions between the Mediterranean shrub Pistacia lentiscus and avian frugivores in fragmented forests

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Frugivory and seed dispersal have a crucial role to play in the novel landscapes that are emerging all around the world in order to maintain the diversity of forests that already exist. Most seed-dispersal systems involving interactions between plants and animals rely on fleshy pulp-rich fruits to attract avian and terrestrial dispersal agents. We compared the bird frugivorous assemblage and fruit removal of the Mediterranean shrub Pistacia lentiscus growing in forest fragments with different degree of isolation in two consecutive dispersal seasons. The objectives of our study were (I), to test whether habitat fragmentation affects species richness and total abundance of frugivores, (II) to assess the impact of habitat fragmentation on fruit removal rates, and (III) to evaluate the final destination of dispersed seeds across four different types of microhabitat. As expected, we found higher abundance of dispersers in connected than in isolated fragments in the first season. However, the opposite pattern was observed in the second season. The same trend was found regarding dispersal rates, with higher rates of seed dispersal in isolated forests in the first season, but not in the second season. The destination of dispersed seeds was, however, consistent across seasons, with most seeds being dispersed under the canopy of female Pistacia plants. In this study we emphasize the importance of seasonality for understanding how environmental variables influence patterns of frugivore-mediated seed dispersal.

Sp.20-13-Oral

Seed banks, fire regimes, and vertical animal dispersal: do plants manipulate animals?

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Scatter-hoarding rodents bury dry, drupe-like fruit of Arctostaphylos (Ericaceae) species permitting most seeds survive fire. These seed are physiologically dormant and remain in the soil until stimulated by a fire. Because seed are dormant for years to decades, seed predation is a major issue for persistence. Arctostaphylos differs in some ways from co-occurring genera like Adenostoma and Ceanothus, which also create persistent soil seed banks. One key difference is that Arctostaphylos produces considerably larger seed than the other two genera. Seed viability, however, can be low and nutlets containing seed are often fused together. This combination of traits of larger seed, variable nutlet fusion and lower seed viability suggests a hypothesis that Arctostaphylos may manipulate rodents to produce higher density seed banks. To investigate this hypothesis, we first describe the relationship of % seed viability against nutlet fusion and whether the species are post-fire sprouters or non-sprouters. We then assess seed bank sizes for a number of species that vary in seed size. We hypothesize that seed banks should contain similar total energy content and determine this by analyzing total energy (kcal) per seed, seed size, and seed bank density. Such an energetic threshold would predict that rodents are responding to a giving up density consistent with optimal foraging theory. Such results would suggest that selection has modified these seed and fruit traits to assure an adequate seed bank density in the context of rodent predation.

Sp.20-14-Oral

Persisting in defaunated landscapes: reduced plant population connectivity after seed dispersal disruption

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Defaunation of large-bodied frugivorous could be causing severe losses of crucial ecosystem functions such as seed dispersal. Immediate consequences may include alteration or even collapse of gene-flow among plant populations, with effects on the regional scale distribution of genetic variation. Yet these far-reaching consequences of defaunation remain understudied. Here we tested whether human-induced downsizing of frugivorous lizards (Gallotia, Lacertidae) from the Canary Islands progressively impaired plant genetic diversity, within-island population connectivity, and large-scale genetic isolation by distance of Neochamaelea pulverulenta (Rutaceae), which relies exclusively on these lizards for seed dispersal. Our study entails an extensive sampling of plant populations along a gradient of defaunation from three islands with large, medium and small lizards, spanning the whole geographic range of the plant. We found no differences in plant genetic diversity among islands, but reduced overall plant population connectivity within islands, and a significant increase of isolation by distance mirroring the trend of lizard downsizing caused by defaunation. Our results indicate that conservation of large-bodied frugivores is essential because their irreplaceable mutualistic dispersal services maintain an extensive movement of seeds across the landscape, crucial for maintaining genetic cohesiveness of metapopulations and the adaptive potential of plant species across their entire geographic range.

Sp.20-15-Poster

The link of mating system and dispersal capacity in the heterocarpic Hypochaeris salzmanniana DC

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Mating and dispersal systems are known to be intrinsically linked, particularly in plants, where the two traits are anatomically and ontogenetically associated. Outcrossing and high dispersal capacity is the most common evolutionary strategy, although in some cases selfing and dispersability has been found. Heterocarpic plants, especially those that present differences in both dispersability and sexual systems, are valuable models for studying the relationship between these two traits. In this work, we aim to test this relationship in the heterocarpic H. salzmanniana (Asteraceae), a species with self-incompatible (SI), partially self-compatible (PSC) and totally self-compatible plants (SC). Moreover, H. salzmanniana produces two types of fruits that could differ in their dispersal ability. We studied whether the two fruits differ in dispersal capacity, whether dispersability is a heritable trait, whether dispersability changes with plant age and the relationship between dispersability and both incompatibility system and pollination type (selfing or outcrossing). Results showed that dispersability was a heritable trait and the two types of fruits differ markedly in their dispersal capacity. A trend to diminish dispersability was found with plant age that could be explained by developmental constraints caused by lack of resources. Dispersability was significantly lower in SI than in SC and PSC plants. Moreover, self-pollinated heads increased their dispersal ability compared to that of cross-pollinated heads. Our results show that in H. salzmanniana selfing is associated to high dispersability. These results are consistent with sib-competition theory, which considers that outcrossing may minimize competitive interactions among relatives falling near the mother plant.

Sp.20-16-Oral

The evolution of seed dispersal is associated with environmental heterogeneity in Pinus

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Seed dispersal is a major life history stage for plants. Because of its influence on reproductive success, dispersal is expected to be under strong selection. Consequently, dispersal mechanisms are often assumed to be adaptive under specific environmental conditions. However, the effect of ecological factors on the evolution of dispersal has been seldom studied in plants. Here, we explore the linkage between dispersal mechanisms and environmental conditions at an evolutionary scale. We use a comparative phylogenetic approach to investigate the evolution of two different dispersal morphologies (winged vs. unwinged seeds) and their connection with environmental unpredictability, aridity and fire. Seed dispersal appears to evolve towards two alternative optima, one with big seed wings and another one with very small or no wings. These two phenotypes correspond mostly to wind- and vertebrate- mediated dispersal, respectively. Our results show a close evolutionary association between dispersal morphology and environmental conditions such that each morph predominates under particular abiotic conditions. Taxa with seeds with bigger wings appear to be selected for primarily in environments with high temperature heterogeneity and/or prone to fire, whereas unwinged seeds are evolutionarily linked primarily to environments with high precipitation heterogeneity. These findings illustrate the adaptive importance of seed dispersal and the influence of the environment in the evolution of plant functional traits.

Sp.20-17-Oral

How might climate change affect seed dispersal by animals?

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Understanding movement of plants is critical to understanding the responses of plant communities to a changing climate. Most considerations of plant movement in response to climate change focus on long distance dispersal (LDD) and the dispersal kernel, in particular whether the tail of the dispersal curve is sufficiently "long" to keep up with the moving climate envelope. However, simply focusing on static dispersal kernels is likely to be very misleading because it ignores the extreme complexity of the seed dispersal process and its consequences. In this talk I will highlight complexities relevant to developing a better understanding of plant movement in a changing climate. A starting point for a more thorough understanding is the seed dispersal effectiveness (SDE) framework, where SDE is a function of the quantity of seeds dispersed and the quality of dispersal provided individual seeds. Climate change can affect both the quantity of seeds dispersed (e.g. altered disperser assemblages, phenological mismatches) and the quality of dispersal (e.g. changes in the net strength of facilitation). Secondarily, we need to consider both local, within population seed dispersal and the LDD needed for migration. If climate change reduces the effectiveness of local dispersal it can reduce source strength and thus the number of LDD events. In addition, LDD and its effectiveness will likely respond in complex ways to climate change. For example, a static dispersal kernel is irrelevant if it extends the tail into a habitat unsuitable for the disperser, limiting seed arrival, or for the plant species, limiting establishment.

Sp.21: Ecoinformatics: data science brings new avenues for ecology

Sp.21-1-Main talk

I have an e-dream: low hanging fruits and future directions in comparative demography

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The last decades have witnessed the online publication of an unprecedented volume of genetic (GenBank), anatomic and physiological (TRY, BIEN, D3, CLO-PLA), and climatic data (FetchClimate, NOAA), to mention a few. The availability of these and other data resources has revolutionised the extent to which biological topics can be addressed at a global scale, providing ecologists and evolutionary biologist the ability to explore universal patterns and rules. Demography, the study of population dynamics and its underlying drivers, is key to answering key questions including: why do some species go locally extinct while others become invasive pests?; how can we secure food provisioning in developing countries?' how do species respond to global change?, why do some species senesce while others do not? However, the availability of demographic data across large numbers of species has limited out ability to tackle these questions. Here, I will review the gap that two new open-access resources help fill in for the demographic realm. The COMPADRE Plant Matrix Database and COMADRE Animal Matrix Database (www.compadre-db.org) contain high-resolution, georeferenced demographic information (e.g. rates of survival, growth/ageing, reproduction and recruitment) of over 2,500 animal and plant species worldwide in the shape of matrix population models. Taking these resources as the current state of the art in animal and plant demography, I discuss some of the low hanging fruits and future directions in comparative demography, and highlight some historically missed opportunities, as well as make recommendations on how to rectify them.

Sp.21-2-Oral

Compiling a global database of sap flow measurements: the SAPFLUXNET data workflow

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Widespread application of thermometric sap flow methods in ecological, hydrological and agronomic studies since the 1990s has generated a massive amount of quasi-continuous (i.e., from sub-daily to interannual) data of whole-plant sap flow. A global compilation of these datasets would enable unprecedented analyses of the environmental and ecological drivers of plant transpiration. However, sap flow datasets can be highly heterogeneous because of differences in methodologies and experimental designs across individual studies. Here we describe the logic behind the data ingestion process implemented in SAPFLUXNET, the first global database of sap flow measurements. This database is being compiled from the contributions by individual researchers across the globe consisting of metadata at various organisational levels (i.e. site, stand, plant…) and sap flow and environmental time series data. The actively developed and highly modular R package, 'sapfluxnetr' performs semi-automatized data processing, standardisation and quality control (i.e., timestamps, units, geographic and species nomenclature checks). Apps created using Rmarkdown and Shiny/HTML generate interactive reports and documents to perform visual checks and to request feedback from data contributors. All the steps in our data workflow are fully documented, reproducible and version-controlled in a GitHub repository, allowing that analogous workflows ensuring quality control can be applied in similar ecological databases. Our approach will also lead to a seamless integration of the datasets in a relational database (PostgreSQL) with a user-friendly data interface (R/Shiny/HTML) to efficiently perform data queries. Overall, SAPFLUXNET constitutes a major step towards openness and reproducibility in plant physiological ecology and ecosystem ecology.

Sp.21-3-Oral

Why use proxies of plant productivity in Mediterranean agrosilvopastoral systems when there is direct production data at local scale?

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In seasonal environments, the ability to reflect annual vegetation productivity is crucial for ecological and management studies. However, up to now, in Mediterranean agrosilvopastoral systems linking climatic effects and plant production has not been an easy task. There is a wide variety of indirect indexes such as local weather variables, measures of water availability (Gaussen Index or Real Bioclimatic Index) or remote satellite imagery (NDVI). Selecting one over the others may be difficult as each has advantages and limitations. However, instead of using indirect indexes, direct data on crop yield could be used as thousands of surveys are performed yearly across Spain and gathered in an open-access database (ESYRCE, MAGRAMA). Here, we sought to highlight the potential value of these surveys to reflect inter-annual variations on primary production compared to other indirect indexes (NDVI, GI and RBI). Based on data of annual pasture productivity collected during 7 years on a Spanish Dehesa, we compared and ranked 4 candidate models (each containing one of the above indexes). Preliminary results revealed that annual crop yield variation from the ESYRCE database showed the highest correlation with the real data collected in field and also presented the lowest AIC of all indexes, followed by NDVI, RBI and GI. Hence, this methodology may be useful for estimations of herbivores individual and population traits, livestock production or the effect of climate change on primary production.

Sp.21-4-Poster

Effects of data quantity and quality on the definition of geographic ranges with geographic algorithms

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Distribution ranges are basic units of information defining the area where a species occurs. They are used in biogeography, macroecology and conservation biology to describe biodiversity patterns, to identify priority areas for conservation or to investigate evolutionary relationships across space. Distribution ranges are typically characterized by variables such as area, shape and other descriptors of their boundaries, their fragmentation or by their internal structure. As a tool, distribution ranges are so successful because they provide a simplified abstraction of the complex spatiotemporal dynamics of species. Therefore, it is important knowing how distribution ranges are defined and the factors that might affect the outcome. Here we focus on algorithms that delineate the extent of occurrence using only records of species observations. Each geographic algorithm may produce different results for the same dataset, making especially important understanding how they are affected by the quantity and quality of the data available. We evaluate five algorithms commonly used to generate range maps, comparing the consistency of their results as a function of the number observations available, their spatial distribution and presence of errors and biases in the simulated observations' datasets. We use hypothetical reference ranges with the same total area, but varying in shape, number of fragments and heterogeneity in fragment size, to generate the simulated sets of observations within those areas. The results have enabled us to offer a series of recommendations when selecting algorithms depending on the quality and quantity of data.

Sp.21-5-Oral

Novel clustering methods as powerful research tools for ecologists: a case study using affinity propagation

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The increasing availability of high-resolution data on species-level distribution, phylogenies and ecological attributes opens new ways for research at the interface between ecology and evolution. Simultaneously, it is more evident the need for quantitative methods aimed to reduce the inherent complexity of data allowing replicable results. In this scenario, modern cluster analyses are revealed as helpful research tools capable of capturing accurately the spatial structure of data. Among them, 'affinity propagation' highlights as a machine-learning algorithm extensively used in bioinformatics and which is making inroads in ecology as a more powerful alternative to other popular clustering methods, especially if large datasets need to be managed. Using global distributions of mammals, birds and amphibians as a case study, I show how affinity propagation is able to classify the world's biota into meaningful geographical units very similar to the zoogeographical regions proposed by Alfred Wallace. The attractiveness of this method is its ability to clustering by exchange real-valued messages between all pairs of data points until a high-quality set of exemplars (spatial locations) and corresponding clusters (bioregions) emerges. Each bioregion contains fauna similar in terms of ecological attributes and phylogenetic relatedness that differs from the rest of bioregions. Affinity propagation is thus really useful for biogeographers as bioregions represent analytical units central to many basic and applied questions in historical and ecological biogeography. Yet, because of its simplicity and general applicability, affinity propagation can be of broad value in other fields as a way to search for patterns in complex ecological data.

Sp.21-6-Oral

Managing floristic data: A free and open source spatial information system for plot-based field data collection

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Plot-based floristic data enables valuable research, such as climate change impact modelling. However, archaic data practices, such as transcription of paper sheets into spreadsheets are time consuming, prone to data entry errors and do not allow concurrent access by multiple users. Additionally, spreadsheets are inefficient tools for large sets of data, prone to update anomalies and link poorly to Geographic Information Systems, impeding spatial data analytics. A database management system circumvents these issues, but are often unused due to high software cost and lack of know-how, resulting in the preceding status quo. This study aimed to develop a cost-effective solution that is portable to floristic surveys. We outline the development and functionality of the Floristic Information Management System (FIMS), a free and open-source, spatially-enabled database system (PostgreSQL and PostGIS) that assists researchers in managing their floristic plot data collections. FIMS enables seamless exchange of information between the database and statistical (R) and GIS software (QGIS) and provides an intuitive data management front-end (Java). Remote field data syncing is achieved via Open Data Kit (ODK) Collect for Android, allowing for submission of field data from mobile devices to FIMS in real-time. We demonstrate the use of FIMS to manage an extensive floristic plot dataset (31,000 plots) collected over 30 years from Southwest Australia's Jarrah Forest. FIMS greatly improved data integrity, extended its usability in a wide range of analytical tools, and currently forms the basis of group-based research investigating the impact of drying climate on moisture vulnerable Jarrah Forest species.

Sp.21-7-Oral

Spatial association of Mediterranean biodiversity: analyzing multivariate variograms of plant species

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Spatial analysis and geostatistics are commonly used to study environmental and ecological spatial patterns by providing an integrated analytical framework for their modeling and interpretation. Focusing on biodiversity, spatial association of plant species aims in identifying distribution patterns based on (dis)similarity between individual species and pairs or groups of species. In this case, empirical variograms and cross-variograms offer useful methodological tools for studying single and paired species spatial (dis)similarities, whereas multivariate variograms can be employed for the interpretation of species groups spatial (dis)similarities. The Mediterranean island of Crete (Greece) was selected as the study area, using presence/absence data of its 1647 plant species recorded on 162 grid-cells (8.25km x 8.25km). Four different types of empirical variograms were considered: auto- and cross-variograms, and complementarity and species richness multivariate variograms. An analysis of species spatial (dis)similarity based on distance, direction and location was performed for all species and species subgroups with emphasis on woody plants. Multiple curves, maps and matrices of variograms were produced for different sets of species groups, variogram types and (dis)similarity measures, enabling a comprehensive multivariate geostatistical analysis of the biological diversity of the study area. Directional variograms of complementarity were identified as the most significant spatial patterns of dissimilarity, especially in woody plants, whereas individual species displayed a vast variability in their spatial distribution. Species multivariate variogram analysis provides significant understanding on the structure of their geospatial distribution, which is necessary to study the complex relationships between plant spatial patterns and environmental and climate controls.

Sp.21-8-Oral

Development of Ecological Restoration Projects on Mediterranean ecosystems: Analyzing trends and statistical complexity

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Ecosystem and biodiversity loss, due to intense anthropogenic pressure, can be halted by using Ecological Restoration Projects (ERPs). ?he aim of these projects is to restore disturbed ecosystems to their historical state. This process can be implemented by using reference sites (areas similar to the restoration goal) and historical data. During the past decades, significant research, concerning the theory and development of ERPs, has taken place, leading to the Directive of the Society for Ecological Restoration (2002). This Directive sets an integrated framework for ERPs' sustainable implementation. A continuous increase, concerning the statistical complexity of the ERPs' analysis, is observed in scientific literature, which is quantified by measuring the inference (number of research hypothesis) and the complexity (number of statistical tests). In this research, the ERPs on Mediterranean ecosystems, of the past 20 years, were studied by reviewing 67 Projects from scientific literature. Their significant parameters - reference sites, ecological attributes, restoration techniques, management practices - were recorded and analyzed. Additionally, the parameters' temporal trends, in combination with the Projects' statistical complexity, were studied. Our results showed two district time periods, before and after the Directive that had affected the structure and process of the ERPs. An increase of statistical complexity was observed, which was higher in Projects where reference sites were not used. Also, statistically significant relationships between the set of parameters were detected. These trends could be used in facilitating the base of an ERP evaluation framework, as well as in designing more efficient future projects.

Sp.22: Plant Invasions in Mediterranean-Type Ecosystems

Sp.22-1-Poster

Effects of non-inversion tillage and no tillage on crop yield and weed communities in Mediterranean cereal steppes: a nine year study

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It is under the context of the so call “Conservation Agriculture”, that different non inversion tillage systems have- been proposed as alternatives ways for weed management and conservation in Mediterranean cereal steppes. However there are still little evidences on their relative effects on weed diversity and crop yields on the medium term. Tillage systems are critical filters under which weeds have evolved, and thus we expect that shifts in them could produce important community changes. Here we assess the effect of subsoil tillage (ST), minimum tillage (MT) and non-tillage (NT)) on arable weed community diversity (taxonomic richness, Simpson diversity and evenness)composition, and on crop yield, in a grain legume-cereal crop sequence during a 9 years period. Inter-year environmental variability was more important than tillage system in determining weed species diversity and assembly. None of the studied tillage systems produced consistent effects neither on weed communities nor on crop yields. In addition, the effect of tillage system on diversity indices was crop type dependent. Main observed effects were related to species composition and were based on changes on less abundant or even rare species, as core species were consistent across tillage systems. The studied tillage systems did not present a clear relative advantage neither on crop yield nor weed diversity. However, traditional crops rotation (cereal-grain legume) appears as a key agricultural practice enhancing weed diversity in steppes croplands and thus the provision of important ecosystems services based on weeds communities.

Sp.22-2-Oral

Microwave soil heating for controlling invasive plant species germination

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Examples of successful long-term eradications of invasive species are rare, partly because eradication methods target only the adult stage and does not take into account the development capacities from a very important propagule bank. Microwave radiation causes dielectric heating of moist material and enables reaching rapidly temperature needed for loss of seed viability (60-80°C range). First we tested the effect of different combinations of powers (2, 4 kW) and durations (2, 4, 8 min) on 3 target invasive plant species (Fallopia japonica, Datura stramonium, Solidago gigantea). We also evaluated the effect of soil humidity (10, 20, 30%) and seed depth (2 cm, 12 cm) on the efficacy of the microwave treatment on germination capacity. The most efficient treatments were: 2kW8min, 4kW4min. Their efficiency decreased with increasing soil humidity. In some cases, efficiency also decreased with depth. Solidago gigantea was the most sensitive species, probably due to the small size of its seeds. We then assessed the efficiency of four microwave treatments (2kW4min, 2kW8min, 4kW2min, 4kW4min) to destroy a complex seed bank as well as the capacity of treated soils to allow the germination and survival of newly arrived seedlings with restoration perspectives in mind. Poaceae were more sensitive to the treatments than dicotyledones, and particularly than Fabaceae. There was no effect of microwave treatments on soil recruiting capacity. These first results are encouraging and experiments are on-going to the effect of soil compaction and texture on treatment efficacy as well as treatment effect on soil properties.

Sp.22-3-Oral

Native and invasive populations of Brassica nigra differ in competition and dispersal traits

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One potential explanation for invasion success of many exotics is the occurrence of evolutionary changes affecting ecologically relevant traits in the introduced range. Selection on dispersal ability in the invasive range has important consequences for population dynamics. However, at high population density, selection may act to increase investment in competitive ability at the expense of dispersal ability. If old invasive populations are denser than native populations and experience stronger competition with conspecifics, then we expect post-introduction selection on dispersal/competition -related traits in dense invasive populations. We compared growth, reproductive and dispersal traits of native and invasive populations of Brassica nigra in a common garden under conspecific (within- or between-range) vs. heterospecific (grass or forb) competition. Populations were collected at similar latitudes and climate in California and Spain to control for latitudinal clines and climatic effects on traits. Invasive populations outcompeted native populations when grown together. Results suggest selection on heavier seeds, early flowering and longer reproductive branches in invasive populations and a cost in terms of seed production per pod, irrespective of competition treatment. In contrast, native populations produced higher amounts of seeds and reproductive branches per plant under low competition intensity (within-range conspectifics and forb). Our results suggest that invasive populations of B. nigra have evolved greater competitive ability than native populations. However, dispersal ability may be context-dependent and achieved by different strategies in invasive and native populations, as indicated by differences found on seed size and number and on maternal plant architecture.

Sp.22-4-Poster

Lantana camara L., a slumber threat for Galapagos Ecosystems

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Oceanic archipelagos such Galapagos Islands are susceptible and vulnerable to the introduction of new species. Lantana camara an invasive species considered on the top 10 worst threats worldwide, is present in Galapagos. In order to understand the current impacts and reveal the potential invasive skills of L. camara for the Galapagos ecosystems; ecological and physiological assessment of their interactions and characteristics, respectively, were carried out, comparing it with its endemic congener from Galapagos Lantana peduncularis. L. camara with a deep root system showed higher levels of leaf growth, water content and better functioning of its photosynthetic apparatus and L. peduncularis with a shallow root system, showed lower levels of leaf growth, water content and higher levels of photosynthetic stress. Consequently, due different strategies to cope with drought, L. camara, besides a permanent, abundant and showy floral production, also has a major volume of nectar by flower, by contrast L. peduncularis showed low volumes of nectar, although higher concentration compared to L. camara in lowland arid zones. L. camara and L. peduncularis share floral characteristics, their flowering periods are overlapped and inhabit in sympatric conditions. The main pollinator for both Lantana was an endemic Lepidoptera (Urbanus galapagensis), with more frequent visits and a major time remaining in the showy flowers of L. camara. In addition, the white flowers of L. peduncularis were unable to self-pollinate and the ground Darwin' finches act as a predator of the seeds of L. camara.

Sp.22-5-Oral

The tale continues: ecophysiological fitness of non-indigenous versus native Spartina species in Mediterranean salt marshes

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The invasion of natural communities by non-indigenous species (NIS) represents one of the most serious threats to biodiversity. Many NIS plants have been introduced more than 100 years ago, while others are more recent arrivals, with the majority of the introductions occurring in the end of the 19th and at the beginning of the 20th centuries. The Spartina genus is one of the most successful among halophytes, being present in a wide range of latitudes across the globe. Typically, Mediterranean systems are inhabited by the endemic Spartina maritima (Curtis) Fernald, native from the Atlantic African and European Atlantic coasts. Alongside and with very similar geographical distribution ranges two invasive species from the Spartina genus have been detected in Mediterranean systems. Spartina versicolor Fabre was first described in the Mediterranean region during the 19th century (Fabre, 1849). Several authors consider that this taxon originated in America, and was introduced in Europe. Spartina densiflora Brongn. is also invasive grass species of a South American origin that has colonized salt marshes in the Gulf of Cadiz in the SW Iberian Peninsula, North Africa and North America. Having this knowledge in mind becomes important to review the history of the introduction of these NIS along with their current colonization status and physiological characteristics. This approach will be integrated in future scenarios of global change environment and increased anthropogenic pressures for a better understanding of these NIS impact and survival in Mediterranean estuarine systems.

Sp.22-6-Poster

Germination patterns of native and invasive Oenothera drummondii populations

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The germination stage is crucial in plant life history and is also a key process for dispersal into new locations and expanding the distribution range of a species. In this study we investigated the germination patterns of Oenothera drummondii, a native species from the Gulf of Mexico, which is an invasive in the Mediterranean coastal dunes of Spain. First, we were looking for differences in the germination patterns of seeds from the extreme limits of the native distribution range (Texas in the USA, and Veracruz in Mexico), with different climate regimes (subtropical and tropical). Second, we wanted to test if invasion success in Mediterranean dunes was related to higher germination rates in seeds from non-native populations (Cadiz and Huelva in Spain). To test this, seeds from the two native populations and from two non-native populations were subjected to four different temperature regimes. Final germination and germination speed were significantly higher for non-native population than for natives. Both variables were significantly higher in seeds from Texas (subtropical) than from Veracruz (tropical). Seeds from Spain and Texas germinated faster than seeds from Veracruz. The patterns of seed germination of Spain and Texas were similar in all four temperature regimes. Final germination percentage and germination rate were significantly lower in the Veracruz seeds after exposure to colder temperature ranges 10-15°C and 15-20°C. These findings imply that the non-native population could come from the subtropical coast of Texas, and that adaptation in germination patterns to the Mediterranean climate in invaded areas has occurred.

Sp.22-7-Oral

Inheritance of competitive ability in native and invasive inter-regional hybrids of Centaurea solstitialis

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The hypothesis of evolution towards Increased Competitive Ability (EICA) might partially explain the spectacular invasive success of Centaurea solstitialis in some of its non-native ranges. According to EICA, in the absence of natural enemies selection will favor reallocation of resources from defense to increased competitive ability. However, little is known about the heritability and maintenance of genetic variation in competitive ability, and the role of potential reintroductions in maintaining newly acquired local adaptations. To test for this, we compared the performances of an F1 generation of hybrids obtained from crosses between native (Spain & Turkey) and non-native populations (Argentina, Chile, California & Australia) of C. solstitialis, in a common garden experiment, using a full factorial design including one to one competition with Lolium perenne and control groups for every treatment. We assessed for differences in competitive ability by using the Relative Interaction Indexes (RII). Our preliminary results suggest that: (1) descendants of the highly invaded regions of Argentina and California are the best competitors with this grass and (2) hybrids from invasive and non-invasive regions show a trend towards intermediate inheritance of competitive ability. These results suggest that, at this stage of invasion, homogenizing gene flow resulting from hypothetical re-introductions from native ranges could lower the competitive effects of the invading populations, which has potential implications in the control strategy of this weed.

Sp.22-8-Poster

Buffering Federal Wildlands from Biotic Invasions with Gateway Communities

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Outside of the southern entrance to Sequoia and Kings Canyon National Parks in California is a small gateway community called Three Rivers. Although these national parks are monitored and managed to protect their enviable natural resources, in many instances, the privately-held adjacent lands that are ranched or farmed or resided upon are not. These neighboring rural lands have been found to support a broad spectrum of exotic plant species, including horticultural escapes whose presence poses potential threats of reinvasion or introduction into the national parks lands. To ameliorate this issue, we have designed and facilitated installation of eight public native plant demonstration gardens in prominent community locations. Our intentions are: 1) to illustrate viable native alternative landscapes to planting with exotic vegetation, 2) educate and awaken local residents to the unique and important biological diversity and ecology of the surrounding wild areas, 3) foster appreciation for the native flora and fauna, 4) engage residents, business owners and the larger community in similar efforts to protect and preserve native habitat, 5) create an informal buffer zone to minimize the presence of weeds aggressively invading from highly disturbed agricultural areas in the nearby San Joaquin Valley.

Sp.22-9-Poster

The adaptive value of herkogamy in native and invasive populations of Datura stramonium (Solanaceae)

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Datura stramonium, an annual herb native to North America, nowadays possesses a worldwide distribution, and behaves as a weed in some regions. This ability to colonize new environments may be linked to its capability to self-fertilization (reproductive assurance). Given that D. stramonium's main pollinators are absent in its invasive range, changes in its mating system and floral morphology are expected owing to relaxed selection. In the absence of pollinators, or if they act very differently, selection to diminish the level of herkogamy is predicted. In order to test whether the lack of herkogamy confers an adaptive value in the introduced environment, favoring self-fertilization, we measured natural selection on herkogamy in native (Mexico) and introduced (Spain, where the species is present since 16th c.) populations. Further, we explore the differences on reproductive biology and pollinator's community at each region, and compare the genetic structure of populations among native and invasive ranges. We hypothesize that the ability to self-fertilization associated to low or nil herkogamy confers an adaptive advantage (i.e. reproductive assurance) in its invasive range, reducing genetic diversity.

Sp.22-10-Oral

Plasticity and heritability of competitive ability on native and non-native ranges of invasive and non-invasive Centaurea species

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Introduced exotic species can rapidly adapt to conditions in non-native ranges, including changes in size and competitive ability, which result in different invasive success for each individual species. Increased competitive ability generally increases invasive success, but the role of plasticity of competitive effects and responses on invasive success is unclear. Additionally, little is known about the heritability of such changes, and on the importance of hypothetical reintroductions in the maintenance of locally adapted traits. To test for this, we experimentally produced cohorts of the invasive Centaurea solstitialis, and the non-invasive C. calcitrapa and C. sulphurea, of ancestry from either the native range in Spain, the invasive range in California, or (for the invasive C. solstitialis only) inter-regional hybrids from both ranges. We then set up one-to-one competition experiments with the grass Bromus hordeaceus. The invasive C. solstitialis was the only species presenting significantly larger competitive effects and responses in the non-native range of California, but also a significantly lower plasticity for this trait. Additionally, while descendants of two Californian parents had almost twice the competitive effect on B. hordeaceus than descendants of two Spanish parents, inter-regional hybrids between Spain and California showed intermediate values. These results suggest that, at this stage of invasion, homogenizing gene flow resulting from hypothetical re-introductions from the native range could reduce their competitive effects on invaded plant communities.

Sp.22-11-Poster

Is the black locust a threat for Mediterranean riparian forests? A matter of water and energy

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Mediterranean riparian zones act as vegetation shelters for several deciduous tree species as black alder (Alnus glutinosa (L.) Gaertn.), black poplar (Populus nigra L.) or ash tree (Fraxinus excelsior L.) that are located at the drier edge of their bioclimatic distribution. Current global warming and human induced disturbances may imply a worsening of their growing conditions. Under such circumstances, black locust (Robinia pseudoacacia L.), is outcompeting autochthonous tree species. We compared temporal and spatial patterns of transpiration and their stem basal area increment for the above mentioned co-occurring riparian tree species during a growing season in a riparian plot with a sharp gradient of soil moisture and water availability to compare their water use efficiency under current climate conditions and to parameterize these tree species to simulate their behavior under climate change conditions with the GOTILWA+ model. We observed no water but energy limitation in tree community's transpiration. Nevertheless, common ash transpiration was water limited under soil water contents below 0.08 cm3•cm-3. Black locust is the most growth-based water use efficient tree species (5.5 g•cm-1•m-3), and alder is the lowest efficient one (1.9 g•cm-1•m-3). The good performance of black locust all across the water availability gradient is important to understand the success of this invasive tree species in Mediterranean riparian forest ecosystems under human or climate-induced disturbances. In future warmer conditions, black locust will be favored by increasing temperatures by an extended growing season, thus increasing the pressure upon autochthonous riparian tree species.

Sp.22-12-Oral

Biotic and abiotic impacts of invasive nitrogen-fixing shrubs in the Pacific Northwest of the United States

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In Mediterranean-type ecosystems in North America, nitrogen-fixing shrubs are some of the most common and aggressive invasive plants. For many years we have studied the impacts of one of these species, Cytisus scoparius, on native-dominated grasslands as well as managed forest ecosystems. Cytisus invasion is associated with failure of reforestation efforts, apparently driven by legacy effects on biotic as well as abiotic features of the soil. Invasion increases soil nitrogen, which enhances tree growth but is also associated with suppression of ectomycorrhizae. Alkaloids in Cytisus leaves and stems also suppress mycorrhizae, with negative consequences for tree seedling success. Using a chronosequence, we find that these impacts develop rapidly after disturbance and invasion, and don't appear to intensify steadily with time. Restoration after invasion by shrubby legumes may require active management to reestablish soil conditions that are conducive to native plant establishment.

Sp.22-13-Oral

Invasive Fabaceae trees and shrubs are changing southern South America ecosystems

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Invasive Fabaceae species have been shown to cause severe impacts on ecosystems globally. However, evidence of such impacts in southern South America remains scarce. In this talk, we review the research on invasive Fabaceae in south-central Chile, with special emphasis in the quantification of their impacts on biodiversity and ecosystem services. We discuss research gaps and priorities. South-central Chile has suffered a long history of anthropogenic disturbances, increasing the susceptibility of ecosystem to Fabaceae invasions. Acacia dealbata (Silver Wattle) and Genista monspessulana (French Broom) are among the most abundant invasive Fabaceae and serve as study models. Acacia dealbata is a tree native to Australia Genista monspessulana (syn. Teline monspessulana) is an introduced shrub from Europe. Acacia dealbata and Genista monspessulana reduce plant diversity by competing with native vegetation, generating allelopathic components, and limiting the recolonization of disturbed areas by native species. Both species increase fuel load and flammability, thus altering fire disturbance regimes. Genista monspessulana develops a seedbank that allows for a fast regeneration after fire. At the landscape scale, we have found that both species are abundant in areas heavily affected by human disturbance, but are rare in more natural environments. More research is needed on the ecological impacts of invasive Fabaceae such as changes in hydrological regimes, nutrient cycling and biotic interactions, but also into the economic and social impacts of these invasions. Funding provided by Institute of Ecology and Biodiversity (IEB) grant CONICYT, PFB-23.

Sp.22-14-Poster

Contribution of the invasive nitrogen-fixing tree species, Robinia pseudoacacia, to nitrogen enrichment of Mediterranean riparian forests soils

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During the last decades, Robinia pseudoacacia has invaded large areas of riparian zones in the Iberian peninsula. This nitrogen (N)-fixing species has the potential to alter soil N dynamics by adding extra N to the forest soil; yet there are little evidences of its real effect on riparian biogeochemistry. We investigated the influence of R. pseudoacacia on soil N cycling and N availability in a Mediterranean riparian zone inhabited by R. pseudoacacia, Alnus glutinosa, Populus nigra, and Fraxinus excelsior. During a year, we measured leaf litter inputs to the forest floor, soil N processes (decomposition, mineralization, and nitrification), and soil N concentrations across the riparian zone. Moreover, we developed a model to estimate the influence of different stages of R. pseudoacacia invasion on soil N availability. Leaf litter of R. pseudoacacia had higher N content (2.39 %) and lower decomposition rates (0.29 year-1) than non-N-fixing species, but did not differ from the native N-fixing A. glutinosa. Across the riparian plot, N inputs from R. pseudoacacia increase from the near-stream zone to the hillslope one (2.73 to 18.55 gN m-2), yet no differences in soil N content (0.36 %) nor soil N processes were found. Finally, model simulations suggested that the complete invasion of R. pseudoacacia would decrease by 12% the soil N availability of this Mediterranean riparian zone. Altogether, our results suggest that R. pseudoacacia could have little effects on the soil N biogeochemistry, at least in those Mediterranean riparian zones that were previously inhabited by native N-fixing tree species.

Sp.22-15-Poster

The New World aquatic plants invade the Mediterranean basin

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Mediterranean basin is one of the most biodiverse regions in the world, and its ecosystems are particularly susceptible to alterations caused by the effects of global change. Particularly alarming is the state of conservation of freshwater ecosystems, because they are extremely vulnerable to these changes. Actually the introduction of exotic species in aquatic Mediterranean ecosystems is one of the main causes of biodiversity loss, owing to the negative effect they have on the habitat they colonize. Ignorance of these species, along with that in the most cases are inconspicuous organisms, such as aquatic plants, does not take into account when establishing management plans for biodiversity conservation. In this study we propose the use of Species Distribution Models (SDM´s) as a tool for the development of prevention strategies against these organisms. To accomplish this study we taken 38 species of aquatic plants of American origin and we developed SDM´s to define the areas likely to be colonized by these species. These models were based on bioclimatic variables and the effect of human in the territory. The results showed as the most susceptible areas are places related to anthropogenic activities, which has allowed these species to find the nutrients necessary for their development and pathways of entry for their colonization and expansion, as well as other variables related to the biology of aquatic plants such as seasonality and water availability in the dry season. We conclude that SDM´s are a powerful and economic tool for management the potential distribution of exotic species.

Sp.22-16-Poster

Reproductive mechanisms that matter in the densification of sisal and henequen (Agave spp.) populations in Mediterranean-arid ecosystems

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In the 1950s two Agave species, henequen (A. fourcroydes Lem.) and sisal (A. sisalana Perr.), were planted in the Parque Natural Cabo de Gata-Níjar (Almería, Spain) to produce fibers. At present, both species continue growing in this area, invading protected ecosystems. Although sterile, their mechanisms of vegetative reproduction (bulbils from scape and shoots from rhizomes), and their CAM metabolism give them a high invader potential in arid areas, threatening native ecosystems. Knowledge about the contribution of reproduction mechanisms in their expansion will allow design useful strategies for their management. We conducted several analysis focused in assess this topic: i) we monitored 60 flowering individuals for record phenology and estimate bulbils production; ii) we also monitored 20 bulbils by each scape to assess their rooting success in field; iii) we performed an experimental plantation of bulbils in greenhouse to know their rooting success under non-limiting conditions; iv) by selecting four individuals by species, and excavating one side by each individual we made a description of root system, and estimated the production of shoots from rhizomes; v) we sampled 60 established shoots to discover their origin (scape or rhizome). Results showed that, though the production of bulbils was high, the rooting success of bulbils was very low. The main mechanism of propagation was the shoots from rhizomes, which are connected to the mother plant at least until they develop roots. In eradication actions the focus must be pointed mainly in new shoots from rhizomes, easily distinguishable, and less in reproductive conspicuous individuals.

Sp.22-17-Oral

Much more give than take: South Africa as a major donor but infrequent recipient of invasive non-native grasses

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In the Americas, Australia and tropical islands, grasses (family Poaceae) are among the most common invaders of natural areas. They are also among the most damaging invasive plant species, radically altering fire regimes and impacting ecosystems by changing litter composition, microbial communities and soil–nutrient feedbacks. However, in Africa and Eurasia these ecosystem impacts are relatively rare. African and Eurasian grasses are also among the most damaging and widespread plant invaders. Why might this be so? In this talk I will explore a number of hypotheses to explain this global disparity in grass invasions. I will specifically focus on South Africa, and the country's Mediterranean biome – the Fynbos, which provides an interesting case study with regards to grass invasions.

Acknowledgments

We would like to express our gratitude to all those who has given us the possibility to configure and prepare this exciting program: Scientific and Working Committees, Special invited speakers, Session Chairmen, Symposium organizers, volunteer assistants and to all Sponsors and Collaborators, i3 Congresos y Eventos Agency, and finally to all people who has submitted a contribution and to all attendees.

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