

BOOK OF ABSTRACTS



Sassari, April 15-16-17, 2015

# PaulisProject



Università  
degli Studi  
di Cagliari

Universitat  
de Girona  
Institut d'Ecologia Aquàtica

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The International Symposium on Mediterranean Temporary Ponds will offer an opportunity to researchers with different cultural background, students, practitioners, policy makers, and other stakeholders for exchanging experiences and information on the ecology, the biodiversity and the management of this type of habitat, with the aim of promoting its effective conservation and improving public awareness.

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*Laura Serrano* – University of Sevilla (Spain)

*Aline Waterkeyn* – KU Leuven (Belgium)

## PROGRAM

April 15<sup>th</sup> 2015

- 8.30-9.30      **Registration**
- 9.30-9.45      **Opening session**
- 9.45-10.00    **Presentation of the project *Paulis***  
*Simonetta Bagella, Dani Boix, Maria Carmela Caria, Jordi Compte, Stéphanie Gascón, Giorgia Filippino, Stefania Pisanu, Elena Pittao, Jordi Sala, Annalena Cogoni*

## SESSION 1

Moderator: *Pascale Nicolet*

- 10.00-10.45   **The plants of Mediterranean temporary pools: do we know enough for their conservation?**  
*Patrick Grillas, Laila Rhazi, Simonetta Bagella*
- 10.45-11.15   **Coffee break**
- 11.15-11.35   **Hydrological and vegetation changes over 25-year period in the Doñana Temporary Ponds (SW Spain)**  
*Laura Serrano, María Zunzunegui, Mari Paz Esquivias-Segura*
- 11.35-11.55   **Seed germination, plant traits and dynamic processes**  
*Angelino Carta*
- 11.55-12.15   **Phylogenetic clustering as a tool for long-term monitoring of plant communities in rockpools**  
*Sandro Lanfranco, Claire Grima, Lara Galea, Kelly Briffa, Sheryl Sammut*
- 12.15-12.35   **Occurrence and distribution of ephemeral wetland communities in South America: completing vegetation data with herbarium records**  
*Miguel Alvarez, Ulrich Deil*

**POSTER INTRODUCTION**

12.35-13.15

*Stéphanie Gascón, Jordi Sala*

**SESSION 2**

Moderator: *Michela Marignani*

15.00-15.45 **Bryophytes as a model organisms: methodological challenges for biodiversity assessment in a changing world**

*Rosalina Gabriel*

15.45-16.05 **Temporary wetlands in southern Australia: predicting responses to climate change**

*Michelle T. Casanova*

16.05-16.25 **Bryoflora of temporary ponds in the Mediterranean Basin: hints for management and conservation**

*Annalena Cogoni, Giorgia Filippino, Monica Zoccheddu, Michela Marignani*

16.25-16.35 **Chara baltica Bruzelius (Characeae) recorded in Sardinia**

*Klaus van de Weyer*

16.35-17.00 **Coffee break**

17.00-18.30 **PHOTO CONTEST: PHOTO PROJECTION AND PRIZE-GIVING**

in collaboration with Società Botanica Italiana Sezione Sarda, Sardegna Natura and P.Ass.I.Flora Ambiente

**April 16<sup>th</sup> 2015**

**SESSION 3**

Moderator: *Beat Oertli*

9.00-9.45 **Ecology and conservation of the fauna of Mediterranean temporary ponds**

*Aline Waterkeyn, Maarten Van den Broeck, Laila Rhazi, Patrick Grillas, Luc Brendonck*

9.45-10.05 **Contrasting intra-annual patterns of six biotic groups with different dispersal mode and ability in Mediterranean temporary ponds**

*Dani Boix, Maria Carmela Caria, Stéphanie Gascón, Maria Antonietta Mariani, Jordi Sala, Albert Ruhí, Jordi Compte, Simonetta Bagella*

10.05-10.25 **A comparison of Cladocera and Copepoda as indicators of hydroperiod length in Mediterranean temporary ponds**

*Marco Seminara, Daria Vagaggini, Fabio Stoch*

10.25-10.45 **Does connectivity mitigate the effects of drying on communities? Insights from a cross-system analysis**

*Véronique Rosset, Albert Ruhí, Michael Bogan, Thibault Datry*

10.45-11.05 **Successional changes in zooplankton of restored ponds with different age: a Russian doll perspective**

*Xavier Armengol, Carla Olmo, Raquel Ortells*

11.05-11.35 **Coffee break**

11.35-11.55 **The role of spatial and environmental factors as determinants of large branchiopod distribution in Tunisian temporary ponds**

*Fabio Stoch, Michael Korn, Souad Turki, Luigi Naselli Flores, Federico Marrone*

11.55-12.15 **Patterns of crustacean assemblages and vascular plants in ponds of different hydroperiod: a case study from the Alta Murgia National Park, Apulia (South-eastern Italy)**

*Giuseppe Alfonso, Leonardo Beccarisi, Valentina Pieri, Annagrazia Frassanito, Genuario Belmonte*

12.15-12.35 **Seasonal succession of crustaceans in Mediterranean Temporary Ponds: community and population traits**

*María Sahuquillo, María Rosa Miracle*

**SESSION 4**

Moderator: *Susana Romo*

14.30-14.50 **Million Ponds Project: successes and lessons learned from monitoring new ponds**

*Pascale Nicolet, Penny Williams, Jeremy Biggs*

14.50-15.10 **The role of the Centers for environmental education and sustainability in the protection of the Mediterranean temporary ponds**

*Maria Rita Viridis, Stefania Pisanu, Paola Bazzoni, Alessandra Manca*

15.10-15.30 **Quick and easy conservation status assessment: is it possible in Mediterranean temporary ponds?**

*Carla Pinto-Cruz, Ana Lumbreras, J. Tiago Marques, Anabela Belo*

15.30-15.50 **Public perception about ponds and their biodiversity in Portugal. Do practical environmental education activities help change public awareness?**

*Eunice Sousa, Ana Maria Rodrigues, José Teixeira*

15.50-16.20 *Coffee break*

16.20-18.15

**POSTER SESSION**

18.15-18.45

**CONCLUSIONS AND FINAL REMARKS**

Moderator: *Dani Boix*

20.00

**SYMPOSIUM DINNER**

**April 17<sup>th</sup> 2015**

7.30-21.00

**FIELD TRIP**

**Conference Venue**

University of Sassari - Polo Bionaturalistico di Piandanna. Via Piandanna 4, Sassari -Italy

## **ORAL PRESENTATIONS**

## **PATTERNS OF CRUSTACEAN ASSEMBLAGES AND VASCULAR PLANTS IN PONDS OF DIFFERENT HYDROPERIOD: A CASE STUDY FROM THE ALTA MURGIA NATIONAL PARK, APULIA (SOUTH-EASTERN ITALY)**

**Alfonso Giuseppe<sup>1</sup>, Beccarisi Leonardo<sup>2</sup>, Pieri Valentina<sup>3</sup>, Frassanito Annagrazia<sup>4</sup>, Belmonte Genuario<sup>1</sup>**

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Apulia (the Southeastern offshoot of the Italian mainland) is mainly a karstic lowland characterized by a steno-Mediterranean climate and vegetation. Recent limnological researches highlighted that the most of the Apulian surface inland waters had a temporary hydroperiod, and some of them (about the 18 %) were identified as Mediterranean Temporary Ponds (MTPs) (code 3170\* *sensu* Council Directive 92/43/EEC). The need of further detailed studies at small scale led to a limnological survey of the small inland waters of the Alta Murgia National Park (AMNP), a plateau of 680 km<sup>2</sup> (maximum altitude is 686 m a.s.l.) in the central Apulia. A monitoring of three years, with two surveys at least for each site per year in the wet season, was carried out between 2012 and 2014 in 19 inland waters located in the area of the AMNP. Most of sites were doline-ponds historically reinforced in their role of water reservoirs being used for agricultural purposes and as watering holes for sheep. Data on the occurrence of vascular plants, strictly connected to the pond environment, and on the crustacean fauna were collected along with the measure of several environmental variables of water (depth, pH, temperature, conductivity, transparency, oxygen, nutrients, metals). Out of the 19 studied water bodies, 4 were permanent, 7 temporary with a long hydroperiod, 8 temporary with a brief hydroperiod. A total of 40 species of vascular plants were identified, and some of them were indicators of the habitat 3170\* in 9 sites. The crustacean fauna was determined with the aim to possibly identify faunal assemblages peculiar of different habitat types, evaluating separately the factors 'hydroperiod' and 'habitat 3170\*'. The crustacean species were 50 in total: 22 Branchiopoda, 12 Copepoda, 15 Ostracoda, 1 Amphipoda. The higher diversity values were recorded in temporary waters. A maximum of 21 crustacean species were detected in a single pond with the extraordinary coexistence of 5 species of Copepoda Calanoida. The Permanova test revealed that the crustacean fauna identified three groups of ponds according three different classes of hydroperiod and, among Crustacea, copepods better characterized the grouping. The Mantel test between the dissimilarity matrices revealed a significant relationship between the distribution of crustaceans and plants, a result supported also by the co-inertia analysis. This case study contributes in the evaluation of new tools, based on faunal assemblages, useful to characterize and identify ponds of different type in addition to information deriving from the plant community.

## **OCCURRENCE AND DISTRIBUTION OF EPHEMERAL WETLAND COMMUNITIES IN SOUTH AMERICA: COMPLETING VEGETATION DATA WITH HERBARIUM RECORDS**

**Alvarez Miguel<sup>1</sup>, Deil Ulrich<sup>2</sup>**

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Ephemeral wetlands in South America harbor a flora highly adapted to the seasonal variation between inundation and desiccation. Both extremes are strong limitations to growth of vascular plants. While some species have a wide distribution (some are even cosmopolitans), the fragmentation and isolation of seasonal pools resulted in the evolution of highly endemic taxa. A compilation of own unpublished relevés and published vegetation data from extra- and oro-tropical South America (including the Mediterranean area in Chile) and their subsequent classification analysis revealed the occurrence of three classes, namely *Limoselletea australis*, *Littorelletea australis* and *Nanojuncetea australis*.

In South America, the knowledge about alpha-diversity and distribution patterns of ephemeral wetland vegetation is very incomplete in comparison with the European-North African Mediterranean biome, since most of the data sources correspond to local or regional studies. And furthermore, the time window for observation and for sampling complete phytosociological data in ephemeral vegetation is short. This poor knowledge hampers a proper assessment about the degree of endangerment of plant communities and their respective floras. And it may bias any effort to determine the distribution of vegetation types by applying habitat modeling.

We propose an alternative procedure to model the occurrence and distribution of syntaxa by combining geo-references of vegetation plots (relevés) with sampling localities of herbarium specimens of those species which are considered as characteristic for the mentioned syntaxonomical classes. Vegetation samples were extracted from the database CL-Dataveg and records of diagnostic species were imported from the Global Biodiversity Information Facility (GBIF). By combining both data sets, the number of records available for habitat modeling increased by 183%, 475% and 518% for the *Nanojuncetea*, *Limoselletea* and *Littorelletea* communities, respectively. Results of habitat suitability by applying MaxEnt models as well as the possible ways to validate model results will be discussed in this presentation. In conclusion, this approach confirmed the close relation of the *Nanojuncetea* communities to the Mediterranean bioclimate (mainly in Chile, but also in southern Uruguay and north-eastern Argentina), while *Limoselletea* and *Littorelletea* communities are widely spread using the Andean Cordillera as a temperate corridor through the Tropics.

## **SUCCESSIONAL CHANGES IN ZOOPLANKTON OF RESTORED PONDS WITH DIFFERENT AGE: A RUSSIAN DOLL PERSPECTIVE**

**Armengol Xavier, Olmo Carla, Ortells Raquel**

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The European Directive (92/43/CEE) considered temporary pools as priority and has been subsidizing a great amount of projects to restore these deteriorated habitats. Restoration attempts at recovering the natural dynamics of these aquatic ecosystems, their particular microhabitats and the associated flora and fauna. An added value is that after restoration, these ponds provide an excellent quasi-experimental unit to study the undergoing succession. Malladas de El Saler is a mosaic of humid dune slacks located within a sand bar that separates Albufera Lake from the Mediterranean Sea. These ponds have been restored during 90's and 2000's and after 30 years of being artificially silted. From 2007 until 2011 we monthly monitored three of these ponds, which were restored in different years with intervals of 4-5 years. In a simplified way, the three ponds restored at different times can be understood as one pond studied during three different moments after restoration. In addition, the ecological changes occurring in these ponds can be conceived as a set of nested structures, each inside the next, like a set of Russian dolls: at the outermost level, the long-term study (restoration); at the middle level, the interannual variation and at the innermost level, the seasonal variation. With respect to zooplankton both, limnological conditions and the community assemblages, were mostly determined by the long-term succession, with the early phase of succession being the most divergent. This succession was determined by a decrease in conductivity, oxygen and pH, an increase of vegetation cover and a gradual increase in species richness and more particularly on crustacean species, leading to more complex communities of zooplankton. There were also changes detected at the inter-annual and intra-annual level, with species replacements markedly influenced by precipitation patterns and hydroperiod length and by seasonality, respectively.

## **“PAULIS” PROJECT: A CHALLENGE FROM A NEGLECTED HABITAT**

**Bagella Simonetta<sup>1,2</sup>, Boix Dani<sup>2</sup>, Caria Maria Carmela<sup>1</sup>, Compte Jordi<sup>1,2</sup>, Gascón Stéphanie<sup>3</sup>, Filippino Giorgia<sup>4</sup>, Pisanu Stefania<sup>1</sup>, Pittao Elena<sup>1</sup>, Sala Jordi<sup>1,3</sup>, Cogoni Annalena<sup>4</sup>**

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The widespread of the toponym “Paule” and of other vernacular names such as “Piskina”, “Padule”, “Lakku” used in the Sardinian languages for designing temporary wetlands suggest a high number and a strong perception at local scale of these habitats in the past. In spite of this, the lack of information on their ecology, biodiversity, temporal dynamics and spatial distribution at regional scale, has made it difficult an adequate consideration in conservation programs. The opportunity of Nature 2000 network was not been adequately exploited because the habitats 3110, 3120 and 3170\*, to which Mediterranean Temporary Wetland could be referred, were rarely recognized inside SIC and protected areas, or left outside their boundaries. Moreover the available scientific literature was little and difficult to access.

“Paulis” project, funded in 2012 by the Region of Sardinia - Regional Law 7 August 2007, n. 7: 'Promotion of scientific research and technological innovation in Sardinia', was aimed to capturing the interest on these neglected habitats through the implementation of scientific and educational products.

The researches carried out by the team of the project have provided the following deliverables:

- scientific papers on: taxonomic and functional diversity of vascular plants, bryophytes and macroinvertebrates living in Sardinian Mediterranean Temporary Ponds; spatial and temporal variability of the habitat and the biotic communities; main drivers of biodiversity; seed and spore soil bank as reserve of biodiversity;
- map of habitat distribution at regional scale;
- data-base of vascular plants, bryophytes and macroinvertebrates;
- interactive guide to the flora [http://drvades.units.it/stagnisardi\\_en/](http://drvades.units.it/stagnisardi_en/);
- assessment of several species according to IUCN categories and criteria;
- priority lists for the conservation of sites and species.

The dissemination of the information and an increased awareness of public, environmental managers and policemen is being promoted through the presentation of communications and posters in congress and seminars, the participation to public events, the engagement of students, the creation of a website <http://paulisproject.jimdo.com/english/> and a facebook community <https://www.facebook.com/paulisproject?ref=hl>, the organization of a photo contest and of the present International Symposium on Mediterranean Temporary Ponds.

Will these actions effective for containing the threats on this habitat in Sardinia?

## **CONTRASTING INTRA-ANNUAL PATTERNS OF SIX BIOTIC GROUPS WITH DIFFERENT DISPERSAL MODE AND ABILITY IN MEDITERRANEAN TEMPORARY PONDS**

**Boix Dani<sup>1</sup>, Caria Maria Carmela<sup>2</sup>, Gascón Stéphanie<sup>1</sup>, Mariani Maria Antonietta<sup>3</sup>, Sala Jordi<sup>1</sup>, Ruhi Albert<sup>4</sup>, Compte Jordi<sup>1,2</sup>, Bagella Simonetta<sup>2</sup>**

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The temporal patterns of six biotic groups (amphibians, macroinvertebrates with active and passive dispersal mode, microcrustaceans, vascular plants and phytoplankton) and the responses of each biotic group to environmental variation (water, pond and landscape variables) were studied in a set of Sardinian temporary ponds. These biotic groups widely differed in dispersal ability and dispersal mode (active vs. passive). We predicted that both their temporal patterns and their underpinning environmental controls would be contingent on each group's dispersal capacity. Six temporary ponds were sampled three times: at the beginning (January), middle (March), and end (May) of the hydroperiod. For each biotic group, temporal variation in composition, species richness, among-pond similarities, and number of typifying taxa was evaluated. Moreover, a beta diversity partitioning procedure was used to obtain the relative contributions of the replacement and richness components to overall beta diversity. Finally, the effects of water, pond, and landscape variables on composition and taxa richness were analysed for each group. Different temporal patterns were observed among the studied biotic groups, and in some (but not all) cases these differences were explained by dispersal ability. Similarly, we observed that environmental controls were group-specific.

## **SEED GERMINATION, PLANT TRAITS AND DYNAMIC PROCESSES**

**Carta Angelino**

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Mediterranean temporary wetlands are a very specialized and threatened habitats found in Mediterranean-type climates worldwide. They are characterized by a considerable spatial and temporal hydrological variability supporting a rich flora and featuring different plant assemblages. Seed germination, dormancy and desiccation tolerance of species living in these vulnerable habitats are poorly investigated. Data are available for selected areas only and information about important species groups are lacking. The association of the germination-dormancy responses with the phenology in the wild should be investigated to gain further insights into the dynamic processes in the vegetation and to test for convergent evolution and niche-equivalent taxa.

Whilst germination and dormancy differ among the species, germination mostly depends on the light. The light acts as a surface sensing mechanism triggering germination in seeds located close to the soil surface and resulting in the persistence of buried seeds until disturbances occur. Species prefer cool temperatures to germinate, which it is associated with the main rainfall period in the Mediterranean basin. Increased germination following drying may be an adaptation to the temporary wetland environment and most seeds exhibit an orthodox storage behavior (tolerating drying to 15 % relative humidity) and may be amenable to seed banking as a means of ex-situ conservation. By also considering the temperature regimes (alternating vs. constant) three strategies of regeneration by seeds could be predicted: (1) species exhibiting weak dormancy degree germinating in an opportunistic way during the whole vegetative season (2) species possessing mild dormancy germinating in a narrow temperature niche and (3) species germinating after specific conditions possessing stronger dormancy or requiring flooding.

In conclusion, these species exhibit characteristics that are typical of neither truly aquatic nor wetland plants. The species show instead a plastic germination response based on both alternating and constant temperature sensitivity and on a weak proportion of dormant seeds which may allow seeds to exploit the temporally and spatially irregular occurrence of water.

## **TEMPORARY WETLANDS IN SOUTHERN AUSTRALIA: PREDICTING RESPONSES TO CLIMATE CHANGE**

**Casanova Michelle T.**

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Temporary wetlands are particularly abundant on the Victorian Volcanic Plains (VVP) and Wimmera bioregions of south-eastern Australia. In the past they have been highly diverse and provided habitat for rare and endangered species. They have declined in abundance since European habitation and are likely to decline in the future due to changed agricultural practices and a drying climate. For these reasons they have been listed as ‘critically endangered’ under the Australian conservation legislation. This study aimed to predict the consequences of climate change for these wetlands. Wetlands in two zones (VVP and Wimmera) were compared in relation to their water regime, species diversity and functional groups of plants (WPGs). It was found that the two zones had similar rainfall variability and seasonality, but the Wimmera wetlands experienced lower average rainfall than VVP wetlands. Using a simple threshold model it was found that Wimmera wetlands were inundated in c.4 years in 10, and VVP wetlands were inundated in c.6 years in 10 between 1900 and 2000. Climate change predictions suggest rainfall will decrease, so that VVP wetlands will fill less frequently, becoming more similar to Wimmera wetlands. Currently VVP and Wimmera wetlands have a different suite of species and WPGs. The results suggest that retention of functionality and diversity in VVP wetlands, as the climate dries, will depend on the invasion of plant species from Wimmera wetlands, which might require management intervention.

## **BRYOFLORA OF TEMPORARY PONDS IN THE MEDITERRANEAN BASIN – HINTS FOR MANAGEMENT AND CONSERVATION**

**Cogoni Annalena, Filippino Giorgia, Zoccheddu Monica, Marignani Michela**

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In the Mediterranean region temporary ponds are classified among the most biologically and biogeographically interesting ecosystems. Despite the important ecological functions of bryophytes in those fragile environments, they are neglected or undervalued in most management actions. We surveyed the bryoflora composition and distribution within 33 Mediterranean temporary ponds in Sardinia (Italy). The bryoflora is composed by 139 taxa, (119 Bryophyta, 19 Marchantiophyta and 1 Antocerothophyta), accounting for 28% of the total Island bryoflora. Among those, *Petalophyllum ralfsii*, *Cephaloziella calyculata* and *Fossombronia pusilla* are critically endangered and *Riccia huebeneriana* and *Hypnum revolutum* var. *revolutum*, are reported for the first time in Sardinia. Three belts were recognized in temporary ponds: a central belt, an intermediate belt, and an outer belt. Species showed a spatial pattern within the temporary ponds, from species Pottiaceae and Brachytheciaceae, with the life strategy colonist and perennial, to species Ricciaceae with life strategy annual shuttle. Species as *Scleropodium touretti* and *Tortella squarrosa* are significantly associated with the outer belt, however the *Riccia canaliculata* is significantly associated with the central belt, because it occurs in these belt only. Those information are useful to build up a scientifically sound knowledge useful for future effective conservation actions.

## **BRYOPHYTES AS MODEL ORGANISMS: METHODOLOGICAL CHALLENGES FOR BIODIVERSITY ASSESSMENT IN A CHANGING WORLD**

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Bryophytes, such as mosses, liverworts and hornworts, are highly diversified plants (second only to angiosperms), able to colonize a vast number of substrates and occurring in all terrestrial ecosystems. They have a successful and long evolutionary history, having endured several extinction periods, since their earlier records date back more than 400 million years. Although they are, individually, quite small, the ensemble of bryophytes is a crucial ecosystem component, retaining water, cycling nutrients, sequestering carbon, providing a buffer system for other plants, supplying habitats to invertebrates, and adding an additional layer of complexity and beauty to the systems where they occur. Having no vascular tissues – hence, no roots, no stems and no leaves, their gametophyte (the dominant generation) is directly exposed to the environment and this circumstance, combined with their ability to tolerate long periods of drought (poikilohydry), is the main rationale behind the use of bryophytes as indicators of long-term micro climatological changes. Notwithstanding, bryophytes remain one of the least included groups of organisms in ecological or conservation studies, although recently, following the publication of good floras, keys and guides, and the increasing awareness of their fast and differentiated responses to change, there has been a surge of projects using these indicator organisms (e.g. PAULIS, BRYOLAT, MOSSCLONE). It is reasonably asserted that global change will impact Earth differently, with more threatening effects on the most vulnerable areas, such as islands, humid zones, forests or mountains. Each one of these ecosystems is subject to a different group of stresses; however, they all need to be thoroughly investigated and model organisms, such as bryophytes, may contribute to the production of well-adjusted restoration and management plans, while their study increases the knowledge regarding the biology, physiology and ecology of species, either common or conservation concern. Project MOVECLIM (Montane vegetation as listening posts for climate change) intends to investigate spatial changes in diversity for bryophytes and ferns along altitudinal transects in four oceanic (La Palma, La Réunion, Pico, Terceira) and one continental island (Madagascar); it addresses issues such as diversity and rarity patterns across elevation gradients and islands, community structure at different spatial scales, and the relative contribution of different factors in shaping species richness distribution patterns. With this project we aim to contribute to the CBD (Convention on Biological Diversity) Aichi Biodiversity Targets, and to foster the understanding of community assemblages, scale effect and elevation shifts under a changing environment.

## THE PLANTS OF MEDITERRANEAN TEMPORARY POOLS: DO WE KNOW ENOUGH FOR THEIR CONSERVATION?

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Mediterranean wetlands combine high conservation value and intense pressure from human activities and climate change. Temporary pools, which are important habitats for biodiversity in the Mediterranean region, are particularly exposed to destruction following their small size and depth. They show high species richness including many rare and specialized species, as well as high beta and gamma diversity resulting from the range of environmental conditions they encompass. While they have recently received increasing attention, efforts in research must target key issues for their conservation. In this perspective and on the basis of a review of literature, we discuss what we know from the distribution and ecology of temporary pools in the Mediterranean region, the threats they are facing, the current gaps in research, and actions that would best contribute to their conservation and restoration.

Mediterranean temporary pools are well identified in the Western but poorly known in the Eastern Mediterranean. The main plant conservation issue concerns “Pool specialist” while the vegetation can also include “wetland generalists” and “opportunistic” species. Often stunted and with irregular appearance, the abundance and distribution of pool specialist species remains insufficiently known. The main selected traits for adapting to these environmental factors are a short life span (dominance of annuals), stunted growth forms, permanent seed/spore stocks, secondary dormancy of seeds/spores, flexibility in the life cycle, and plasticity of growth form. The traits related to the spores and seeds stocks are of paramount importance in the plant ecology. Pool specialist populations are resilient to a number of environmental pressures such as grazing or mechanical disturbance. In contrast, specialist species can be sensitive to many environmental factors which modify the hydrology and connectivity of pools.

The conservation of the vegetation of Mediterranean temporary pools requires a better understanding of the species dynamics within a given pool to adapt to ecological change. Long-term studies are needed to assess the impact of infrequent events and long-term processes. Little is known on plant dispersal and its importance in maintaining metapopulations and colonization of new sites. In this perspective, more research is needed at the regional level to understand the importance of the surrounding habitats on the ecology of the pool. Conservation strategies need to take into account the scattered distribution of temporary pools in the landscape, many of which are located on private lands and integrate their uses and the various stakeholders.

## **PHYLOGENETIC CLUSTERING AS A TOOL FOR LONG-TERM MONITORING OF PLANT COMMUNITIES IN ROCKPOOLS**

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The use of temporary freshwater rockpools as sentinel systems for climate change is favoured by the small size of these pools and the annual life-cycles of many of their plant species. This function is, in turn, dependent on the sensitivity of long-term monitoring programmes to floristic changes that may indicate directional shifts in community composition.

We hypothesise that phylogenetic clustering or dispersion of the macrophytes colonising pools and the humid ecotones around their margins may represent an effective method for detecting such shifts.

We carried out a preliminary assessment of the effectiveness of using phylogenetic patterns as a monitoring tool by analysing a series of species lists for a number of pools in the Maltese Islands. The Net Relatedness Index (NRI) and Nearest Taxon Index (NTI) were calculated for each pool using Phylocom software and compared across pools after taking morphometric heterogeneity into account. In general, deeper basins with long hydroperiods and restricted ecotones were characterised by lower values of NTI and higher NRI, both indicative of phylogenetic clustering, suggesting that abiotic filtering was the dominant process in structuring the macrophyte community. Conversely, shallower basins with shorter and more fragmented hydroperiods displayed higher NTI and lower NRI indicating competitive exclusion as a key community process in these zones. Collection of data from a large number of pools was used to construct a NTI-NRI continuum axis along which any given pool may 'migrate' in response to climatic warming. Monitoring of the mean positions of individual pools along this axis may be used to detect any directional changes in the relative significance of abiotic filtering and competitive exclusion in the structuring of communities. Such shifts may be caused by changes in hydroperiod duration and fragmentation which, in turn, would reflect climatic cycles.

Further tests of this method are planned, in order to indicate whether this approach provides a viable alternative to interannual comparisons of species lists as part of long-term monitoring programmes.

## MILLION PONDS PROJECT: SUCCESSES AND LESSONS LEARNED FROM MONITORING NEW PONDS

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Pond creation has now become a widespread conservation tool to protect and enhance freshwater biodiversity in the UK. New pond schemes are aimed either at improving biodiversity generally, or targeted at creating new populations of declining species. There is growing evidence of the benefits of clean water pond creation for the conservation of wetland species and habitats, but monitoring studies are still relatively scarce.

This presentation will provide an overview of current new pond monitoring activities in the UK, and a review of successes and lessons learned from phase I of the Million Ponds Project (2008-2012), which saw the creation of over 1,000 ponds in England and Wales. A range of monitoring case studies will be presented with a focus on the results of a 2014 baseline monitoring programme including c.60 new ponds created in three Important Areas for Ponds (IAPs) in Wales. These new ponds were created at sites protected by national or international legislation and known to supporting important freshwater species. The results showed that, only a few years after creation, half of the ponds had already attained Priority Status according to UK criteria based on species richness and rarity. The study reported new populations of declining species including *Pilularia globulifera*, *Oenanthe fistulosa*, *Baldellia ranunculoides* and *Bufo bufo*. Unsurprisingly, between ponds variation at site level was high, according to local differences in substrate and water source. Water quality was generally good, but there was some evidence that nutrient enrichment affected ponds at the margin of protected sites surrounded by intensive agriculture, and also those ponds fed by streams. This raises questions about the need to buffer protected sites to maintain their integrity in the long-term. This study and other monitoring work have also highlighted the importance of providing technical input to land managers so that ponds are suitably located, designed and managed for maximum benefit to biodiversity. Clearly, to improve species conservation work we need to gain a better understanding of dispersal processes.

With the emergence of the Freshwater Network initiative, a UK partnership project to identify, protect and enhance Important Freshwater Areas (IAF) and increase landscape scale connectivity, the need to collect and collate evidence on the benefits of practical measures to protect and restore the water environment is ever more needed. Pond creation is a relatively cheap and easy tool to create new high quality habitats, strengthen the population of plant and animal species struggling with habitat loss and degradation, and increase connectivity.

## QUICK AND EASY CONSERVATION STATUS ASSESSMENT: IS IT POSSIBLE IN MEDITERRANEAN TEMPORARY PONDS?

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LIFE+ Nature Project - Temporary Ponds Conservation in Southwest Coast of Portugal (LIFE Charcos) - is being developed in the coastal plain of southwest Portugal, classified under the European Natura 2000 Network as Site of Community Importance (SCI Costa Sudoeste). This area hosts a large number of Mediterranean temporary ponds. In the last two-decades, modern industrialized agriculture and tourism are causing a steep decline of this habitat. The objective of LIFE Charcos project is to support and promote the temporary ponds conservation status in SW Portugal. In this context, it is essential the transmission of scientific knowledge to technicians and stakeholders. This work has two aims: (i) to establish criteria for evaluating the conservation status of temporary ponds and (ii) to create an efficient evaluation tool for technical staff.

We classified 80 temporary ponds according to their conservation status taking into account plant species, number of vegetation belts, topography, threats and human activities with severe impacts. In each pond several biotic and abiotic factors, which could be used as a proxy of the pond conservation status, were surveyed. We found several indicators related to the conservation status of the ponds. But to create the abovementioned evaluation tool we selected only criteria that are easy to measure or assess by technicians without specialization in this habitat. Furthermore, not only must these indicators be scientifically significant but also easy to recognize in field in order to save time, money and human resources.

## DOES CONNECTIVITY MITIGATE THE EFFECTS OF DRYING ON COMMUNITIES? INSIGHTS FROM A CROSS-SYSTEM ANALYSIS

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Disturbance plays an important role in determining community composition and dynamics. High connectivity among habitat patches may increase colonization rates and thus increase community resilience to disturbance. Temporary waterbodies experience regular disturbance (i.e. drying) and exhibit varying levels of connectivity. Intermittent streams are often connected by flow to perennial refuges during wet periods, while temporary ponds are isolated in a matrix of terrestrial habitat. We tested whether the community responses to drying differ among lotic and lentic habitats by using ten published case studies of temporary and permanent water bodies from different climates. We investigated the effects of drying on invertebrate (i) taxonomic richness, (ii) beta diversity, and (iii) taxonomic relatedness. Because drying is a severe disturbance, we expected and found striking similarities across systems, with local taxonomic richness being lower in intermittent systems. However, we also found contrasts between systems. For example, the magnitude of drying effect on taxonomic richness was smaller for streams than for ponds, suggesting that flow events, and subsequent connectivity, may moderate the impacts of drying. In contrast, drying clustered stream communities, indicating that flow connectivity did not necessarily constrain their taxonomic relatedness. Overall, our results suggest that connectivity mitigates some community responses to disturbance.

## SEASONAL SUCCESSION OF CRUSTACEANS IN MEDITERRANEAN TEMPORARY PONDS: COMMUNITY AND POPULATION TRAITS

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Temporary ponds represent an extremely variable physical and chemical environment and they host a highly specialized fauna adapted to this unpredictable habitat. Studies based on frequent samplings in a single pond but covering different seasons showed a high temporal variation of species. We studied seasonal changes in crustacean population dynamics, species composition and diversity parameters in four Mediterranean ponds. These ponds, characterized by different hydroperiods, host different crustacean communities well adapted to the temporary environment. We found high crustacean community turnover; increasing hydroperiod length results into a better organization of the species over time and in consequence successional stages are more clearly distinguishable. Crustacean richness per site was related with hydroperiod and highest crustacean diversity was found in spring. We also observed differences in population dynamics. In the more turbid ponds with shorter hydroperiods, crustaceans are dominated by large size open water species showing a rapid population growth and highly variable number of eggs (3-73), whilst in vegetated ponds, with more stable conditions, crustaceans are dominated by small size macrophyte associated species with relatively constant population density and small brood size (usually 2 eggs). Finally, we compare the life history traits of crustacean populations and crustacean community structure in temporary pond with that of permanent ponds to straighten out the most important characteristics resulting from their adaptation to these variable environments.

## A COMPARISON OF CLADOCERA AND COPEPODA AS INDICATORS OF HYDROPERIOD LENGTH IN MEDITERRANEAN TEMPORARY PONDS

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Yearly variation in water availability patterns has a remarkable effect on the presence of aquatic species, particularly those dependent upon intermittent or seasonally inundated aquatic habitats.

Microcrustacean assemblages (Cladocera and Copepoda) from ponds and pools of residual Thyrrhenian woodlands in Latium (Castelporziano Presidential Estate, Foglino Nature 2000 site, and Lamone Natural Reserve) were analysed to evaluate their role as indicators of the hydroperiod length. The cladoceran and copepod fauna of these woodlands was intensively studied; rarefaction curves demonstrated that a percentage between 91 and 95% of total species richness was collected after three decades of researches. Samples from a subset of 38 well-studied water bodies classified into four main groups (permanent and semi-permanent ponds, and temporary long and short - i.e. less than three months - hydroperiod pools), were analysed.

As a whole, 41 microcrustacean species (25 cladocerans and 16 copepods) were present in the sampling sites. Correspondence analysis performed on the copepod species matrix clearly arranged the sites along a hydroperiod gradient (explained variance of the first two ordination axes 46%); the separation of the group barycentres along the gradient was statistically significant for all pairwise comparisons ( $p < 0.001$ ), and analysis of similarities confirmed the results. Conversely, the same analyses carried out on the cladoceran species matrix separated the temporary pools from the permanent and semi-permanent ponds ( $p < 0.01$ ), but failed to distinguish between the other hydroperiod groups. An indicator species analysis confirmed that copepods have a higher fidelity to the target site group, while most of cladoceran species have a low or very low indicator value. The cyclopoids *Macrocyclops albidus* and *Eucyclops serrulatus*, lacking resting stages, are exclusive of permanent waters; the calanoid *Eudiaptomus etruscus* is an indicator of permanent and semi-permanent ponds, while the cyclopoid *Diacyclops lubbocki* is exclusive of temporary pools. Within temporary water bodies, the calanoid *Diaptomus serbicus* is closely linked to long hydroperiod pools, while the cyclopoids *Cyclops ankyrae* and an undescribed species of the *Megacyclops viridis* complex are exclusive of short hydroperiod pools. Finally, the calanoids *Mixodiaptomus kupelwieseri* and *Hemidiaptomus gurneyi* characterize non-permanent ponds and pools, requiring at least a short desiccation period. The high ability of copepod species in sharply discriminating different wet phase duration of water bodies suggests they should be helpful indicators of hydroperiod variation due to climate as well as land use changes.

## HYDROLOGICAL AND VEGETATION CHANGES OVER A 25-YEAR PERIOD IN THE DOÑANA TEMPORARY PONDS (SW SPAIN)

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Long-term records are useful tools for assessing changes, particularly in fluctuating environments. The vegetation growing around the temporary dune ponds of the Doñana National Park (SW) is a fine example of plant composition and distribution driven by water availability. Furthermore, pond vegetation behaves as a dynamic system driven by the erratic yearly rainfall typical of the Mediterranean climate, but vegetation is also affected by other factors such as pond altitude, location and groundwater abstraction. In fact, the natural cycling dynamic of the Doñana pond vegetation has been recently altered, and set into a directional colonization of upland and woody species at the expense of flooding-dependent species. The colonization may further accelerate the decline of these ponds through a positive loop of terrestrialization dominated by flood-intolerant species. Therefore vegetation and hydrological changes have been monitored over 25 years (1<sup>st</sup> October 1989 to 30<sup>th</sup> September 2014) in three of these temporary ponds. The shallow water table and the duration of the pond wet phase (or hydroperiod) have been recorded at 1–8-week intervals, while plant cover and species composition have been monitored in May 1990, 2005 and 2014. The average rainfall for the study period was 560 mm, and included 9 wet, 8 moderate and 8 dry years according to a confidence limit at 95% significance. As expected, the water table generally oscillated following the seasonal alternation of rainy and dry seasons, but this fluctuation was so small at some ponds that they failed to hold surface water on many occasions, particularly in Charco del Toro pond located at < 1.0 km to the ground water pumping area of a nearby tourist resort. Since 1998-99, the average hydroperiod has shortened by more than 3 months in Charco del Toro pond (Mann-Whitney test,  $p < 0.05$ ), while no significant reduction has occurred in the other study ponds at 1.2-3.2 km away from the pumping area. Nevertheless, changes in plant species composition were already observed in all study ponds in May 2014. The total absence of the emergent macrophyte *Scirpus lacustris* in all ponds, particularly in those where its cover had rated at 25-40% in May 1990 and 20-42% in May 2005, indicates that the Doñana ponds continue to follow a trend towards terrestrialization. Given the general decline of the Doñana aquifer in recent years, it is very likely that the vegetation fluctuating dynamic of these ponds will soon be lost, and that these unique aquatic habitats will disappear.

## **PUBLIC PERCEPTION ABOUT PONDS AND THEIR BIODIVERSITY IN PORTUGAL. DO PRACTICAL ENVIRONMENTAL EDUCATION ACTIVITIES HELP CHANGE PUBLIC AWARENESS?**

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Ponds are biodiversity hotspots, valuable habitats and breeding sites for several fauna and aquatic flora. These small wetlands are threatened due to habitat degradation and its number is decreasing in all Mediterranean region.

Nonetheless, in Portugal the importance of ponds and their biodiversity is traditionally not recognized by society and public awareness campaigns are needed in order to invert this situation. The environmental education campaign “Charcos com Vida” (“Ponds With Life”) was developed with the purpose of raising awareness and to encourage the pedagogical exploration and conservation of ponds.

This study reports the first results about the public perception changes on ponds and their biodiversity in eight scholar groups that developed several “Charcos com Vida” activities during one year.

Positive changes in the students’ public perception were found for all biodiversity groups in particular for those that were previously more unpopular (amphibians, especially Urodela order, reptiles and macroinvertebrates). A significative improvement in the public attitude towards ponds was also identified in the study group.

In general this study supports that environmental education campaigns, especially through practical and outdoor activities, are highly important and effective tools to help change public awareness about ponds and its biodiversity.

## THE ROLE OF SPATIAL AND ENVIRONMENTAL FACTORS AS DETERMINANTS OF LARGE BRANCHIOPOD DISTRIBUTION IN TUNISIAN TEMPORARY PONDS

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The relative influence and combined effects of spatial and environmental factors in explaining variation in the composition and distribution of large brachiopod assemblages at different spatial scales is still poorly explored.

We analyzed the distributional patterns of 14 species found in 107 temporary ponds out of a set of 300 temporary water bodies sampled in winter and early spring in Tunisia and in its main islands (Kerkennah and Djerba). Species were identified on a morphological basis according to existing literature, complemented by sequencing a fragment of the 12S and 16S rDNA genes. Local physico-chemical and morphological data were measured in the field, while climatic data (annual actual evapotranspiration, maximum annual air temperature, and mean monthly precipitation as surrogates of productive energy, ambient energy, and water availability, respectively) were obtained from on-line databases. Spatial structures were described using distance-based Moran's Eigenvector Maps (dbMEMs); moreover, a Mantel's autocorrelogram of the species distribution similarity matrix was examined. The relationship between large brachiopod distribution and the measured environmental and spatial variables was examined using distance-based Redundancy Analysis (dbRDA). Variance partitioning was performed on partial dbRDAs to identify the relative importance of environmental and spatial explanatory variables.

The analysis clearly distinguished five different ecoregions and their characteristic species. The multivariate model explained around one half (48.4%) of total variation. The pure contribution of significant environmental factors (electrical conductivity, basin size, water turbidity, and macrophyte cover at a local scale, and the three climatic variables at a regional scale) was about 15%, while the pure contribution of the five significant dbMEMs (three large-scale and two local-scale factors) was 13%. Finally, the main contribution derived by the joint effects of spatial and environmental factors was 21%. The strong influence of spatial factors (explaining around one third of total variation, i.e. 34%) is related to the large ecoclimatic gradient from Mediterranean to inner steppic and desertic areas; turbidity, macrophyte cover and pond morphology finely tune species distribution, while the strong influence of salinity is independent from any spatial scale. Finally, Mantel's autocorrelogram demonstrated that species composition was spatially autocorrelated at distances shorter than 110 kms; this limit is determined by species dispersal ability in the area. These results suggest that both dispersal limitation and species response to spatially structured environmental gradients and a small set of local limiting factors are involved in determining large brachiopod distribution in Tunisia.

## **CHARA BALTICA BRUZELIUS (CHARACEAE) RECORDED IN SARDINIA**

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In 2014, *Chara baltica* Bruzelius was recorded at the Northern coast of Sardinia. This is the first record of this species for Sardinia and Italy (Bazzichelli & Abdelahad 2009). *Chara baltica* was found in an oligohalin costal lagoon. Associated species were *Potamogeton coloratus*, *Potamogeton pectinatus*, *Najas marina* ssp. *intermedia*, *Chara globularis* and *Nitella hyalina*.

*Chara baltica* and *Chara intermedia* form a cluster of a physiological, morphological and genetic continuum (Boegle et al. 2010). Notes on the determination and taxonomy of *Chara baltica* with respect to the Mediterranean form of *Chara baltica* are presented.

Bazzichelli, G., Abdelahad, N. 2009: Alghe d'acqua dolce d'Italia: Flora analitica delle Caroficee: 73 pp., Rome

Boegle, M. G., Schneider, S. C., Schubert, H., Melzer, A. 2010: *Chara baltica* Bruzelius 1824 and *Chara intermedia* A. Braun 1859 – Distinct species or habitat modifications? Aquatic Botany 93: 195-201

## THE ROLE OF THE CENTERS FOR ENVIRONMENTAL EDUCATION AND SUSTAINABILITY IN THE PROTECTION OF THE MEDITERRANEAN TEMPORARY PONDS

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The Centers for Environmental Education and Sustainability (C.E.A.S.) are recognized regionally, nationally and internationally as local points for the promotion of short and long-term projects and individual initiatives. The aim is to raise awareness on environmental and cultural sustainability issues, starting from the territories in which they operate and towards a large scale.

Environmental and biodiversity protection are among the main objectives for the activity of the C.E.A.S. and the protection of the Mediterranean temporary ponds is the goal of the project “*And yet it moves*” – *Life, Evolution and Management of a Temporary Wetland*” promoted in cooperation by two C.E.A.S. of central Sardinia, operating respectively in “Guilcier – Barigadu” and “Marghine”.

The project, funded by the Region of Sardinia through a public competition and inserted in the project ZOUMATE (“*Zone Umide: Ambiente, Tutela, Educazione*” – *Programma Transfrontaliero Italia – Francia Marittimo 2007-2013*), has been addressed in a special way to primary schools of first and second grade, in six municipalities belonging to two Sites of Community Interest in which the Habitat 3170\* “Mediterranean temporary ponds” is well represented: “*Media Valle del Tirso – Altopiano di Abbasanta - Rio Siddo*” (ITB031104) and “*Altopiano di Campeda*” (ITB021101). It allowed 90 students belonging to the Municipality of Sedilo, Ghilarza, Paulilatino, Macomer, Sindia and Bortigali to conduct for the first time a specific field educational activities on flora, fauna, threats and sustainable management of temporary ponds. These activities were carried out by experts of the CEAS, environmental educators, supported by educational experts, biologists, and faunists by the Forestry and Environmental Surveillance.

A specific action of the project, led by the operators of the two C.E.A.S. and finalized to discover the temporary ponds that characterize the Abbasanta and the Campeda Plateau, has also been addressed to the adult population.,

The project also produced, in cooperation with the schools, informational materials intended to inform the population and the tourists on the peculiarities and fragility of Mediterranean temporary ponds.

The C.E.A.S. can therefore effectively contribute to raise awareness on the relevance of the Habitat 3170\* and to promote a conscious and sustainable naturalistic tourism in the areas of the *Natura 2000* network.

## ECOLOGY AND CONSERVATION OF THE FAUNA OF MEDITERRANEAN TEMPORARY PONDS

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Certain plants of Mediterranean temporary ponds are considered to be ‘jewels of the Mediterranean flora’ (Braun-Blanquet, 1936). However, this could just as well be said for their fauna. Many amphibians and invertebrates have developed a high affinity for Mediterranean temporary ponds, because of the absence of fish associated with their periodic drying. Due to the specific hydrological functioning of these habitats and the adaptations required to survive unpredictable drying, Mediterranean temporary ponds house many specialized, unique and endemic species that contribute to regional aquatic biodiversity. Unfortunately, due to their small dimensions, Mediterranean temporary ponds are easily destroyed and vulnerable to degradation due to land use changes. Identifying the key factors that determine species distributions and drive community structure is very important in order to effectively conserve these unique habitats. Using datasets of ponds in the North (Camargue, Southern France) and South (Benslimane, Western Morocco) of the Mediterranean basin, we will review key abiotic and biotic factors that shape the faunal communities of Mediterranean temporary ponds. We will, for example, discuss the role of hydroperiod and salinity as key abiotic factors. Additionally, we will focus on the role of tadpole shrimp acting as keystone predators and ecosystem engineers in these habitats. Also, we will discuss dispersal and colonization dynamics of typical Mediterranean temporary pond species. Finally, we will show how anthropogenic activities can disturb natural community dynamics and how pond destruction and degradation can affect the diversity and distribution of flagship species in a very short period of time, when no conservation actions are undertaken.

## **POSTER PRESENTATIONS**

## BUTTERFLY SPECIES RICHNESS, ABUNDANCE AND DIVERSITY IN MEDITERRANEAN TEMPORARY POND NETWORK IN APULIA, SOUTH ITALY

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Diversity of butterfly communities was studied in different habitats within the Regional Nature Reserve of "Laghi di Conversano and Gravina di Monsignore" in Conversano (Bari), Apulia, South Italy. The Nature Reserve protects a 347,80 ha priority freshwater habitat type (3170\*, NATURA 2000) area and preserves a set of ten karst ponds (dolines) located in a fragmented agricultural matrix. This study was part of "On the wings of knowledge (Sulle ali della Conoscenza)" programme, a citizen science project for public participation in environmental research. Butterflies were surveyed from April to September 2014 in 2 different Nature Reserve sites (4 transects), selected to be representative of the predominant vegetation structures: wetland, grassland and shrubland.

The Pollard & Yates walk method was followed for observing butterflies. 1202 specimens belonging to 28 species, 25 genera and 5 families were recorded in total in the study sites. Pieridae was the most abundant family (67.1 %) followed by Nymphalidae (15.3 %), Lycaenidae (10.2 %) Papilionidae (4.5 %) and Hesperiiidae (2.8 %). A preliminary checklist was compiled in which *Zerynthia cassandra* (Geyer, 1828) is of particular interest as it is included in the EC Habitats Directive 92/43 and two species, *Thymelicus acteon* (Rottemburg, 1775) and *Hipparchia fagi* (Scopoli, 1763), are listed as NT (near threatened) in IUCN European Red List of Butterflies.

Subsequently, the butterfly communities' diversity was analysed in different vegetation structure using the following biodiversity indices: Shannon-Wiener's, Simpson's and Species evenness. In temporary ponds was found a significantly lower species richness and abundance of butterflies than in peripheral areas. Shrubland has the greatest individual number and contains the greatest species number, while the Wetland shows the lower species richness ( $n = 15$ ) and the poorest butterfly diversity Shannon ( $H' = 1.94$ ), Simpson ( $D = 0.21$ ) and Evenness ( $J = 0.71$ ) indices. Butterfly species richness was highest in shrubland whereas Shannon ( $H' = 2.44$ ), Simpson ( $D = 0.11$ ) and Evenness ( $J = 0.77$ ) were also the most relevant indices.

An assessment of the abundance and diversity of butterfly species in Nature Reserve can therefore indicate the role of different habitats in biodiversity conservation, and is also useful as a good indication of the health of the environment in and around Mediterranean temporary ponds. All these results suggest that a larger network between ponds (e.g. with corridors or stepping stones) provides a long-term persistence of the whole butterfly communities.

## **RELATIONSHIP BETWEEN PIGMENT COMPOSITION AND IDENTIFICATION OF PHYTOPLANKTON IN DIFFERENT MEDITERRANEAN SYSTEMS: COASTAL LAGOONS AND FRESHWATER TEMPORARY PONDS**

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Photosynthetic pigments and chemotaxonomic association has been used in the study of the phytoplankton composition and their physiological status. The taxonomic classification based on the specificity of photosynthetic pigments analyzed by high-performance liquid chromatography (HPLC), is an alternative to microscopy techniques that allows the quickly analysis of hundreds of samples and also the inclusion of smaller organisms such as picoplankton that cannot be identified by microscopy. Coastal lagoons and freshwater temporary ponds differ in nutrient availability and environmental variables that are important factors determining planktonic community's composition. The frequency of flooding, the water entries' origin and the nutrient concentration can produce very different situations, which in turn affect the functional and taxonomical composition of the microbial community. The main objective of this study is to analyse the relationship between environmental factors and the composition of pigments and to determine the variation of the phytoplankton community in two different Mediterranean systems, by means of a redundancy detrended analysis. Our preliminary results show differences in environmental key factors driving the phytoplankton communities in the two types of ecosystems.

## THE VASCULAR FLORA OF MEDITERRANEAN TEMPORARY WETLANDS IN WIKIPLANTBASE #SARDEGNA

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Mediterranean temporary wetlands are considered among the most biologically and biogeographically interesting ecosystems in the Mediterranean region (Médail, 2004) so much to be defined “a floristic jewel” (Braun-Blanquet 1936).

Although a check list of vascular flora associated to these habitats is available (Bagella & Caria, 2012) for Sardinia, the information on species distribution is fragmented. Moreover many species are under-recorded because they are inconspicuous, exhibit a very short life cycle and are absent during unfavorable years, giving the impression that they have disappeared, whereas in fact they are still present in the soil seed-bank.

Floristic records provide baseline data for ecological and biogeographical researches and are necessary for the assessment of conservation status of the species. Any attempt of data update must take into account the acquisition of a vast, heterogeneous, and “dormant” documentation, both published and unpublished, as well as any future exclusion / inclusion of taxa. To this end, floristic records on Mediterranean temporary wetlands have been inserted in the collaborative online database "[Wikiplantbase #Sardegna](#)". This tool presents the following characteristics, shared with the sister project [Wikiplantbase #Toscana](#): a basic floristic record is a combination of a plant name, a locality, a date, and a source. Data are entered on an online platform by registered collaborators, accessing the platform across the Internet; data homogeneity and integrity is enforced by the platform software rather than data entry operators; all data are validated by a project coordinator; all validated data are freely accessible across Internet and displayed on a map as georeferenced points with associated data, in a dedicated interface (no registration is required for querying and viewing the database). Taxonomic integrity was implemented by linking the database to a working copy of the Italian checklist of vascular plants; furthermore, the database was linked to a database comprising of toponyms along with administrative boundaries and geographic coordinates (Bedini et al., 2014).

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## **MAKING IT EASIER THE IDENTIFICATION OF VASCULAR PLANTS IN MEDITERRANEAN TEMPORARY PONDS: THE ONLINE INTERACTIVE GUIDE**

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Despite their relevance for conservation, Mediterranean temporary ponds are poorly known and their importance is not appreciated, which makes them vulnerable to unintentional destruction. The need for stimulating protection measures through the improvement of public perception is thus urgent. This neglected habitat, however, is ideal for engaging public in practical actions, which could be strongly encouraged with the support of interactive identification guides.

The aims of our research were: i) to implement a checklist of vascular plants, and ii) to create an interactive guide for the identification of plants growing in the Mediterranean temporary ponds of Sardinia.

Data collected in about 60 ponds were integrated with published plant inventories and the revision of herbarium material.

The online interactive guide, created with program FRIDA (FRiendly IDentificAtion), consists of two query interfaces: a multi-entry query permitting to specify several easily observable characters is followed by a richly illustrated dichotomous key to the species sharing those characters. Experts can also use the first interface to create keys to all species of a given taxon. The key is also available as a stand-alone application for Apple and Android mobile devices. The system is open to new findings and can be extended to other areas.

## LINKING WATER STOCK IN MEDITERRANEAN TEMPORARY PONDS WITH HYDROLOGICAL BALANCE AT LANDSCAPE SCALE

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Water stock in Mediterranean Temporary ponds results from the hydrological balance between direct or indirect rainwater supply (inflow) and losses in the atmosphere, overflow, infiltration (outflow). Losses into the atmosphere are due either to evapotranspiration, which includes evaporation from open water, soil and canopy dampened by the rain and plant transpiration.

The high variability in seasonal and inter-annual rainfall, typical of Mediterranean climate, makes water dynamic in Mediterranean temporary ponds unpredictable. On the other side flooding duration, dates of flooding and drying out, size of the inundated area and water depth characterize the different habitats which occupy the same space throughout the time offering place to organisms with contrasting water requirements, i.e. aquatic, amphibious and terrestrial, duration of their life cycle, their phenology and the success in reproductive processes.

Long-term monitoring of water stock in the ponds and its relationships with the hydrological balance could provide a sound information for better understanding species distribution models and phenology, for the management of the habitat and also to evaluate the effects of climate changes under different scenarios. The lack of this information is due to the need of long time-series of data and to the high cost of both hydrometric equipment and hydrological/hydrogeological studies.

Our research was aimed to relate the hydrological balance evaluated at landscape scale with the presence and size of over 100 ponds using historical series of meteorological data and satellite images freely available online. The study area is located in Sardinia, on a 44 km<sup>2</sup> basaltic plateau, 550 m a.s.l, named Giara di Gesturi.

Daily hydrological balance was assessed considering rainfall and potential evapotranspiration calculated using Hargreaves equation on a data set from the nearest meteorological station. Water stock was evaluated considering as proxies both the presence/absence and size of ponds, which have been visually interpreted and delineated by computer-aided visual interpretation on 89 Landsat images acquired between 1984 and 2014. Relationships between hydrological balance and water stock were tested using the Pearson correlation coefficient considering different overflow values.

The results show a high significant correlation between the hydrological balance and the proxy of water stock.

## ASSESSING NICHE BREADTH OF VASCULAR PLANTS IN MEDITERRANEAN TEMPORARY WETLANDS

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The high interest in Mediterranean temporary wetlands, which are habitats of Community Interest (3120, 3130 and 3170\*) in the Habitat Directive 92/43/EEC, is mainly for their characteristic flora or fauna which includes several rare or endangered species.

Although the attention on the ecology and biodiversity of these habitats is continuously increasing, the majority of the available studies are based on a qualitative approach or separate statistical analyses of physical, chemical and biodiversity data while little information is available on the relation between plants and environmental features (e.g. Bagella et al., 2010).

The aim of this research was to relate a set of plant considered as “indicator” species in Mediterranean temporary wetlands with some relevant environmental factors.

The analysis were performed on 21 species from 42 temporary wetlands located in Sardinia and Apulia (Italy) using a data set describing the main features of the water and the soil. The ecological responses of each plant species in relation to each environmental factor were elaborated using the fuzzy set theory's approach (Zadeh, 1965). According to this method, the species are described as fuzzy sets, which present a specific degree of belonging to the whole range of an ecological factor. This analysis defines the optimum ecological value and the compatibility range of each species in relation to the variability of environmental factors (Andreucci et al., 2000, Biondi et al., 2004, Ceschin et al., 2012).

Based on the results achieved, we defined the autoecology of the indicator species and discussed the possible applications of our results for the management and conservation of Mediterranean temporary wetlands.

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## SEASONAL AQUATIC HABITATS IN THE TORRE GUACETO STATE NATURE RESERVE (APULIA, ITALY). TYPES, BIOLOGICAL CHARACTERISTICS AND MANAGEMENT

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The Torre Guaceto State Natural Reserve extends across 1110 ha of Italian coastal landscape on the Southern Adriatic, including fields, partly made of ancient olive groves, scrublands and a wetland. This latter is 108 ha wide, formed for 85% of its extension by reeds with *Phragmites australis*, and for the remaining part by different types of habitat whose ecological characteristics vary mainly according to the soil texture, salinity and hydroperiod. Seasonal aquatic habitats include the following types: a) Rock pools, flooded with fresh water, attributable to habitat type 3170\* of the Directive 92/43/EEC, with several rare plant species (e.g. *Isoetes iapygia* and *Solenopsis laurentia*); b) Waterlogged soils, rarely flooded and little salty, also attributable to habitat type 3170\*; c) Sandy soils with higher salt content, colonized by rushes and meadows with *Plantago crassifolia*, attributable to habitat type 1410; d) Sandy and muddy soils with high salinity, colonized by communities mostly of annuals and grasses, attributable to habitat type 1310; e) And finally, seasonally flooded soils, little salty and not rocky, in contact with permanent water bodies, usually subject to mowing and plowing, that host communities related to habitat type 6420, and represent trophic areas for many bird species of Directive. The ecological importance and distribution within the Reserve of all these types of habitats have been recognized only recently. They are mostly localized in the interface between the wetland and farmland and are among those most negatively affected by historical processes of landscape transformation. They are also among those particularly vulnerable to the current human pressure, because of their proximity to the fields. The present contribution discusses ecological aspects of such habitats, their historical transformation and their biological peculiarities, with reference to the vascular flora, vertebrates, dragonflies and ants. It also presents the measures that the management organization has started in the last period to address the specific problems of conservation and the results of actions for ecological restoration.

## THE AZOREAN BIODIVERSITY PORTAL AS AN EXEMPLAR E-INFRASTRUCTURE FOR SMALL ISLANDS AND OUTERMOST REGIONS OF EUROPE

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The Azorean Biodiversity Portal (ABP) is an e-infrastructure based in Azores Islands and now associated with Portuguese POBIOTA -LIFE-WATCH Europe and GBIF -Portugal. The ABP is a key e-infrastructure for the integrated management of biodiversity data of the Azores, providing a large number of specialized services supporting research, policy and education. This was the first Biodiversity Portal in Portugal, starting in 2008, and the only one which provides easy access to island biodiversity data. ABP is currently recognized as a valuable outreach, management and conservation tool for all those who work in science and protection of biodiversity. The 3000 visits per day, the numerous international scientific collaborations, resulting in publications and academic theses, and the connection with other prestigious databases demonstrate the Portal's scientific quality as well as its wide appeal.

The great investment made to halt biodiversity loss has still to fulfill its expectations as species abundance and distribution continue to decrease, deferring many of the 2010 Biodiversity targets to the EU Biodiversity strategy to 2020. Nevertheless, there is a wealth of biodiversity information, which is ever increasing, and managing all these data is a daunting task. Using a more collaborative framework and powerful information technologies will enhance the efficacy of conservation measurements. The main ABP action lines for the period 2015-2020 are: a) improve the informatics system of the e-infrastructure to allow complex queries and improve user-friendliness; b) guarantee a rigorous classification for every species, providing updated comprehensive checklists, ensuring accuracy on the compilation of biogeographical information; this is the backbone of the Portal and all its products and services; c) provide innovative biodiversity analytical tools for both researchers and community members and invite them to contribute data to the Portal, establishing effective science communication

Data collated by this project are relevant in contributing to the EU BEST Indicator Essential Biodiversity Variables for Islands and for the new IPBE platform. Moreover, we will contribute to Strategic Goal C of the Aichi Biodiversity Targets for 2020 as defined in the CBD 2011-2020 Strategic Plan (see [www.cbd.int](http://www.cbd.int)). Finally, we expect this project to provide strong baseline information regarding the processes structuring diversity on these outermost regions of Europe.

## **RESILIENCE OF MACROINVERTEBRATE ASSEMBLAGES OF MEDITERRANEAN TEMPORARY PONDS AGAINST WILDFIRE IMPACT: THE “METACOMMUNITY RESCUE EFFECT”**

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Wildfires are common disturbances on Mediterranean areas, where native fauna and flora have evolved to survive them. These disturbances are likely to become more frequent in Mediterranean region due to an increase of drought periods and temperatures with climate change. Studies aiming at characterize system response to wildfires will be needed to enhance future management strategies under new climatic conditions. Although wildfire effects on terrestrial ecosystems have been widely studied, more research is needed to understand how these impacts can affect Mediterranean temporary ponds fauna (priority habitats following European Directive). In order to achieve a better understanding on wildfire effects on aquatic fauna of temporary ponds, we analysed macroinvertebrates response to wildfire in six Mediterranean temporary ponds in the NE of Iberian Peninsula, where a wildfire burned 10,476 Ha in July 2012. The burned area included the Albera site, where more than thirty well preserved temporary ponds are known. Near all the ponds were dried during the wildfire, but not all of them were affected similarly: some burned completely and some of them did not burn. Macroinvertebrates were sampled before the wildfire and during the following hydroperiod in order to detect changes in macroinvertebrate assemblages. A change on dynamics and succession patterns were expected due, in essence, to habitat loss (i.e. destruction of aquatic vegetation) and also to algal blooms (i.e. change on availability of resource types). However, our results showed that macroinvertebrate assemblages were not clearly affected by wildfire impacts. Dispersion between unburned and burned ponds increased macroinvertebrate assemblage's resistance to this type of perturbation. We suggest that the lack of significant changes may be ascribed to the fact that unburned ponds acted efficiently as sources of individuals for the burned ones during the subsequent hydroperiod, thus generating a “metacommunity rescue effect” that buffered the hypothesized effects of wildfire.

## AQUATIC FAUNAL BIODIVERSITY OF MEDITERRANEAN TEMPORARY PONDS IN SARDINIA

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Invertebrate and amphibian biodiversity of Mediterranean temporary ponds has been studied in the island of Sardinia (Italy). Thirty-six temporary ponds have been sampled between 2007 and 2014. All the ponds were small (less than 8 ha), shallow (less than 2 m depth) and presented low human impacts (the main disturbance was the presence of livestock). The specimens collected have been identified to species level whenever possible. The microcrustacean and chironomid fauna was identified from a subset of 17 ponds.

Overall, 225 taxa were identified, of which 55 were referred to Diptera (24%), 52 to Coleoptera (23%), 29 to Cladocera (13%) and 18 to Ostracoda (8%). Moreover, some Turbellaria, Oligochaeta, Hirudinea, Gastropoda, Anostraca, Copepoda, Hydracarina, Ephemeroptera, Odonata, and Trichoptera taxa were identified. Finally, three species of amphibians were also found. It is interesting to note the presence the ostracod *Paralimnocythere* cf. *messanai*, first record in Sardinia; the corixid *Cymatia rogenhoferi*, third record in Italy; and the cladoceran *Leydigia korovchinskyi*, first record in Italy.

Four types of ponds were identified by a MDS using macroinvertebrate and amphibian characteristic species. The presence of *Lestes barbarus*, *Notonecta meridionalis*, *Bidessus goudoti* and water mites (*Arrenurus* sp., *Eylais* sp. and *Hydrachna* sp.) determined a type of pond with high total taxonomic distinctness ( $S\Delta^+$ ). On the other hand, ponds with the presence of *Limnephilus vittatus*, *Lestes barbarus* and water mites had high Shanon-Wiener diversity ( $H'$ ), taxonomic distinctness ( $\Delta^*$ ) and average taxonomic distinctness ( $\Delta^+$ ). *Hydroporus pubescens* and *Hydroporus tessellatus* characterized ponds with low  $H'$ , evenness and  $\Delta^+$ , but high total abundance. Finally, two ponds with low taxa richness, total abundance and  $S\Delta^+$  did not have characteristic species.

## **INTRA AND INTER-ANNUAL VARIATION OF FUNCTIONAL STRUCTURE OF MACROINVERTEBRATE ASSEMBLAGES IN MEDITERRANEAN TEMPORARY PONDS**

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Temporal variation of the functional structure of macroinvertebrate assemblages in Mediterranean temporary ponds has been studied in Sardinia (Italy). Sixteen small and shallow ponds (less than 2 ha and less than 2 m deep) subject to low human pressure were sampled in different periods. To study the intra-annual variation, one sampling in each hydroperiod phase were performed during 2007: at the beginning (January), middle (March), and end (May) of the ponds' hydroperiod. Moreover, in order to study the possible inter-annual variation, samples from May 2007 and May 2013 were compared.

Macroinvertebrate taxa were assigned to nine functional groups (traits) according biological characteristics: maximal size, life cycle duration, number of reproduction cycles per year, dispersal abilities, resistance forms, type of food, feeding mechanisms, temperature range, and locomotion mechanisms and relation of the organisms to the substrate. ANOSIM analyses were performed in order to check if functional structure differed along the hydroperiod (intra-annual variation) and between hydroperiods (inter-annual variation). The preliminary results showed a significant intra-annual variation (i.e., among hydroperiod phases) of the functional structure. Similarly, significant differences in functional structure were observed between the two sampled years suggesting that the functional structure did not have the same pattern each year.

## HYDRODYNAMIC NUMERICAL MODELING OF THE GROUNDWATER DECLINE IN THE DOÑANA TEMPORARY PONDS (SW SPAIN)

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Although the Doñana National Park is given the highest degree of environmental protection in Spain, several ponds have been damaged due to groundwater abstraction in a nearby tourist village. In 1992, an International Expert Commission issued a call for the sustainable use of water resources in the area, including moving away the groundwater pumping area further to the west. Since then, a golf course opened in 2000 under the false pretence of using treated waste-water for watering the grass. A legal investigation into the unlawful transfer of this golf business to the local municipality is being conducted since 2012, thus revealing the magnitude of the scam. An aeolian sand mantle, composed of several dune generations originally deposited by the marine drift during the Holocene, holds an unconfined aquifer with several flow systems, with a depth of about 90 m in the study area. Thousands of temporary ponds can appear amid depressions when the water-table rises above the topographic surface during very wet years, but only a few of them can hold water for several months or years. Changes in the water-table depth have been monitored over 25 years in three of these temporary ponds (Las Verdes, Zahillo and Charco del Toro) located along the border between the stable and the mobile dunes, and at decreasing distance to the tourist village pumping area (4.5, 1.3 and 0.8 km, respectively). The numerical model MIKE SHE was set up to simulate pond water level fluctuations. It was calibrated and validated (split-sample test) on a daily basis to assess whether the duration of the pond wet phase (hydroperiod) significantly deviated from an expected pattern driven by rainfall and evapotranspiration. The model was calibrated for the period of nine hydrological years (October 1989-September 1998). In order to reduce uncertainty, the model was validated for the periods October 1998-September 2006 and October 2006-September 2014 (two split-sample tests of eight years each), and it was tested against statistical criteria such as the Nash-Sutcliffe coefficient for efficiency (NSE). The ponds of Las Verdes and Zahillo were calibrated and validated to a good extent with a NSE coefficient of over 80% for the calibration period and >64% for the validation periods, and their average yearly hydroperiod for the 25-year period was 296 and 190 days, respectively. On the contrary the validation for the Charco del Toro pond was not satisfactory/acceptable, suggesting that groundwater abstraction was likely damaging this pond.

## BIOGEOGRAPHIC DISTRIBUTION OF BRYOFLORA IN THE MEDITERRANEAN TEMPORARY PONDS

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In Europe, Mediterranean temporary ponds are indicated as priority natural habitats under the Habitats Directive 92/43/EEC: despite in those habitats bryophytes are recognized to have an important ecological function, there are very few studies on the chorological and ecological characteristics driving bryophytes diversity and on the biogeographical factors influencing species' variability. We compared the bryoflora composition of temporary ponds in Sardinia (Italy) with the available bibliographical data on temporary ponds in the Mediterranean (Spain, France and main Mediterranean islands such as Balearic Islands, Corsica, Sicily) to define their characteristic floristic composition. A total of 212 bryophyte species, which included 166 Bryophyta, 44 Marchantiophyta and 2 Antocerotophyta are reported. Among these species, those most typically connected with such habitats are: *Archidium alternifolium*, *Bryum dichotomum*, *Imbrybryum alpinum*, *Fossombronia caespitiformis*, *Ptychostomum capillare*, *Ptychostomum pseudotriquetrum*, *Riccia beyrichiana*, *Tortella squarrosa* and *Trichostomum brachydontium*. In particular, *Archidium alterifolium* and *Bryum dichotomum* are the most common species found in Mediterranean temporary ponds, being surveyed in more than 83% of the investigated ponds. The strictly hydrophytic taxa are: *Drepanocladus aduncus*, *Leptodictyum riparium*, *Riccia fluitans* and *Riella helicophylla*. The genus *Riccia* is common in these habitat. In a distinctly Mediterranean climatic context the presence of a large number of Pottiaceae is predictable: they are characterized by species with a short lifecycle, making them more competitive in areas with a Mediterranean climate. Several species of conservation concern are present (7 species) highlighting the conservation importance of this habitat, e.g. *Petalophyllum ralfsii* in Sardinia. Due to the fragility of the habitat and its unique ecology, *P. ralfsii* is potentially threatened by a number of factors including pressure from tourism, removal, or drying of the thallus due to the reduction of water level or reforestation.

## THE MAN AND THE MEDITERRANEAN TEMPORARY PONDS IN MENORCA: CHARACTERIZATION OF HISTORICAL MODIFICATIONS

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A common trait on some of the most important Mediterranean temporary ponds of Menorca is their strong relationship with some traditional anthropic practices, mainly for their use as a natural source of freshwater for the cattle. Within the LIFE BASSES project (2005-2009; [www.cime.es/lifebasses](http://www.cime.es/lifebasses)) this evidence was an important argument for the use of some traditional techniques (i.e. dry stone walls) for a long-term conservation of the ponds and also to give back them again a usefulness within farms.

However, in the frame of the project a complete assessment or characterization of the anthropic constructions or modifications associated to the ponds and how they could have changed their original configuration was not realised.

Based on the information collected and generated along the project, an inventory and characterization of anthropic constructions and structures related to some of the most important temporary ponds (i.e. Torrellafuda, Corniola, Bassa Verda d'Algiarens, Es Mal Lloc, Son quart, Son Catlar, Cocons de Binicodrell, Clot des Guix) have been made.

Results show that different methodologies and techniques have been used to adapt the pond to the requirements of farm activities. In some cases modifications could have changed the original aspect of the pond through the realisation of structures to favour drainage (i.e. Corniola), or to regulate the inundation level by the construction of a subterranean system of channels to connect the ponds to a chasm (i.e. Corniola). In other ponds, human actuations have worked in opposite way by rising inundation level through construction of dams (i.e. Bassa Verda d'Algaiarens) or modification of surface hydrological network (i. e. Clot des Guix). Other localities show a reverse situation: ponds originated from constructions o structures destined to very different uses (e.g. burial sites, water filtering systems).

All these cases confirm the importance of the man in the management and conservation of the temporary ponds of Menorca, and also explain the negative evolution of the habitat in the last years, when many traditional techniques of land management have been abandoned.

## PTERIDOPHYTES IN THE MEDITERRANEAN TEMPORARY PONDS OF MENORCA. DISTRIBUTION, CONSERVATION STATUS AND MORPHOLOGICAL OBSERVATIONS

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An important issue for the conservation of the Mediterranean temporary ponds is the presence of a singular biodiversity. Within the vascular flora are terrestrial and aquatic pteridophytes that give a special importance to this habitat. In the ponds of Menorca five pteridophytes are found: *Isoetes durieui* Bory, *I. histrix* Bory, *I. longissima* Bory s.l., *Marsileta strigosa* Willd. and *Pilularia minuta* Durieu ex A. Braun. Two LIFE Nature projects (LIFE FLORA. <http://lifeflora.cime.es>; LIFE BASSES. [www.cime.es/lifebasses](http://www.cime.es/lifebasses)) have worked on the conservation of most of these species and provided much information about their distribution and conservation status.

After the finalisation of the LIFE BASSES project fields works to improve the knowledge about pteridophytes in the temporary ponds of Menorca continued and expanded the distribution area some species, mainly *Isoetes*. Here is presented and updated overview of their distribution, conservation status and some comments on the morphological traits of *I. longissima* Broy s.l. populations.

## BOTANICAL TREASURES IN SOUTHERN PORTUGAL TEMPORARY PONDS

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Mediterranean Temporary Ponds in south of Portugal host a high biodiversity compared to other freshwater ecosystems in the same area. This richness is related to their spatio-temporal ecological gradient. We conducted a field survey in 120 temporary ponds, as part of an effort to sample and systematize the value of this habitat for conservation. In all of them we surveyed flora and gathered information about human pressures.

The floristic diversity per pond ranges from 10 to 64 species. Low values of richness are related to pond subjected to pressures like intensive agriculture, heavy grazing or drainage. Even though, in this human influenced landscape, we found well preserved ponds that are refuges for a large number of plant species with high conservation value. The conservation value was assessed in terms of endemism degree, rarity at different geographical scales, protection status according to Habitats Directive and IUCN Red List criteria and category. As a result we highlight species such as: *Pilularia minuta*, *Litorella uniflora*, *Pinguicula lusitanica*, *Eryngium corniculatum*, *Eryngium galioides*, *Isoetes setaceum*, *Isoetes velatum*, *Elatine brochonii*, *Caropsis verticillato-inundata*, *Cicendia filiformis*, *Exaculum pusillum*, *Juncus emmanuelis*, *Solenopsis laurentia*, *Hyacinthoides vicentina* and *Juncus heterophyllus*. The confirmation of this species actual distribution emphasizes the importance to preserve temporary ponds in this territory. The mapping of these flora refuges is a basic tool to their conservation and is essential to support land management plans.

## IMPORTANCE OF ECOSYSTEM SIZE IN DETERMINING THE ENVIRONMENTAL CHARACTERISTICS OF TEMPORARY PONDS

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Ecosystem size is known to affect community stability and structure at a trophic and at a taxonomic level. However, little is known about ecosystem size influence on ecosystem environmental characteristics. For example: had larger ecosystems a higher nutrient availability? This relationship is of relevance to understand whether ecosystem size effect on community functioning is direct or indirect. Indirect effects may exist when larger ecosystems show different values of environmental characteristics than smaller ones, so that the different functioning of communities observed along the ecosystem size gradient may respond to, for example, different nutrient availability, and not uniquely to different ecosystem sizes. In the present study we tested whether temporary ponds with different sizes had different environmental characteristics (i.e. physical, chemical and biological characteristics of ponds). As the occurrence of temporary ponds is usually spatially clustered, pond locality might be also important in determining its environmental characteristics, e.g. ponds with close location may share similar features. Therefore, the present study takes into account also the “locality factor” in order to investigate if it is more important than size in determining pond environmental characteristics. In order to do so, we have sampled environmental characteristics (Chlorophyll-a, nutrient concentrations, macrophyte biomass, water temperature, electric conductivity, pH, dissolved oxygen, and total organic and inorganic carbon) in ponds located in 5 different localities. In each locality a cluster of ponds was sampled (10 to 12 ponds). The ponds were selected in order to obtain a wide range of pond sizes within each locality. Our results showed a strong effect of locality and a weak influence of size on pond environmental characteristics.

## **TOLYPELLA SALINA, ALTHENIA FILIFORMIS AND RIELLA HELICOPHYLLA: THREE RARE MACROPHYTES IN COASTAL BRACKISH POOLS**

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Coastal ponds, like coastal marshes, are particularly exposed to destruction or degradation resulting from development pressures. Temporarily flooded brackish wetlands have been less studied. Recent inventories have highlighted the occurrence of very rare species, *Althenia filiformis*, *Riella helicophylla* and *Tolypella salina* on a site in S-France threatened by destruction through industrial development. Because of their rarity, the ecology and distribution of these species and plant communities are poorly known. A two-year study has been carried out, with the aim of identifying (1) the distribution and abundance of *Althenia filiformis*, *Riella helicophylla* and *Tolypella salina* in Caban temporary marsh, (2) their main life-history traits and (3) their ecological requirements. Field monitoring (abundance of species, depth and salinity of water, ...) was conducted over two years. The density of seed and spore banks were assessed on systematically distributed sediment samples. Community experiments were carried out to test the impact of salinity and season on the development and reproduction of these three species. The results show a broad distribution and large abundance of *Althenia filiformis*, while *Tolypella salina*, *T. hispanica* and *Riella helicophylla* are more restricted to the margins of the marsh. Experiments in tanks highlighted an opportunistic development of *Althenia filiformis* and *Riella helicophylla* growing during both cool and warm seasons. In contrast *Tolypella salina* and *T. hispanica* developed only after flooding in cool conditions (winter-spring) All species appeared tolerant to high salinities although the decrease of salinity during winter favored their germination. *Riella helicophylla* and, to a lesser extent, *Tolypella spp.* require high levels of light, and water transparency plays an important role in the development of these species.

## HOW TO SURVIVE AND PERSIST IN EPHEMERAL WATER BODIES? THE CASE OF SPONGES (PORIFERA: SPONGILLINA)\*

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Ephemeral water bodies are subjected to unforeseeable and extreme fluctuations of environmental conditions constraining biodiversity values. Although data are fragmentary and scattered in the literature sponges are known to be able to colonize temporary/intermittent water bodies. Records at the global level refer to a wide range of climates from arid (e.g. African deserts) to temperate (e.g. Mediterranean islands), and cold (e.g. Nearctic permafrost) areas. Sponges face environmental constraints displaying chronic morphogenesis, clonality, modularity, and cryptobiosis by dormancy of resting bodies (gemmules) allowing both dispersal and short- to long-term persistence. Gemmules are small spherules (0.25 to over 1 mm in diameter) containing totipotent cells protected by a siliceous/proteic theca. Adaptive strategies of freshwater sponges are based on a high plasticity of body bauplan, physiology, life cycle, and reproductive behaviour. The life cycle rhythm is characterized by the alternation of vegetative (active sponges) and cryptobiotic phases (gemmules). A metamorphic process occurs by loss of the mother sponge functional body (total/partial degeneration) and production of gemmules (channeling of biomass/energy into staminal cells). Hibernation or aestivation occurs cyclically according with the climatic regime. During both long- or short-term dormancy sponges are represented only by gemmules adhering to hard substrata, floating at the water surface, or resting on the silty/sandy bottoms. Chronic morphogenesis from gemmules supports the regeneration of the mother sponge. Clonal gemmules enhance colonization and survival potentialities by performing a double functional role as resistant bodies to persist *in situ* and as propagules by passive dispersal (e.g. by wind or animal carriers).

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## **MATCHING THREATENED SPECIES WITH PRIORITY HABITATS: DO VOLES PREFER TO LIVE IN WELL PRESERVED MEDITERRANEAN TEMPORARY PONDS?**

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The conservation of biodiversity is a global priority in the Anthropocene. We may achieve this important goal using efficient conservation strategies, which target simultaneously multiple natural values. At the same time, there is a need to find indicators of habitat conservation status, particularly for threatened freshwater habitats like the Mediterranean temporary ponds.

In this work we aim to assess the use of two species of voles, Cabrera's vole (*Microtus cabreræ*) and water vole (*Arvicola sapidus*), as indicators or proxies of the conservation status of Mediterranean temporary ponds.

We surveyed 74 ponds for the presence of the two voles. Species presence was assessed by the search and identification of droppings during both the flooded and the dry season. The absence of a vole species was always recorded when we found no sign of its presence during the survey period. Because of the variable pond size, the length of the survey period was calculated considering the area of potential habitat present in each pond.

The vole survey results were then compared to the pond conservation status. Each pond was assigned a conservation status of good, intermediate or bad based on plant richness, number of vegetation belts, topography and the presence of natural and anthropic threats.

During the flooded season, Cabrera's vole was present in more ponds (n= 28) than the water vole (n=21). But in the dry season both species were present in similar numbers of ponds, i.e. n=26 and n=25 respectively.

One of the vole species showed a potential to be used as an indicator of the pond conservation status. Cabrera's vole was in fact present in a higher percentage in ponds with good conservation status during the flooded season, although the result was only marginally significant (Fisher exact test  $p=0.065$ ). However, during the dry season results were not different across the ponds characterised by different conservation status ( $p=0.715$ ). In contrast, the water vole showed no differences between the three groups of pond conservation status in both seasons (flooded season  $p=0.445$ ; dry season  $p=0.127$ ).

The vegetation structure and number of vegetation belts probably provide the ecological conditions for the Cabrera's vole to prefer ponds in good condition, such as the presence of shrubby vegetation on the pond margins. Our results highlight that vole species possibly can be used as indicators of the pond conservation status, but further research is needed.

## **LEAF LITTER BREAKDOWN OF *POPULUS NIGRA* L. ALONG A GRADIENT OF AQUATIC HABITATS RESULTING FROM FLOW FRAGMENTATION IN A TEMPORARY STREAM**

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In the Mediterranean basins most of the streams are temporary, and therefore, characterized by a drying and rewetting period. Before the dry period, there is a contraction and fragmentation phase where the flow gradually decreases until the formation of isolated pools. The aim of this study is to assess the development of the early decomposition process along a gradient of aquatic habitats resulting from flow fragmentation. To achieve this objective, we used 5 mm mesh size litter-bags in an 11-day field experiment to evaluate difference between habitats in litter breakdown. We observed an increase of the breakdown rate with the moisture level. Despite a non-significant difference in macroinvertebrate abundance, higher breakdown rates appear in running waters than in the isolated pools, related mainly to the high fungal and bacterial biomass on the leaf litter in running waters. DOM (dissolved organic matter) release from leaf litter shows differences between sites and appears to be positive related to mass remaining. A high heterogeneity was observed between the physicochemical characteristics of water, breakdown rates and abundance of macroinvertebrates between the isolated pools in spite of its proximity, suggesting the importance to study the processes occurring in these temporal habitats and its effect in the fluvial ecosystem functioning.

## MAIN PATTERNS OF PLANKTON COMMUNITIES CHANGES IN TWO TEMPORAL MEDITERRANEAN PONDS WITH DIFFERENT TROPHIC STATUS

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We studied phytoplankton and zooplankton changes in two close temporal ponds of Llobregat river delta, one mesotrophic (Pi pond) and another eutrophic (Pollancre pond). The systems were sampled monthly during water contraction period from late January until the summer drought in 2012. In the eutrophic pond an exponential increase of water conductivity, chlorophyll *a* and SRP and a decrease of nitrate concentration were observed through time in accordance to temperature and solar radiation. According to water conditions changes, plankton species succeeded throughout time: phytoplankton changed from a Cryptophyta dominated community to a less diverse Cyanobacteria bloom state in late spring whereas zooplankton succeed from Copepoda and Cladocera to a community dominated by Rotifera, mainly *Brachionus* species. However in the mesotrophic pond water conductivity, dissolved nutrient and chlorophyll *a* levels were more stable all over the studied period. Phytoplankton community was mainly dominated by Chrysophyceae and Cryptophyta, and only sporadically some Chlorophyta species became abundant. Zooplankton community was permanently dominated by nauplius, with Cladocera of the genus *Daphnia* from March to May followed by *Alona* in June just before the summer desiccation period. Rotifera community was more diverse than in Pollancre pond and dominance of different species succeeded (*Notholca*, *Brachionus*, *Polyarthra* and *Hexarthra*). The dynamic of both trophic levels, zooplankton and phytoplankton, appear largely different in the two temporal ponds still there were only 500 m distant. Surface water circulation and aquifer communication explained such trophic divergences. Our study provides data on phytoplankton and zooplankton communities composition and makes clear the importance of hydrology affecting the trophic status and the pattern of plankton succession along the natural process of desiccation.

## ECOLOGY OF MEDITERRANEAN TEMPORARY POND PLANT COMMUNITIES ON VOLCANIC SUBSTRATES OF SICILY

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Mediterranean temporary ponds represent a remarkable habitat for plant and fauna diversity and are classified among the most biologically and biogeographically interesting ecosystems in the Mediterranean region (Deil 2005; Zacharias et al. 2007; Bagella & Caria 2012; Minissale & Sciandrello 2014). Among them, rock pools are particularly relevant because they are small seasonal wetlands, annually subjected to extreme and unstable ecological conditions (Pinto-Cruz et al. 2009; Rhazi et al. 2009; Ghosn et al. 2010). Although several phytosociological studies have been carried out on this habitat in Sicily, (Brullo & Di Martino 1974; Brullo & Marcenò 1974; Brullo et al. 1976; Brullo et al. 1977; Raimondo 1980; Raimondo et al. 1981; Minissale & Spampinato 1987; Brullo et al. 1998; Brullo & Minissale 1998; Brullo & Sciandrello 2006; Pasta et al. 2008; Sciandrello 2007, 2009; Minissale et al. 2011; Sciandrello et al. 2013), few data are available on their ecology and spatial organization (Minissale & Sciandrello 2014).

Temporary ponds on volcanic bedrock are mainly localized in the Etna region, in the south-eastern sector (Hyblaean volcanism) and are also present in the island of Pantelleria.

With this contribution we want to improve the knowledge about the ecological conditions affecting and selecting the floristic composition of communities with reference to those that grow on soils derived from volcanic rocks.

Therefore the main objectives of this research were: (1) to analyse the floristic composition of temporary volcanic rock pool plant communities; (2) to evaluate the effects of ecological features on the species richness and diversity; (3) to define spatial patterns of plant communities.

### Syntaxonomical scheme

ISÖETO-NANOJUNCETEA Br.-Bl. & R.Tx. ex Westhoff et al. 1946

ISÖETALIA Br.-Bl. 1936

ISÖETION Br.-Bl. 1936

*Isöeto-Ranunculetum parviflori* Brullo, Di Martino & Marcenò 1977 (Pantelleria, Brullo et al. 1977)

*Isöetum duriei* community (Cozzofico, Carlentini, unpublished data.)

PRESLION CERVINAE Br.-Bl. ex Moor 1937

*Ranunculo-Antinorietum insularis* Brullo, Grillo & Terrasi 1976 subass. *isöetetosum duriei* (M. Lauro, Brullo et al. 1976)

*Ranunculo lateriflori-Callitrichetum brutiae* Brullo & Minissale 1998 (M. Lauro, Brullo et al. 1976)

*Callitricho-Crassuletum vaillantii* Brullo, Scelsi, Siracusa & Tomaselli 1998 (Bosco Pisano, M. Lauro, Brullo et al. 1998 and unpublished data)

CICENDIO-SOLENOPSIS LAURENTIAE Brullo & Minissale 1998

*Archidio-Isöetum velatae* Brullo & Minissale 1998 (Cozzo Ogliastris, da Brullo & Minissale 1997)

*Anagallido parviflorae-Molinierietum minutae* Brullo, Scelsi, Siracusa & Tomaselli 1998 (Bosco Pisano, Brullo et al. 1998)

NANOCYPERETALIA Klika 1935

VERBENION SUPINAE Slavnic 1951

*Coronopo-Sisymbrelletum dentatae* Minissale & Spampinato 1986 (La Gurrada, Etna, Minissale & Spampinato 1986 and unpublished data)

*Corrigiola litoralis* community (Sciare di Santa Venera (Bronte) unpublished data)

## **PHYTOPLANKTON COMMUNITY STRUCTURE IN SMALL MEDITERRANEAN TEMPORARY PONDS IN RELATION TO CLIMATE AND HUMAN IMPACT**

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Phytoplankton communities are very sensitive to environmental change and could be excellent indicators of ecological conditions; therefore they have been well studied in most aquatic systems, but not much in temporary ponds. The aim of this work is to characterize the phytoplankton communities of small temporary ponds differing in morphology, type of soil, hydroperiod length and human impact. Phytoplankton from thirty five temporary freshwater ponds located in Eastern Spain was quantified from samples taken during late winter-early spring. Triangular diagrams based on nutrient ratios (TP:TN:SRSi) and on biovolumes of main planktonic/semiplanktonic algal groups are used to explore the influence between nutrient stoichiometry and phytoplankton communities. Pond typology was further examined by means of multivariate statistical analysis combining phytoplankton species composition and environmental variables. Groups obtained from species associations were well related with type of soil/alkalinity, depth/water permanency, clay turbidity/water transparency and flooded area/macrophyte cover. Euglenophytes and cryptophytes dominated in ponds with higher phytoplankton biomass, chlorophytes dominated in ponds with higher mineral turbidity and total phosphorous, whereas diatoms, chrysophytes and desmids were more abundant in deeper ponds with clearer waters and macrophyte cover. Most ponds are used for livestock drinking and trampling, a simple visual variable indicating human impact, was positively associated with mineral turbidity, nutrients and chlorophyll and also with phytoplankton composition and diversity. Phytoplankton species occurrence patterns and richness are also discussed in relation to pond size, hydroperiod length and human impact.

## ENVIRONMENTAL UNCERTAINTY AND ROTIFER LIPID CONTENT

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Populations of the monogonont rotifer *Brachionus plicatilis* in Eastern Spain inhabit ponds known to experience adverse episodes with variable frequency and degree of predictability (e.g. desiccation, presence of antagonists). These episodes interrupt rotifer population dynamics in the water column (i.e. the planktonic growing season) with a forced dormancy in form of diapausing embryos that remain latent in the sediment for variable time.

We hypothesise that environmental uncertainty affects physiological traits of diapausing embryos such as neutral lipid content. Since diapause guarantees survival during adverse periods, one would expect diapausing embryos to contain more energetic storages in the form of lipids in those populations inhabiting ponds with higher variance in the length of dry periods. Water permanence and pond unpredictability were characterized by satellite imagery. Lipid content was indirectly measured as pixel intensity of decapsulated diapausing embryos stained with Oil Red-O.

We report negative correlations between lipid content with both permanence (Pearson's  $r = -0.609$ ,  $P=0.04$ ) and predictability (Pearson's  $r = -0.543$ ,  $P=0.07$ ). Our findings provide insight for understanding how animals adapt to their environment, and suggest that hydroperiod has influenced rotifer evolution promoting higher allocation of resources in diapausing embryos of those populations inhabiting the most episodic and unpredictable environments.

## **PHYSICO-CHEMICAL CHARACTERIZATION OF A RESTORED DUNESLACK SYSTEM**

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Malladas (local name for humid dune slacks) belonging to the Albufera Natural Park, is a mosaic of ponds located in a sand bar that separates the Albufera lagoon from the Mediterranean Sea. The area was included in an urban planning until the late 70's, and most of these ponds were artificially silted. During the 80's the urban plans stopped and the area was catalogued as a Natural Park, trying to recover its natural values. For this, some restoration projects were developed at different periods during the 90's and 2000's. The attempts to recover the ecological functioning of ponds consisted in digging out the alien material that buried the former basins. In order to evaluate the restoration process, we monthly monitored 17 of these ponds during four consecutive years (from 2007 until 2011). The ponds were restored in three different time periods: six in 1998, four in 2003 and seven in 2007. The ponds also differed in hydroperiod (4 of them were permanent and 13 temporary). We used a multivariate statistical approach to detect the most important sources of variation in the environmental gradient and the main forces driving the inter-annual variation observed in this period. In general terms, since they were digged, conditions in the ponds tended to loose conductivity, pH, depth and oxygen with time. In addition, vegetation cover and faunal richness also increased with time, suggesting the recovery of ecological functioning of this area.

## OSTRACODS OF MEDITERRANEAN TEMPORARY INLAND WATERS (GREECE, SOUTHERN ITALY, AND MALTA)

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In the frame of a wider survey aimed at investigating the temporary inland water crustaceans of the Mediterranean area, a case study concerning non-marine ostracod fauna collected in Mediterranean temporary inland waters is here presented. A total of 351 ostracod samples were collected from 274 sites (44 of them located in Apulia, 198 in Sicily, 5 in the Maltese islands, and 27 in Greece) between 2002 and 2014. Sites were selected to encompass the most widespread types of temporary freshwater aquatic habitats (i.e., pools, ponds, flooded fields, etc.). For most of the sites water temperature, conductivity and pH were also measured.

The analysis of samples from the new surveys yielded a total of 41 ostracod species and 17 taxa identified to supraspecific level, belonging to 7 families (Candonidae, Cyprididae, Darwinulidae, Hemicytheridae, Ilyocyprididae, Limnocytheridae, and Notodromadidae).

The most frequently-encountered taxa were the *Eucypris virens* species complex (131 sites) and *Heterocypris incongruens* (78 sites), followed by *Plesiocypridopsis newtoni* (27 sites). Seventeen taxa have been found only in a single site each.

Of particular interest is the occurrence of *Ilyocypris getica*, a species new to the Italian ostracod fauna and currently exclusively recorded from a single pool on Ustica island. In addition, we found one putative new species, (*Eucypris* sp.1), which may be endemic to Sicily and is currently under study.

The obtained results show the presence of a high diversified ostracod fauna in Mediterranean temporary inland waters. The analysis of data revealed that the most influential environmental factors in determining species distribution in the study area are conductivity and altitude, although no clear biogeographical and ecological patterns have been found. This may depend on the fact that sampled species are generally characterised by broad ecological tolerance, and because of the high frequency of few taxa. However, notwithstanding a large overlap, a significant difference in species composition was observed between mainland Sicily and its surrounding islands and Apulia.

## INFLUENCE OF SEASONAL MULTIANNUAL DROUGHT EVENTS ON THE RESILIENCE OF ECOSYSTEM PROCESSES AND MACROINVERTEBRATE ASSEMBLAGES IN A CENTRAL APENNINE STREAM (ATERNO RIVER, ITALY)

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This research provides a rare field experiment on the resilience of ecosystem processes and macroinvertebrate assemblages by multiannual drought events, in a Mediterranean river. Here, we studied the influence of multiannual drought events on the decomposition process of leaf detritus and on the recovery of macroinvertebrate assemblages, both in the leaf-bag and in the bottom samples. Two sites, Acciano and Tione, located in a third order branch of a Central Apennines river (Abruzzo, Italy) were monitored from 2007 to 2009 with the aim to record the drought events during summer and bottom samples of macroinvertebrate assemblages were collected in the flowing period of the summer. In the monitored years, Acciano was exposed to drought events during the summer of each monitored year, while Tione was always flowing. In the 2010, we performed an experimental design to analyse the effect of progressive desiccation on leaf detritus decomposition process and on macroinvertebrate assemblages from the leaf-bags and bottom samples. Unexpected, during the 2010 year Acciano was always flowing and sampling was carried out from June to September. Since Tione was right, the unexpected event was a great fortune for us because we were able to analyze the recovery of both functional process and macroinvertebrate community structure and traits in Acciano site respect to Tione site, after multiannual seasonal drought disturbance. Decomposition process was analyzed in both sites and in 4 periods (from June to September, monthly) using the leaf-bag technique; 12 leaf-bag containing 3 g of dry *Phragmites australis* (Cav.) Steudel leaves were submerged at each site and period, and retrieved after 30 days. Macroinvertebrate assemblages were collected from both leaf-bag samples and bottom samples, and the main structural descriptors and traits were compared between sites and among sampling periods. Bottom samples were available also in the previous three years. The obtained results showed no difference between sites of the decomposition process of *Phragmites australis* leaves, while significant differences of the structural descriptors and traits of macroinvertebrate assemblages were rarely observed between sites, just in some month were significant and main linked to trophic traits. Finally, this study showed that also in correspondence of climate change drought disturbance become more unpredictable mainly in Mediterranean type rivers, moreover functional processes are not affected by *draining memory*, while the descriptors of trophic traits seem to be more affected by *draining memory*.

**Keywords:** Drought disturbance, Mediterranean type rivers, benthic macroinvertebrates, climate change, draining memory, decomposition process, *Phragmites australis*

## ROLE OF BRYOPHYTES IN THE VEGETATION OF MEDITERRANEAN TEMPORARY PONDS CLOSE TO THE TEMPERATE BIOCLIMATIC BORDER

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Preliminary data on the bryoflora of the temporary pools and waterlogged soils in Piana di Ferretto (Umbria, inland Central Italy), a biotope of great conservation interest and a Natura 2000 site (IT5210020), are here discussed and interpreted in the light of the vascular plant communities which house them. The area belongs to the Mesomediterranean belt of the Mediterranean Bioclimate, although transitional traits to the Temperate Bioclimate affect its floristic and ecologic features. The Mediterranean temporary pond systems can only seldom develop in such inland territories, depending on a peculiar combination of water regime, mesoclimate and soil characteristics. Bryological data from the area date back to the 80s (Cortini Pedrotti, 1985; Aleffi, 1992), while the vascular component has been firstly studied in the 80s and more recently reorganized in a phytosociological framework including new and complete descriptions of amphibian plant communities (Gigante *et al.*, 2013). Eight vegetation types were identified: *Junco-Solenopsietum laurentiae*, *Hypochoerido-Cicendietum filiformis*, *Callitricho-Ranunculetum ophioglossifolii*, *Callitricho-Juncetum bulbosi*, *Serapio-Isoëtetum histricis lotetosum angustissimi*, *Solenopsio-Juncetum pygmaei isolepidetosum cernuae*, *Alismo-Gratioletum officinalis juncetosum conglomerati*, *Callitricho-Ranunculetum ophioglossifolii glycerietosum fluitantis*. Twenty-eight taxa of mosses and liverworts (23 *Bryophyta*, 5 *Marchantiophyta*) were found in the area, identified and named following Cortini Pedrotti (2006) and Aleffi *et al.* (2008). Eight species are new records for Umbria: *Campylopus introflexus*, *C. pilifer*, *Dicranella cerviculata*, *Ephemerum recurvifolium*, *Fossombronia wondraczekii*, *Plagiomnium ellipticum*, *Pohlia nutans*, *Riccia canaliculata*. According to Aleffi & Schumacker (1995) and the European Committee for Conservation of Bryophytes (ECCB), *R. canaliculata* is considered vanished (Ev) in the region, *F. wondraczekii* and *R. beyrichiana* are considered rare (R), showing the high relevance of these systems, also emphasized by the presence of two Habitats from 92/43/EEC Directive's Annex I (3110, 3170\*). Furthermore, the study area shows remarkable peculiarities, in that its transitional climatic condition generates a shift between bryophyte and vascular species phenology. The bryophytic species show a late-winter development and disappear almost completely before the vascular communities reach their maximum level of development (start of May). This prevents from the possibility to include bryophytes in the vegetation relevés. With the present study, based on diachronic samplings and the use of gps technology, it was possible to relate the bryophytic species to each vascular plant community.

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## NOTES ON THE BRYOPHYTE VEGETATION OF THE MEDITERRANEAN TEMPORARY PONDS IN ITALY

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The Mediterranean temporary ponds are very important habitats for the survival and conservation of plants, including Bryophytes. These shallow water bodies, subjected to intermittent and unstable environmental conditions, remain flooded only in winter and spring, allowing the development of a specialized bryophyte flora. Few and difficult to find are the bryophyte species strictly linked to this habitat, depending mainly on the flooding/drying regime to complete their life cycle. The peculiarity of the habitat causes a selection, therefore only few species can find here a favorite biotope, as some *Riccia*, *Fossombronia*, *Anthoceros*, *Bryum* (e.g. Casas et al., 1998; Hugonnot, 2004; Cogoni et al. 2009).

A phytosociological investigation on the bryophytes of the Mediterranean temporary ponds was carried out in some territories of the insular and Central-Southern peninsular Italy. Here, the occurrence of a rich set of liverworts, normally poorly represented in the bryophyte flora of the Mediterranean ecosystems, is very significant. These are mainly some species of *Riccia* which characterize the communities from a physiognomical, ecological and syntaxonomical point of view. Other significant species is the moss *Archidium alternifolium*, which often forms large populations and plays a important phytosociological role. The surveyed bryophyte communities can be referred to the alliance *Mannion androgynae* Ros & Guerra 1987, a Mediterranean spring vegetation rich in thalloid liverworts included in the class *Barbuletea unguiculatae* Mohan 1978 (Puglisi & Privitera, 2012).

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## **HYDROLOGICAL REGIME AND MODELING OF THREE PONDS OF THE MEDITERRANEAN AREA (SOUTH OF CÓRDOBA, SPAIN)**

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In this investigation, hydrological time series of three ponds located in the province of Córdoba (southern Spain) at a daily scale have been analyzed. For the first time, a detailed evolution of the water level of Jarales, Conde and Amarga ponds have been acquired by means of the installation of level loggers in the deepest point of each of the ponds.

The studied period (2011 – 2012) was exceptionally humid in the region. Due to that reason, the ponds, which normally desiccate in summer due to its shallowness, remained flooded during all the period and reached their maximum depth. This led us to model the water level evolution using a simple one-dimensional model based on daily water balances and compare our results with the actual water level measured.

We detect a different hydrological behavior, a shift in the hydrological regime, in one of the ponds, located over a karstic aquifer. In this pond, a groundwater recharge phase was inferred after a rainy period, and this recharge phase was not computed in the other ponds. The recharge of the karstic aquifer took place through several sinkholes when the pond reached a certain depth. The other ponds were classified as discharge ponds; which is the hydrological regime of the majority of southern Spain's continental ponds.

In this investigation, a new approach to investigate the hydrological functioning of temporary ponds is presented, and could be applied to other similar water bodies in the future.

## **QUANTITATIVE STATUS OF THE GROUNDWATER RESOURCES BASED ON WATER LEVEL INDICATORS FROM 1985 TO 2013 IN FUENTE DE PIEDRA SALT LAKE (MÁLAGA, SPAIN)**

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The Fuente de Piedra Salt Lake is located in Southern Spain. It occupies the center of a topographically closed basin with a watershed of an area of about 150 km<sup>2</sup>. The Fuente de Piedra salt-lake shows a length of 6.8 km and a width of 2.5 km. Groundwater resources are withdrawn in the area for both agricultural and urban supply uses. To analyze the quantitative status of the groundwater in the different aquifers in this system, and its possible affection to the playa-lake, several environmental indicators based on the evolution of the water level were applied in six piezometers located in the watershed. Also, the evolution of the water level of the lake was analyzed using the same methodology. The study period covers from 1985 to 2013 at a monthly basis. The results obtained from the indicators showed that the associated aquifers have different behaviors and are affected by extraction in different ways. In the Miocene - Quaternary aquifer various sectors are under strong pressure and piezometric levels do not recover after rainy periods. On the other hand, there are other areas in this aquifer where a slight increase of the piezometric surface was measured. In the Jurassic aquifers of Sierra Mollina -La Camorra, the piezometric level drops continuously over time. Such levels show no signs of recovery during rainy years. The indicators clearly show what is happening in this system and the evolution of the water levels in different sector. This methodology will allow system managers, even with little hydrogeological training, to participate in the process of managing and decision-making in this type of ecosystems elsewhere in the future.

## CHAROPHYTES IN SOME TEMPORARY MEDITERRANEAN PONDS. OOSPORES BANK AND GERMINATION

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Temporary ponds are frequently found in some of the most important Spanish Natural Parks. Although these systems are increasingly under human pressure, in the Natural Park of the Albufera (Valencia, Spain) several dune Mediterranean ponds have been restored since 1997. In this study, we focus on the oospores bank and germination in three ponds with similar size and hydroperiod, but different age. They were restored respectively during 1998, 2003 and 2007. They are temporary, oligohaline and oligo-mesotrophy ponds, which dry during summer and flood normally during autumn. The top two centimetres of dry sediment from each pond was collected after summer to assess the potential of the oospores bank both by germination and direct counting. Integrated cores across each pond were taken for at least a soil surface area of 0.15 m<sup>2</sup> according to standard methods for semi-arid wetlands. Species richness, population densities, axis length and numbers and maturity states of oospores were recorded during the germination experiment. Direct counts of oospores abundance in the sediment from each pond was done to examine the relationship between the oospore bank and the extant vegetation. Germination differed among ponds, with higher rates in recently restored ponds. *Chara canescens*, *Ch. galioides* and *Ch. aspera* were the predominant species during the germination experiment. These characean species were also developed in the study ponds. Species germinated fast, although with different elongation rate and oospores production. A total of nine different oospores were registered and counted in the soil of the three ponds. The amount of oospores in the bank sediment was related to the emergence observed and to the thresholds for germination reported in the literature. The results pointed out that charophytes had a high potential for oospore germination and colonization in the study temporary ponds. Oospores bank was differently rich depending on the pond age and colonization of the soil by benthic algae and other plants (e.g. helophytes). Connectivity of these systems within the wetland and easy transport of resting propagules by birds and humans seem important factors affecting charophytes and aquatic plant colonization. Since climate change predicts longer dry seasons in the Mediterranean area and in consequence, an increase in the number of temporary water bodies, conservation of ponds and wetlands might be a way to preserve organism and genetic biodiversity in stand and dormancy stages.

## **NUTRIENTS AND CARBON IN DUNE PONDS: A STUDY CASE IN THE IBERIAN MEDITERRANEAN COAST**

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Nutrients and carbon concentrations were studied in the water and sediment of 17 dune ponds, located in the Natural Park of the Albufera, a wetland included in the RAMSAR and NATURE list. Some restoration plans have been carried out to recover part of the initial environment of the dune ponds and their high ecological value, which were altered by an urban plan in the decade of 1960s. The studied ponds had a good water quality and are interesting ecosystems to study carbon and nutrient balances. The permanent and temporary dune ponds were similar in nutrient concentrations, but they differed in carbon levels. The mean carbon dioxide partial pressure was higher in the older ponds, both permanent and temporary, with a gradual decrease from old to new restored ponds. The presence of submerged plants in some of the permanent ponds resulted also in significantly lower carbon dioxide concentrations than in the non-vegetated permanent ponds. The new restored ponds (both permanent and temporary) had lower dissolved organic carbon level in the water. The concentrations of nutrients, carbon and organic matter in the sediment were unrelated to those of the water column. In the sediment, the older temporary ponds accumulated more nitrogen and carbon. Most of this carbon and nutrients were bounded into benthic algae. It was observed that the starting of the pond inundation significantly reduced total carbon in the sediment by about 40%, while did not change significantly the concentrations of total nitrogen and phosphorus. However, comparative dry summer periods (September 2009 and 2010) accumulated in the sediment about 25 % of organic matter and 37% of total nitrogen, while TP did not significantly change. The data pointed out the potential of carbon mineralization of dune ponds. They mineralize carbon in a rapid way after flooding, while dry phases accumulate organic matter and nutrients, probably from a terrestrial origin. This is important in order to evaluate the creation of new ponds and for the conservation of these highly valuable dune ecosystems.

## CONSERVATION BIOLOGY OF RARE AND ENDANGERED LIVERWORT FROM MEDITERRANEAN TEMPORARY PONDS: *RIELLA HELICOPHYLLA*

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*Riella* Mont., with ca. 27 species is the most diversified of the Riellaceae (Sphaerocarpaceae). Species of *Riella* grow commonly submerged in clean, shallow, fresh or brackish waters of seasonal ponds, more rarely in permanent waters of arid and semiarid regions and have disjunct distributions and scattered populations. The species of *Riella* are rare and/or underrecorded due to their specific habitat types, ecology and biology. They are aquatic ephemerals that survive drought periods in the spore bank. For species of conservation importance such as *Riella helicophylla*, the presence of large spore banks serve as “insurance” against local extinction. Such strategy may take on special importance in Mediterranean temporary aquatic habitats where environmental conditions vary in unpredictable ways from year to year. In these variable habitats, there is no guarantee of yearly spore input into the spore bank. In this study, we test the effect of different culture media in the axenic establishment and propagation, of *R. helicophylla* (Mont.) Hook. Spanish genotype for the purpose of *ex situ* conservation and its biology research. We used ripe unopened sporophytes as starting material for *in vitro* cultures. The spores from the fresh capsules did not germinated immediately after collection but showed some kind of dormancy. The treatment with gibberellins shortly upon collection did not improved germinability. However, dry storage at 20°C for about three months broke the dormancy of spores which germinated in high percentage (over 90%). Two phase system (solid and liquid) culture media were developed for the purpose of achieving fully developed gametophytes. Spores were able to germinate on solid medium rather than in pure liquid, and they developed some kind of callous tissue that developed into green plants – gametophores, after being transferred to the two phase culture. Testing on many media which were tried as solid and liquid phases showed that the germination were best in solid BCD medium free of liquid phase, which contained mineral salts. Therefore, we tested the plants establishment on solid BCD medium and cover it with two types of liquid phases: (1) distilled water and (2) water containing electrolytes simulating brackish water. The plant morphogenesis was better achieved on BCD medium covered with electrolyte-enriched liquid phase. The experiments on sporulation by growing female and male plants and acclimation to xenic condition are ongoing.

## TAXONOMIC AND BIOLOGICAL TRAITS PATTERNS OF MACROINVERTEBRATE ASSEMBLAGES OF MEDITERRANEAN TEMPORARY PONDS IN AN AGRICULTURAL LANDSCAPE IN SOUTHERN PORTUGAL

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Mediterranean temporary ponds are known to harbor a high biodiversity of flora and fauna, and their conservation is threatened due to a large number of human activities (e.g., hydrological changes, land reclamation, pollution, agricultural or livestock rising). In the case of agricultural and livestock rising practices, it is known that these activities can affect the faunal assemblages, but less is known about their effects on the functional structure of the macroinvertebrate assemblages. In Alentejo region (S Portugal), a large number of Mediterranean temporary ponds are located around Mértola and in the Guadiana Valley Natural Park in an agricultural landscape characterized by traditional practices. During the hydrological year 2001-02, fifteen ponds with different hydroperiod duration were surveyed. They were sampled three times (beginning, middle and end) when it was possible (some ponds with short hydroperiods were sampled only once or twice). Some ponds showed two consecutive hydroperiods, that were sampled independently. Macroinvertebrates were captured with a dip-net, and were later sorted and identified to genus level whenever possible. Biological traits of the macroinvertebrate taxa were also recorded according to existing literature. Interviews to land owners and Natural Park technicians allowed us to classify the ponds in different disturbance levels depending on plowing and fertilization frequencies and type of livestock using the pond. The results showed that community composition and biological traits patterns changed according to hydroperiod phase, and no significant differences were found for disturbance level. The beginnings of the hydroperiods were characterized by high abundances of large branchiopods and some dytiscid taxa, whereas culicids, baetids and coenagrionids were characteristic of the final periods of the hydroperiods. Changes in assemblage composition were mostly responsible for changes in trait characteristics. Traditional low-intensity agricultural and livestock raising activities seem to be compatible with diverse macroinvertebrate assemblages in Mediterranean temporary ponds.

## A NEW TOOL FOR THE ASSESSMENT OF SEVERE ANTHROPOGENIC EUTROPHICATION IN WETLANDS UNDER INCREASING HUMAN PRESSURE

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It is about time the assessment of trophic state in wetlands is no longer estimated through the regressions and thresholds modelled for deep-stratified lakes where sediment nutrient recycling was purposely neglected. We are in badly need of a system trophic indicator to be used as a reference for biological indicators. The recent use of biological communities (macro-invertebrates, diatoms, etc) for the evaluation of the “ecological state” of a water body implicitly requires the assessment of its “trophic state”. We need a sediment approach to change the concept of “trophic state” in shallow systems from that currently used in lakes in order to account for the expected higher productivity (and hence naturally higher eutrophy) of shallow aquatic systems compared to lakes within the same area. More so in wetlands of the Mediterranean-climate region where sediment-water interactions and its associated benthic productivity are particularly relevant to primary production. The ever increasing pressure on Mediterranean wetlands, however, makes it more difficult to distinguish between natural eutrophy and anthropic eutrophication due to direct impacts on hydrology (that changes both the quantity and quality of water), and to the long-lasting effect of diffuse nutrient pollution on small endorheic water bodies. Primary production in shallow systems can be modelled as a function of nutrient availability during spring-summer growth where sediment plays an important role in the availability of dissolved inorganic phosphate depending on its capacity for P-adsorption. Dissolved inorganic N can also limit primary production whenever denitrification processes dominates the N-cycle though we have primary focused on P-bioavailability by exploring some of the predictions of the chemical equilibrium of P concentrations between sediment and water modelled by Golterman (2004). In this sense, we can expect that in shallow systems where the P-sediment capacity has not been oversaturated by severe nutrient anthropic loads, the relationship between particulate-P and total-P in the surface water may be equal or close to a 1:1 ratio. Furthermore, a ratio above 1:1.3 would indicate a severe deviation from the equilibrium as a consequence of anthropic eutrophication since the dissolved inorganic phosphate concentration was modelled as the cubic ratio of P-sediment (Golterman, 2004). We, then, forecast that in highly protected wetlands this 1:1 ratio will be observed, whereas it will not be so in other systems with less protection or more impacts. This tool was validated across a wide spectrum of soil, hydrology and land use factors.

## STUDY OF THE WATER BEETLES OF THE CORSICAN TEMPORARY PONDS

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### ***A particularly rich and diversified fauna***

Aquatic beetles are an important component of lotic and lentic freshwaters, and even some of them are adapted to live in brackish waters. The fauna of France is one of the richest in Europe.

Although the continental fauna consists of 600 species from 22 families, of which 21 families are present in Corsica, the species diversity of the island is smaller and could be estimated on 444 species according to the bibliographic data available considering that the Mediterranean continental species could be also present in Corsica.

The first aim of the present study is to establish, as complete as possible, the checklist of species actually present on the island. The species present in Corsica, in general, have a size between 2 and 5 mm, and for its taxonomic identification the species, which is usually challenging, is necessary to perform the dissection of the genitalia. Moreover, the spread of the specialized bibliography, as well as the difficulty to have access to some of the documentation, also difficult the identification of the species. Additionally, continuous changes on species nomenclature, especially within Hydrophilidae, the lack of a synthesis work on French aquatic coleopterans (within the framework of the European fauna), and the large number of habitats to be inventoried for Corsica, make this work more demanding.

### ***The studied temporary ponds***

Corsica has 91 temporary ponds spread over sixty sites, mainly found in the south of the island. Corsican temporary ponds are found along the roads, or highly isolated in the bush, covering a range of altitude from sea level to approximately 300 m.

The inventory of aquatic beetles presented was conducted in 2013 and 2014 in 5 sites located in the south of Corsica (Frasselli, Catarellu, Padulellu Muratellu and the Natural Reserve of Tre Padule de Suartone). The sites have different origin, substrate and morphology.

A total of 60 species were found, including 2 new observations for Corsica in Frasselli ponds: *Eretes griseus* in pond D and *Hygrotus (Coelambus) confluens* in ponds D and H. Moreover, larvae of *Eretes griseus* were found in the pond D in 2014 which confirms its permanent membership in the Corsican fauna.

Forthcoming studies including the rest of sites, from the northern part of Corsica (ponds of Agriate or in Cap Corse), and also from the south (ponds in the Sartenais, or in the region of Porto-Vecchio and Bonifacio, ...) will improve the checklist and make it more complete.

## STUDY OF THE BRANCHIOPODS OF CORSICAN MEDITERRANEAN TEMPORARY PONDS

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Mediterranean temporary ponds have a high ecological value within the Mediterranean region. They host a fauna and flora adapted to highly variable environmental conditions. Large branchiopods are crustaceans considered as a key group of Mediterranean temporary ponds, as they are strictly confined to this environment through their resistance ecophase, the cyst. Within the 91 temporary ponds known in the island, 27 are home to one of the 5 species of large branchiopods present in Corsica: *Tanymastix stagnalis*, *Triops cancriformis cancriformis*, *Chirocephalus salinus*, *Branchipus schaefferi* and *Branchipus* sp.

To complete this checklist, the Office de l'Environnement de la Corse (Agency for the Environment of Corsica) and the laboratory of Biology of Organisms and Aquatic Ecosystems of the National Museum of Natural History have teamed up to study the branchiopods (anostracans and notostracans) of Corsican Mediterranean temporary ponds. This project should eventually lead to a mapping of Corsican large branchiopods.

Sampling of the resistance forms was conducted during the dry phase on 27 temporary ponds, collecting a total of 68 sediment samples, containing 200 to 500 g of sediment per sample.

The technical study of the dry sediment for each temporary pond was done in two steps. First, the sediment collected was rehydrated to posteriorly isolate the floating eggs. The identification of the egg is done directly at the genus level. In Corsica, the genera concerned were *Branchipus*, *Tanymastix* and *Triops*. The second step consists in a hatching experiment with the sediment previously rehydrated. The hatching experiment was conducted with constant temperatures between 14-16 °C to allow the hatching of all the remaining species that were undetectable by the first method (e.g. *Chirocephalus salinus*). Because *Tanymastix stagnalis* is difficult to hatch, in most cases its presence was indicated by the presence of eggs collected in the first step.

At this stage of the study, 13 sediment samples were treated and allowed to highlight new data: *Tanymastix stagnalis* on Frasselli F and Padulaccia 3, *Triops cancriformis* on Frasselli D, *Branchipus schaefferi* on Alzu di Gallina, *Branchipus* sp. on Padulellu.

The forthcoming study of northern Corsica sites (ponds of Agriate) and South Corsica (ponds of the Sartenais, or the region of Porto-Vecchio and Bonifacio, ...) and new habitats as rockpools will complete the inventory and make it more exhaustive, which would allow a better management of the biotope.

Additionally, genetic studies can be conducted on *Tanymastix stagnalis* and *Chirocephalus salinus* to better understand the structure of the island populations.

## USE OF LANDSAT 5 TM REMOTE SENSING IN MEDITERRANEAN COASTAL SMALL TEMPORARY AND PERMANENT PONDS

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The Landsat 5 satellite remote sensing has been the longest series of images obtained continuously since Remote Sensing used. From spring 1984 to autumn 2011 has provided Thematic Mapper sensor images that allow us to perform temporal studies with a sufficiently long series. "Dehesa de La Albufera" is the dunar coastal area of the Mediterranean Sea, south of the city of Valencia (Spain) and has been declared a Natural Park since 1986. The flooded areas between the dunes are known as "mallades". They are ponds of limited depth (between 0.5 and 1.9 m) and variable conductivity. These dune ponds have also variable size, from a few square meters to hundreds, depending on the rainfall in the area.

The daily rainfall series for the period of operation of Landsat 5 provides about forty episodes of intense rainfall greater than 50 mm per day. In eight periods of these, the rainfall exceeded 100 mm. The higher values recorded were 365.8 mm on 23<sup>rd</sup> September 2008, 274.6 mm 12 – 15<sup>th</sup> December 1995 and 204.6 mm 28 – 29<sup>th</sup> September 2009.

The images obtained after the rains dates allow us to evaluate the extent of the flooded area using Band 4 of Thematic Mapper Remote Sensor of Landsat 5. In the following months, the images allow to evaluate the water level changes during drying of the ponds in periods of low rainfall. We are unable to get direct data about the trophic status and the water quality of the ponds due to its transparency and the presence of emergent vegetation. By means of a vegetation index, the status of wetland in all the period studied will be determined. The images of Landsat 5 and 7 provide valuable information about these small water bodies and its changes in a long-term period were there is an absence of data field.

## AMPHIBIAN OCCUPANCY AND POND ASSESSMENT IN ALENTEJO REGION (PORTUGAL)

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The Alentejo is an extensive rural region spread in the south part of Portugal. Among diverse landscapes that sustain a high level of species, temporary ponds are a common sight across the landscape. But here ponds are still poorly known or protected in most of the region. In this study 43 temporary ponds were surveyed for amphibian presence and plant communities in this region. We also registered 13 features to describe each pond. Globally 13 amphibian species were found, while ranging between 2 to 8 species per pond (average  $1.86 \pm 1.44$ ), with species richness increases with pond area. The most present species were *Pelobates cultripes* (86.0%), *Hyla meridionalis* (69.8%) and *Pleurodeles waltl* (67.%), while the less ones (2.3%) were *Salamandra salamandra* and *Alytes cisternasii*. Statistical analyses were also conducted to find out which variables could explain the pond variance. The results showed that three principal components (PCA) explain 53.8% of variance based on the 13 features, but only 7 factor loadings ( $> 0.60$ ) tend to split the ponds.

## PLANARIANS OF TEMPORARY WATERS (PLATYHELMINTHES TRICLADIDA)

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Freshwater planarians are fragile animals susceptible to desiccation and high temperature and characterized by a poor dispersal power requiring contiguous freshwaters to survive and disperse. They are indeed excellent biogeographic models. However, some species of Planariidae (genera *Phagocata* and *Hymanella*) and Dugesiidae (genus *Spathula*) are known inhabiting temporary waters particularly from the Nearctic, Palaearctic and Australasian regions. It is noteworthy that some species of these flatworms are specifically adapted to these habitats and do not occur in permanent water bodies. The adaptation of the species to the intermittent waters and to their extreme fluctuations in time and space, is achieved by resistant stages and modifications of the reproductive cycle. Sexual species can produce thick-shelled cocoons capable of withstanding drought. Species reproducing both sexually and asexually face the unfavourable environmental conditions by processes driving the encasing of the entire individual in a mucous coat which hardens forming a cyst. In other cases these flatworms undergo to multiple fission or fragmentation followed by encystment of each body fragment. As far as Sardinian biodiversity only recently a sexual population of *Schmidtea* sp. (Dugesiidae) was discovered in ephemeral waters of North-West Sardinia. A cave-dwelling sexual population of Planariidae was recently found in a comparable SE-Sardinian habitat *i.e.* intermittent dripping water. Studies on the reproductive cycles and modes of these populations are in progress both in the field and in laboratory conditions to clarify the life history and survival strategies of flatworms in both underground and surface ephemeral waters. These new discoveries and previous data suggest underestimated values of taxonomic richness and confirm the status of Sardinia as a biodiversity hot spot.

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## SPATIAL PATTERNS IN PLANT AND MACROFAUNAL ASSEMBLAGES IN MEDITERRANEAN TEMPORARY PONDS: RESPONSE TO CONNECTIVITY AND POND SIZE GRADIENT

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We studied the relation between three different biotic groups (animal active dispersers, animal passive dispersers and plants) and spatial patterns and environmental conditions in two networks of Mediterranean temporary ponds. Plant and macrofaunal assemblages in Mediterranean temporary ponds seem to have different spatio-temporal patterns, being plants more dependent on spatial factors and macrofauna on temporal changes. Moreover, environmental controls may differ across dispersal capabilities. All of this can affect the relationship between one biotic group and habitat size. Habitat size is supposed to have a positive relationship with species richness. However, this relationship is still unclear in the case of temporary ponds due to their environmental variability during the hydroperiod. Moreover, the spatial connectivity of the system can modulate the influence of pond size on the community structure. The two studied networks of Mediterranean temporary ponds were located in Vila Nova de Milfontes (SW Portugal) and Giara di Gesturi (Sardinia, Italy). Each network was characterized by a pond size gradient (from 245 to 79000 m<sup>2</sup> and from 565 to 80000 m<sup>2</sup>, respectively) and by a high connectivity among ponds: the proximity and the absence of physical barriers between them enable the dispersal of organisms, especially in the case of active dispersers. Thus, a continuous exchange of organisms was expected in both networks. We hypothesised that 1) community similarity among assemblages of active dispersers would be higher than community similarity among the other biotic groups due to their dispersal ability; and 2) the higher number of micro- and mesohabitats in largest ponds could favour floristic richness more than faunal richness, since plants are more related to spatial factors than animals. The average of community similarity was quantified by means of SIMPER analysis. A correlation analysis was performed to study the possible relationship between pond size and species richness per group. Our first prediction was validated in both ponds networks. In relation to our second hypothesis, we only found a marginally significant relationship between pond size and active dispersers' richness in the Giara di Gesturi network.

## VEGETATION OF THE CISTERNS/WATERING-PLACES OF THE ISLAND OF BRAČ (DALMATIA, CROATIA)

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Vegetational and floristic researches on cisterns/watering-places were carried out during 2014 in three locations on the island of Brač (Dalmatia, Croatia). Cisterns/watering-places are artificial, except one watering-place on Vidova gora mountain (Trolokve). These habitats were completely neglected before so that floristic and vegetational knowledge on diversity of the island of Brač were increased by our study. Following phytosociological method on the following plant communities were detected in the explored locations: Ass. *Potameto-Najadetum* Horvatić et Micevski 1960, Ass. *Potametum natantis* Lkšić. et Pavlović 1976, Ass. *Typhetum angustifoliae* Pignatti 1953 and Ass. *Cyperetum flavescens* W. Koch 1926 em. Aichinger 1933. Moreover eighteen taxa of vascular plants were recorded for the first time for the flora of the island of Brač. Total number of taxa registered for the flora of the island of Brač is 1144.

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