Article

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The Mediterranean Island Wetlands (MedIsWet) inventory: strengths and shortfalls of the currently available floristic data

Abstract

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MedIsWet (Conservation of the island wetlands of the Mediterranean Basin) is a MAVA funded project which aims at investigating all seasonal or permanent island wetlands both natural and artificial, with a minimum extent of 0.1 hectares. More than 16,000 wetlands from almost all the Mediterranean, including islands from France, Italy, Malta, Croatia, Cyprus, Tunisia, Turkey, Greece and Spain were mapped. Over 2,500 of them were inventoried in the field and more than 500 scientific contributions catalogued. In total, more than 35,000 plant occurrences were uploaded, in a standardised and comparable way, on the national open-source web portals. These can be related to the recorded threats, uses and other spatially retrievable information. Here, we show strengths and shortfalls of the already available information about the floristic records. Although further improvements are needed, we discuss how these data can be used for research and policy actions and to develop conservation projects.

Key words: databases, floristic records, field surveys, rapid assessment, hydro-hygrophilous vegetation.

Introduction

The Mediterranean is a crossroads for both humans and wildlife, where nearly 30,000 plant species (~20% of the world total) cohabit with five hundred million people (~10% of

the world total) in less around 5% of the Earth's surface (Cowling & al. 1996; Blondel & al. 2010). It is the second largest biodiversity mega-hotspot in the world, and 60% of its total flora is constituted by Mediterranean endemics, with 4,500 of them considered to be endangered by the increasing human population and their related activities (Greuter 1994).

A significant component of the Mediterranean plant biodiversity is harboured in about 11,000 islands and islets, of which 250 are inhabited by humans, representing one of the largest 'archipelagos' in the world (Fois & al. 2020; Médail 2013; 2022). Being mostly 'continental' or 'chersogenous' islands, with some exceptions such as Cyprus, they are generally conservative systems, also known as 'refugia', remarkably well buffered against the effects of climatic and evolutionary changes and rich in old relic elements (Greuter 2001; Médail & Diadema 2009). Moreover, recent diversifications of species or still diversifying lineages are favoured by the isolation and environmental heterogeneity of most Mediterranean islands (Fois & al. 2022; Médail 2022). The phytogeographic interest of Mediterranean islands has been more recently accompanied by their conservation concerns, with high rates of their floras endangered due to both intrinsic (e.g., low genetic diversity, narrow and/or fragmented populations) and extrinsic causes (e.g., human-induced pressures). Consequently, wetlands, which are generally not particularly rich in plants of phytogeographic interest, are instead increasingly investigated by botanists because they are recognised as one of the most fragile Mediterranean ecosystems (Almond & al. 2020). It is not surprising, for instance, that several plants living in wet habitats (henceforth: wetland plants) are listed in the Annexes of the 'Habitats' Directive (92/43/EEC) and in the 'Top 50 Mediterranean Island Plants' to be urgently conserved (Pasta & al. 2017).

Recent literature reviews from Sardinia have summarised research trends in wetlands and identified some patterns which are shared with most Mediterranean islands (Cuena-Lombraña & al. 2021; Fois & al. 2021): plants (especially vascular plants) and vertebrates (especially birds) were the most investigated 'species groups' in Sardinian wetlands. An exponentially increasing number of papers was detected from the beginning of this century, with topics principally related to ecology and conservation. These were possibly favoured by the increasing attention given to wetlands by several associations and supported by policy initiatives. Amongst wetland types, large coastal wetlands were the most investigated, with important knowledge and conservation gaps found for small wetlands, especially if ephemeral. In Italy as a whole, instead, most papers are mainly focused on lakes and rivers (Barone & al. 2022). Even basic floristic inventories in irrigation ponds and other similar artificial wetlands are very scarce, despite their high representativeness, especially in Sicily (Panzeca & al. 2021). A similar situation can be identified by exploring Ramsar sites (https://rsis.ramsar.org). Of the 24 Ramsar sites found in Mediterranean islands (none in Greek, Croatian and Turkish islands), the Tourbière de Moltifao and Mares temporaires de Tre Padule de Suartone (Corsica) are the only two inland freshwater wetlands, despite their demonstrated conservation importance, especially for plants, amphibians and invertebrates (e.g. Grillas & al. 2004; Minissale & Sciandrello 2016; Bagella & al. 2016).

In this context, the "Conservation of the island wetlands of the Mediterranean Basin" (MedIsWet) project, funded by MAVA Foundation, has been conceived to fill knowledge and conservation gaps in the relevant set of Mediterranean wetlands in islands, giving particular attention to the hitherto less investigated ones, such as small wetlands and artificial ones. Accordingly, the main project objectives were to: i) document the existence and significance of the Mediterranean island wetlands (both natural and artificial, above 0.1 ha,

no linear systems included) and disseminate knowledge to the public and scientific community; ii) mature and implement restoration projects in at least nine wetlands across the Mediterranean islands; and iii) promote their protection through laws, concrete legislative measures and activities at local, national and Mediterranean scale. MedIsWet has evolved as a natural progression of WWF Greece's project "Conservation of the island wetlands of Greece" that launched in 2004 and which was completed in 2016, also in response to the Ramsar resolution XII.14 "Conservation of the Mediterranean basin island wetlands" that was adopted in 2015 and provided for the documentation and protection of the Mediterranean island wetlands. Among the abiotic and biotic information available on the online national databases, a species list of plants was also reported for each inventoried wetland. Here, we present these floristic datasets of potential interest for all Mediterranean botanists and wetland managers.

The MedIsWet Databases

All nine national databases (data from the Croatian database were not included in this publication) were identically structured and they are compatible to allow for the merging of all databases under one host in the future. The interdependent and combined search options allow the user to select a set of wetlands of interest by combining different filters such as location (e.g., island, municipality), protection status, wetland type, and many more. All data from each database can be exported and can be freely used under the Attribution-Share Alike 4.0 International licensing (CC BY-SA 4.0).

For this paper, we retrieved floristic data from the following databases:

Greece: https://www.ygrotopio.gr; Cyprus: https://www.cypruswetlands.org, Spain: https://www.humedalesdebaleares.es; Turkey: https://adasulakalanlari.org, France: https://franceiswet.fr; Malta: https://www.maltawetlands.org; Tunisia: https://zoneshumides-tunisie.tn; Italy: https://italiaiswet.it.

In most cases, data are available both in English and in the national languages and include both data from cited literature and from original field surveys. The information in the field was gathered following the "Rapid Assessment" protocol, defined by MedWet (significant modifications in the protocol were made for the Greek project) in order to provide a general overview of a maximum number of sites with limited resources (Tomàs-Vives 2008). The plant species checklist is only one of the 17 parameters recorded by desktop and field surveys. We inventoried all plants found within wetland boundaries, including several terrestrial ones, which are nevertheless also common along wetland banks and saturated soils. Each record represents a species which is reported with the respective taxonomical binomial name (or genus, when a specific identification was not possible) and family, wetland site (toponym and code), vegetation type, and approximated coverage (dominant, co-dominant, present). Nomenclature was standardised as far as possible according to global accepted taxonomy (e.g., http://www.theplantlist.org), although local adaptations were accepted. For summarising results here, possible synonymy was revised only for the most common taxa.

Results

Descriptive statistics

A total of 35,659 records of plant presence, including both data collected on the field and on existing literature, were uploaded in the above listed databases, around 92% of them are reported at species and subspecies levels. Data were gathered in 2,645 sites from 107 Mediterranean islands belonging to eight different countries (Table 1). It should be noted that the databases may include more sites, but without plant species information.

With some case-by-case exceptions, floristic inventories were almost equally covering the different wetland types (Fig. 1). Considering the databases together, floristic data were reported for 1,022 artificial wetlands (39% of the total), 1,148 small wetlands with a surface area < 1 ha and 1,146 coastal wetlands (each accounting for nearly 43% of the total).

Plant families and species

Among the 224 families present in the databases, including around 4,080 specific and subspecific taxa, the most representative was *Poaceae* (460 specific and subspecific taxa), followed by *Asteraceae* (377) and *Fabaceae* (366) (Fig. 2). In terms of number of records, the richest family is *Poaceae* (4,909 records), followed by *Asteraceae* (2,922), and *Juncaceae* (1,864) (Fig. 3). The most recorded were *Phragmites australis* (Cav.) Steud. (1,288 records) and the introduced *Arundo donax* L. (723), followed by *Pistacia lentiscus* L., *Dittrichia viscosa* (L.) Greuter and *Tamarix africana* Poir. (around 550 each) (Fig. 3).

Table 1. Information on number of sites with plant information, islands and records per country or Italian administrative region (Sardinia and Sicily). The total number of plant presence records and respective percentages at species level are also reported in the last column.

Country/Region	N. sites	N. islands	N. records (% sp. level)
Greece	698	61	4563 (63)
Cyprus	297	1	2519 (78)
Spain	135	5	1702 (94)
Turkey	58	22	528 (86)
France	382	3	9329 (97)
Malta	54	2	365 (94)
Tunisia	5	3	135 (100)
Sicily (Italy)	514	4	2558 (100)
Sardinia (Italy)	502	6	13960 (99)

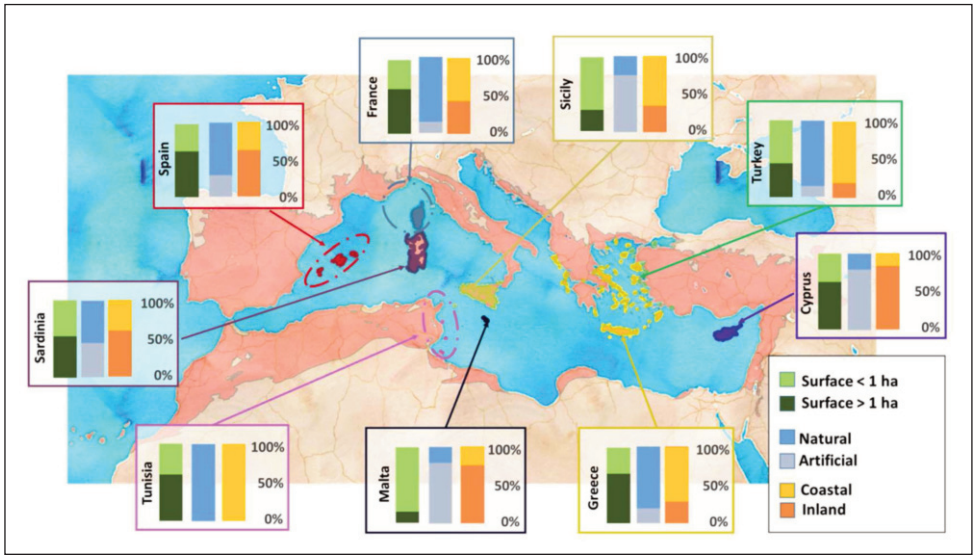

Fig. 1. Distribution of wetlands included in the MedIsWet databases per country/region with floristic data and relative percentages of natural *vs*. artificial, coastal *vs*. inland, and wetlands with a surface area < *vs*. > 1 hectare.

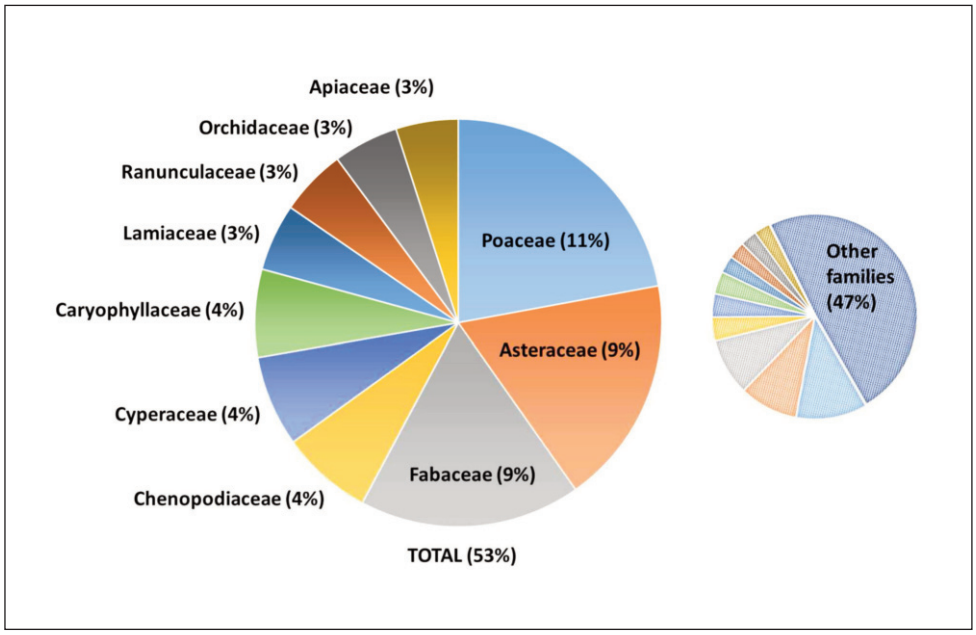

Fig. 2. The most species-rich families spectrum of the flora of Mediterranean islands wetlands.

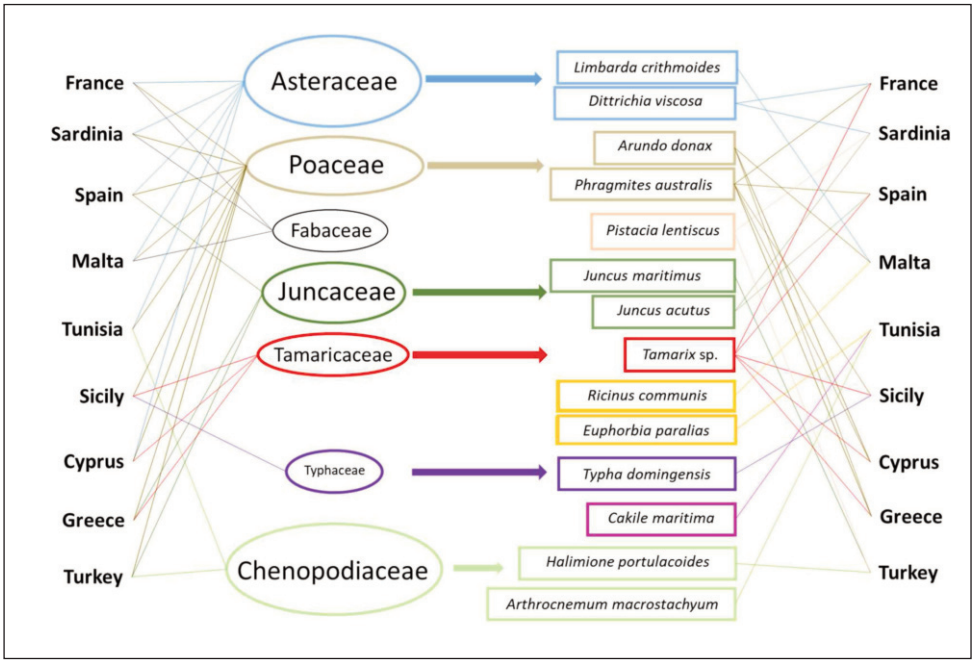

Fig. 3. Synthetic scheme of most recorded families and taxa. Connectors are referred to the top three families and taxa in each country/region. Arrows indicate the corresponding families of the taxa. In the cases of *Pistacia lentiscus* (*Anacardiaceae*), *Cakile maritima* Scop. (*Brassicaceae*), *Ricinus communis* L. and *Euphorbia paralias* L. (*Euphorbiaceae*), the respective families were not reported because these did not result as 'top recorded' ones, despite the high number of records of such taxa belonging to them.

Discussion

This paper briefly summarises the floristic data collected to date and that is currently available from the above-mentioned databases. It is important to highlight that the project has been designed with a multidisciplinary approach, which also includes faunistic inventories, human activities, threats, ecosystem services provided by wetlands, etc. Therefore, incomplete floristic datasets were compensated for a large variety of information. Moreover, the database was conceived as a baseline to be continually updated and implemented by the same providers and also by possible external support from managers or visitors, who are always invited to inform the authors about possible missing relevant information.

MedIsWet datasets are as exhaustive as possible in compiling records already published and mostly already reported in other databases. However, particular efforts were invested in inventorying all those sites that were never recorded before, in order to fill gaps in knowledge and enlarge the representativeness of the current status, including the negative aspects. The numbers of the most common taxa are incomparable – although complementary – to global datasets, such as GBIF (https://www.gbif.org). However, floristic information for several understudied

sites were for the first time documented, providing useful information on the presence of both native rare and alien invasive taxa. For instance, one unknown population of the rare *Thelypteris palustris* Schott was recently found during one field survey in the Sicilian Nebrodi mountains (wetland code ITG13SIC11403; Sciandrello & al. 2021), and *Ludwigia palustris* (L.) Elliott and *Halopeplis amplexicaulis* (Vahl) Ces., Pass. & Gibelli were for the first time recorded in one small dam in Sardinia (wetland code ITG27SAR2050) and for the island of San Pietro (wetland code ITG27PIE0005), respectively. Some alien taxa were also recorded for the first time, as in the case of *Tetragonia tetragonoides* (Pall.) Kuntze that was found in one natural coastal wetland (ITG26SAR2741; Galasso & al. 2021), while others such as *Carpobrotus edulis* (L.) N.E. Br., included in the "100 worst" invasive species of Europe (Nentwig & al. 2018), have been recorded almost everywhere exerting its ground cover effect on natural vegetation in degraded environments.

Similar to the MedIsWet dataset, *Poaceae*, *Asteraceae*, and *Fabaceae* are generally the most represented families in general floras of several Mediterranean islands, such as Sardinia and Baleares (Mayoral & al. 2018) or Sicily (Raimondo & al. 2010). This spectrum sensibly differ to those obtained from checklists of macrophytes or aquatic plants (e.g., Murphy & al. 2019), as we also inventoried several terrestrial plants found along wetland banks and saturated soils, such as *Pistacia lentiscus* or *Dittrichia viscosa* or invasive taxa like *Ricinus communis.* Since wetlands are generally associated with salt marsh, dune and sandy coastal habitats, plant species richness increases with the inclusion of halophytic and psammophytic vegetation due to variable site conditions (Yılmaz & al. 2020).

As regards the record frequencies per family and species, the third most common family in Mediterranean floras, *Fabaceae*, is in the case of Mediterranean wetlands, replaced by the *Juncaceae*, due to the large presence of species of the genus *Juncus* living in wet habitats. The 27 species of *Juncus* reported in our datasets are present in a large array of wetland types, from coastal salt marshes to inland freshwater places; some taxa, such as *Juncus acutus* L., are also common in degraded (e.g., overgrazed) and artificial environments but it frequently occurs as the only or almost only marsh vegetation representative in wetlands with few flora species.

Without claiming our information is complete, the inventories presented here constitute a basic tool with geographic and field data in support of research and conservation plans, which has to be continuously updated and implemented. Like most shared data, this is a complementary tool in support of diverse other initiatives, such as satellite-based wetland monitoring programs (Weise & al. 2020), concrete policy and conservation actions (Emmanouilidou 2019) or research programmes on wetland plants ecology and distribution. Plant inventories, and biological data more in general, are fundamental to individuate the areas of conservation irreplaceability as well as potential risks related, for instance, to the presence of some harmful or invasive species. Otherwise, conservation projects have to include further information related, among others, to economic interests or the general potential feasibility of a project. The MedIsWet project itself was conceived with a view to having a second phase of concrete restoration actions, subsequent or simultaneous to the initial inventory stage. As presented during the 12th European Conference on Ecological Restoration (SERE 2021), all project partners are currently implementing at least one restoration action in sites identified in the initial phase. The data can be replicated or used for implementing similar strategies by any organisation interested in wetlands conservation.

Conclusions

The wetland inventories presented herewith are important complementary contributions to plant knowledge, which is still recognised as a crucial gap to be filled across the Mediterranean. However, without the improvement and regular update of such information, the protection of wetlands would risk being insufficient. Acknowledging that human and economic resources are as crucial as they are limited, enlarging collaborations to develop and fund new and more integrated projects is one of, if not the only, possibility to ensure the long-term maintenance of what has been done so far (Taylor & al. 2021). Accordingly, the data presented here, and all the rest of the information reported in the databases is freely available, with the aim of laying the foundations of an even more inclusive and constructive network of wetland conservationists.

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