

The wetland flora of Milos, western Kiklades, Greece

Burkhard Biel¹ & Kit Tan²

¹ Am Judengarten 3, D-97204 Höchberg, Germany

² Institute of Biology, University of Copenhagen, Universitetsparken15, DK-2100 Copenhagen Ø, Denmark, e-mail: kitt@bio.ku.dk (author for correspondence)

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Abstract. Numerous wet places exist on Milos which can be categorized as follows – natural lakes, gravel and quarry pits (artificial lakes), reed swamps and sulphurous swamps, ephemeral or vernal pools and ponds, stream valleys with temporary pools, and estuaries at the outflow of the larger streams.

The wetlands are indicated in a map and their typical component plants listed. The flora alters every year depending on local rainfall and condensation (dew). Among the more interesting and rare species are *Cicendia filiformis*, *Eleocharis multicaulis*, *Illecebrum verticillatum*, *Isoetes hystrix*, *Isoetes phrygia*, *Juncus pygmaeus*, *Potamogeton schweinfurthii* and *Ranunculus tripartitus*. The discovery of *Triops cancriformis* in a temporary pool is significant as an indicator species of muddy vernal pools; this is a branchiopod only once documented from Greece.

Key words: Aegean area, floristic composition, Greece, Kiklades, temporary pools, *Triops cancriformis*, wetlands

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Introduction

The island of Milos is situated in SW Kiklades. It forms part of the Hellenic Volcanic Arc which stretches from Aegina in the west, along Methana, Milos, Santorini, Kos and Nisiros to Bodrum in SW Anatolia in the east. Geologically it consists of an old eroded strato-volcano overlaid by more recent lava-domes, pyroclastic cones and rings of tuff. The last eruption on the island dates back more than 60,000 years, but a few fumaroles and submerged hot springs are still bubbling. The highest peaks are Profitis Ilias (750 m) and Chodro Vouno (635 m) in the southwest. Larger plains suitable for agriculture are restricted to the eastern part of the island.

The climate is characterized by semi-arid winter-rain with an annual precipitation of c. 400 mm (<https://weather.milos.net/climate>). There are numerous streams and rivulets cascading down the “mountains” and hills, but none are permanent. The vegetation mainly consists of phrygana, the density of which depends on subsoil, humidity and grazing; it is typical of most Aegean islands. Slopes in the north and stream valleys have small patches of shrubby vegetation. *Stipa capensis* grassland occurs on old volcanic slopes in the southeast. A large part of the island is influenced by traditional agriculture, active or abandoned. A summary of characteristics of Mediterranean wetlands can be found in Pearce & Crivelli (1994) and an account of the Isoëto-Nano-

juncetea vegetation in Greece provided by Bergmeier & Raus (1999).

Mining has been the most important source of income on Milos since colonisation (www.photovolcanica.com/VolcanoInfo/Milos/Milos.html). The vast areas of open-cast mining (entry forbidden!) mostly in the east, southeast and southwest are impressive. The largest bentonite mine in Europe (and one of the largest in the world) has been quarried in the northeast of the island since 1952 (Fig. 1). The quarries together with the accompanying slag heaps have destroyed both ground and vegetation tremendously. Tourism is on the increase, to the detriment of the natural environment.

Milos was the first Greek port of call for Sibthorp and Bauer in the spring of 1786 at the beginning of their celebrated expedition which laid the foundations for *Flora Graeca Sibthorpiana*. Travelling independently, Hawkins visited the island in 1787 and again in 1794, making some botanical observations.

Dumont d'Urville (1822) reported 27 species from Milos. Orphanides collected on the island in 1856 and 1857, and Heldreich in 1889, but their collections were not numerous. Reching visited the island in 1927, gathering at least 61 species. Runemark & al. collected extensively on Milos in 1967 and again in 2003, harvesting a total of 528 species including several wetland taxa. Browicz (1997) reported on the woody flora, Delforge (1998, 2002) on the orchids, and Lansdown & al. (2017) on *Callitriche*. Raus (2012) provided many new floristic records. Important recent collectors are Tsopra in 2002 (material mainly at ATHU) and Raus & Sipman in 2011 (material mainly at B).

Up to 2017 a total of 808 vascular plant species had been registered from Milos in the *Flora Hellenica Database* (unpublished database). The number has substantially increased due to recent field work by Biel. The total number of species recorded for the island now stands at nearly 1000.



Fig. 1. Bentonite mine at Ag. Irini, Milos.

Material and methods

In general Milos is known as a dry island in the dry Kiklades. Almost all areas on the island of Milos suffer from heat and water-shortage at the height of summer. However, we found an unexpected number of wetlands on the island during our research in the years 2010, 2019 to 2022 and considered them worthy of interest. The winter of 2021 (with snowfall) and spring of 2022 have been particularly and unusually wet. The wetlands we have selected in the following text are the more developed ones. The different wetlands on Milos were categorized as follows:

- natural lakes
- gravel and quarry pits (artificial lakes)
- reed swamps and sulphurous swamps
- ephemeral or vernal pools and ponds
- stream valleys with temporary pools
- estuaries at the outflow of the larger streams

We define a *pool* as a small collection of usually fresh water, as one supplied by a spring, or occurring in the course of a stream, while *pond* is an inland body of standing water, either natural or man-made (definitions according to WikiDiff). Vernal pools and ponds are always seasonal, providing a special habitat for certain plants and animals (Grillas & al. 2004). They serve as breeding grounds for many amphibian and invertebrate species. As they have no predatory fish they allow the larval development of several insect species. The pools are dry for part of the year, fill up with winter rain (rarely snow melt as in winter 2021) and rising water tables, drying out slowly during spring and completely during the summer. Thus there are extreme seasonal changes in environmental conditions which allow only certain plants to flourish. Vernal pools are so called because they are often at their maximum depth in spring.

The stream valleys with temporary pools are wetlands with inflow and outflow channels and so are categorized separately from isolated vernal pools.

Most of the wetlands investigated are surrounded by stony, ± open phrygana, the estuaries with temporary pools are entrenched in sandy beach areas.

Vouchers collected for the specimens are kept in the private herbarium of the first author.

Results

The wetlands are widely distributed, especially in the western and southern parts of the island. Their localities are indicated in a map (see Fig. 2); with further exploration in the wet season (winter and spring) more areas will probably be identified. The component flora typical of each wetland-type is listed. The flora behaves differently every year depending on local rainfall and condensation (dew), varying from luxuriant growth to desiccation and eventual loss of species. Typical members of spring wetlands such as flooded plains, depressions and streambeds with impermeable ground are *Crassula* spp., *Isoetes histrix* and *Ophioglossum lusitanicum* (see Fig. 3).

The rare *Isoetes phrygia*, new for the floristic region Kiklades, was found on 5 April 2022 at locality no. 8 in the northwest of the island, and again in May 2022 at locality no. 9 in the south of the island. The latter was the same site where Runemark had first collected it on Milos (ENE of Psatadika, 17 May 2003, *Runemark* 51782, LD). Until now it had only been recorded for Greece on Crete, Elafonisos and the southern part of the Malea peninsula. During our research 13 of the wetland taxa were reported for the first time for the island of Milos and two of them found to be new for the Kiklades (Biel & Tan 2021, 2022). The list of taxa is incomplete pending further investigations.

Natural lakes

1. Chivadolimni (Fig. 4) is the only natural lake on Milos which rarely dries out by late summer. It is situated behind the southern coast of the inner Kolpos ("To Limani") and separated from the sea by a sandy beach 100–150 m wide; there is an overflow channel to the sea. A small stream enters at the western margin and a spring below the Ag. Konstantinos chapel provides some water. It is an important stopover for migrating birds. The Balkan terrapin *Mauremys rivulata*

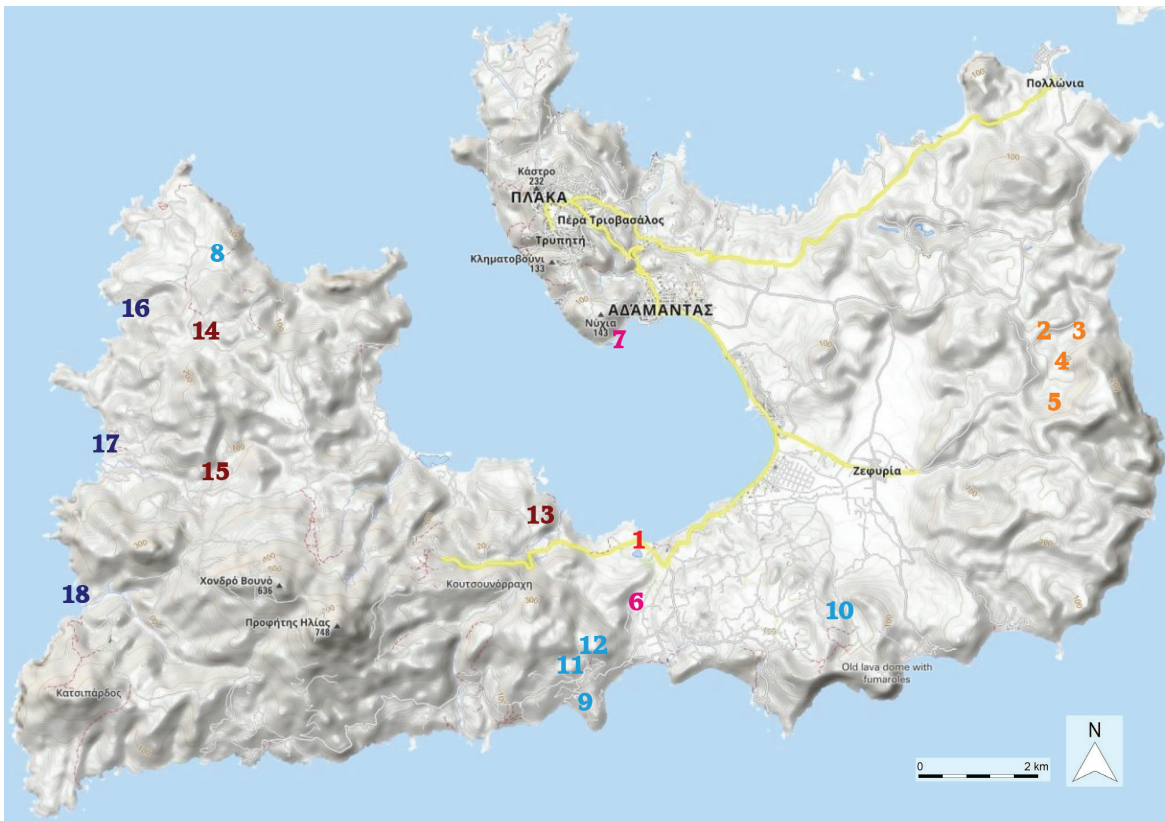


Fig. 2. Distribution of wetlands on the island of Milos (numbered as in text).

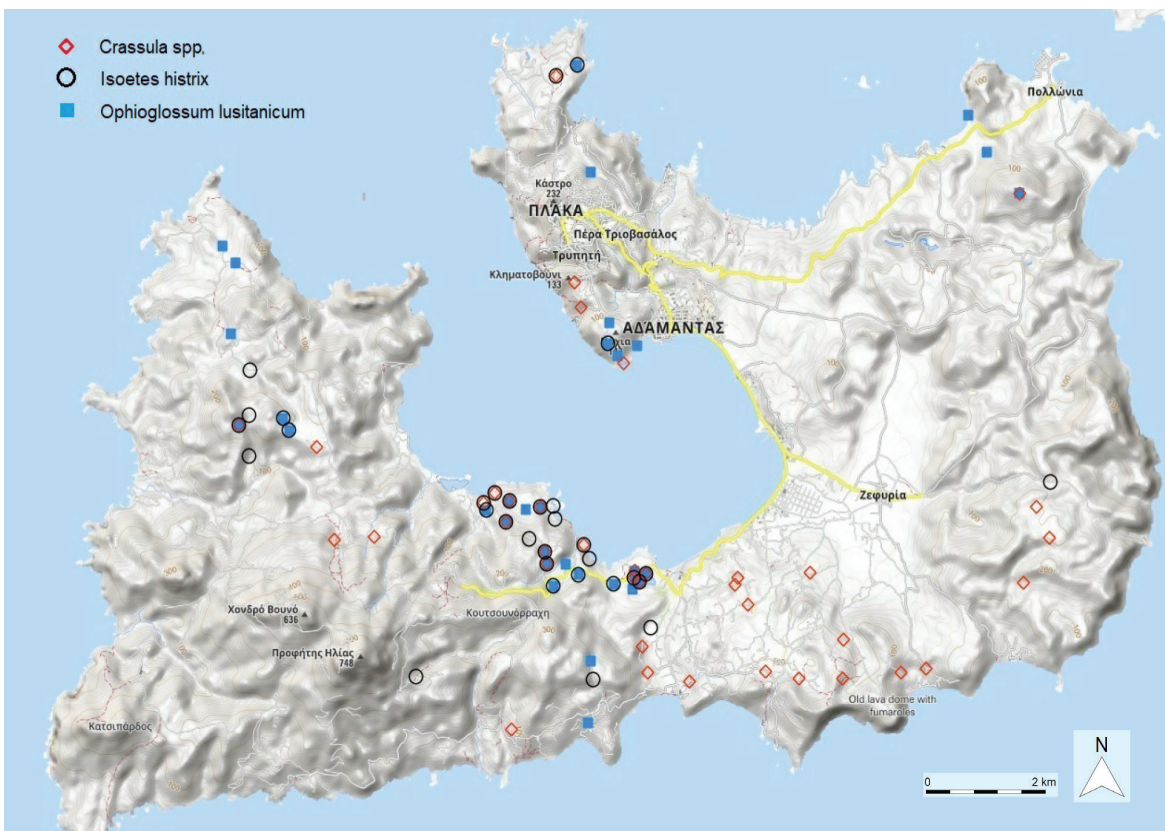


Fig. 3. Distribution of four indicator species on spring wetland: *Crassula* spp., *Isoetes histrix* and *Ophioglossum lusitanicum*.



Fig. 4. Chivadolimni, the only natural lake (locality 1).

has been observed here. Typical plants in and around the lake are *Aeluropus littoralis*, *Arundo donax*, *Bellis annua* subsp. *annua*, *Briza minor*, *Callitriche brutia*, *Callitriche cophocarpa*, *Carex divisa*, *Centaureum maritimum*, *Corrigiola littoralis*, *Crassula tillaea*, *Crassula vaillantii*, *Cyperus badius*, *Cyperus longus* agg., *Isoetes histrix*, *Isolepis cernua*, *Juncus bufonius*, *Juncus capitatus*, *Juncus heldreichianus*, *Lotus angustissimus*, *Lotus halophilus*, *Lythrum borysthenticum*, *Lythrum hyssopifolia*, *Lythrum tribracteatum*, *Medicago littoralis*, *Mentha pulegium*, *Myosotis incrassata*, *Ophioglossum lusitanicum*, *Phragmites frutescens*, *Plantago coronopus*, *Poa trivialis*, *Polypogon viridis*, *Ranunculus muricatus*, *Ranunculus peltatus* subsp. *peltatus*, *Ranunculus tripartitus*, *Ruppia maritima*, *Ruppia spiralis*, *Scirpoides holoschoenus*, *Sedum litoreum*, *Teesdalia coronopifolia* and *Zostera marina*.

Old gravel and quarry pits (artificial lakes)

We made a selection of the more accessible, more species-rich and less disturbed sites. Characteristic or constantly occurring taxa are *Centaureum* spp., *Inula viscosa*, *Lythrum tribracteatum* and *Schenkia spicata*.

2. Shallow gravel pit drying out in summer, located W of Kato Komia. Typical plants are *Bolboschoenus maritimus* agg., *Centaureum pulchellum*, *Centaureum tenuiflorum*, *Inula viscosa*, *Lythrum tribracteatum*, *Phalaris aquatica*, *Phalaris minor*,

Phalaris paradoxa, *Phragmites australis*, *Plantago coronopus*, *Polypogon maritimus* subsp. *maritimus*, *Ranunculus peltatus* subsp. *peltatus*, *Schenkia spicata* and *Typha domingensis*.

3. Deep quarry pond fringed by reeds, located W of Kato Komia, size c. 1.1 ha, used as irrigation reservoir (Fig. 5). Typical plants are *Blackstonia perfoliata*, *Centaureum tenuiflorum*, *Inula viscosa*, *Lythrum tribracteatum*, *Nerium oleander*, *Ononis diffusa*, *Phragmites australis*, *Polypogon monspeliensis*, *Potamogeton schweinfurthii*, *Schenkia spicata*, *Symphytotrichum squamatum* and *Typha domingensis*.
4. Deep quarry pond SSW of Kato Komia, size c. 0.7 ha, used as reservoir. Typical plants are as for no. 3 with the absence of *Centaureum* and *Lythrum* spp.
5. Quarry pond SSW of Kato Komia, occupying c. 0.4 ha, covered with reeds, drying out in summer. Typical plants are *Blackstonia perfoliata*, *Centaureum pulchellum*, *Centaureum tenuiflorum*, *Inula viscosa*, *Juncus heldreichianus*, *Lythrum hyssopifolia*, *Lythrum tribracteatum*, *Mentha pulegium*, *Ononis diffusa*, *Phragmites australis*, *Polypogon monspeliensis*, *Schenkia spicata* and *Typha domingensis*.

Reed swamps and sulphurous swamps

These are important rest and stopovers for passage migrants, together with lake Chivadolimni which lies between.



Fig. 5. Deep quarry pond W of Kato Komia (locality 4).



Fig. 6. Brackish swamp SW of Adamas (locality 7).



Fig. 7. Group of three ponds at edge of Fyriplaka crater, surroundings heavily grazed (locality 10).

6. *Bolboschoenus* swamp north of Provatas (c. 2.4 ha). It is fed by a small stream on the SW edge, completely flooded in spring and drying out in summer. Typical plants are *Arundo donax*, *Bolboschoenus glaucus*, *Carex divisa*, *Eleocharis palustris*, *Heliotropium supinum*, *Imperata cylindrica*, *Isoetes histrix*, *Linum bienne*, *Lotus angustissimus*, *Lythrum borysthenicum*, *Phalaris paradoxa*, *Polypogon maritimus* subsp. *maritimus*, *Populus alba*, *Ranunculus peltatus* subsp. *peltatus*, *Rumex conglomeratus*, *Scirpoides holoschoenus*, *Symphotrichum squamatum* and *Vitex agnus-castus*.
7. Brackish swamp SW of Adamas (c. 0.3 ha), directly behind a narrow gravelly rampart to the sea (Fig. 6). It is strongly influenced by gaseous springs of volcanic sulphur, and dries out in summer. Typical plants are *Caroxylon aegaeum*, *Centaurium maritimum*, *Crassula tillaea*, *Juncus bufonius*, *Juncus heldreichianus*, *Limonium roridum*, *Limonium virgatum*, *Mesembryanthemum nodiflorum*, *Poa infirma*, *Sagina maritima*, *Sarcocornia fruticosa*, and *Sarcocornia perennis*.
- ### Ephemeral or vernal pools and temporary ponds
- Characteristic or constant species for this type were noted as *Eleocharis* spp., *Juncus* spp., *Lythrum borysthenicum* and *Ranunculus peltatus* subsp. *peltatus*.
8. Round pond NW of Embourios (size c. 220 m²), “Limnari” in open *Juniperus turbinata* woodland, without feed tributary, drying out in summer. Typical plants are *Eleocharis palustris*, *Isoetes phrygia*, *Juncus bufonius*, *Juncus capitatus*, *Lythrum borysthenicum*, *Plantago coronopus*, *Polypogon maritimus* subsp. *subspathaceus*, *Ranunculus muricatus* and *Ranunculus peltatus* subsp. *peltatus*, also *Callitriche* spp. and *Chara* spp.
9. Small round pool within the village of Kipos (c. 150 m²), on rocky slope with phrygana, fed by a small stream. Typical plants are *Carex divisa*, *Centaurium tenuiflorum*, *Eleocharis palustris*, *Isoetes phrygia*, *Lotus angustissimus*, *Lythrum borysthenicum*, *Lythrum tribracteatum*, *Ophioglossum lusitanicum*, *Phalaris paradoxa* and *Ranunculus peltatus* subsp. *peltatus*.
10. Group of three ponds at the NE margin of the Fyriplaka crater, between Ag. Kyriaki and Aliko salt marsh, surrounded by sandy and partly stony phrygana, heavily grazed (Fig. 7). Typical plants are *Centaurium maritimum*, *Corrigiola litoralis*, *Glinus lotoides*, *Illecebrum verticillatum*, *Juncus heldreichianus*, *Juncus pygmaeus*, *Linum bienne*,



Fig. 8. Muddy pond N of Kipos, with *Triops cancriformis* (locality 12).

Lotus angustissimus, *Lythrum borysthenicum*, *Lythrum tribracteatum*, *Phalaris minor*, *Polypogon maritimus* subsp. *maritimus*, *Ranunculus peltatus* subsp. *peltatus*, *Scirpoides holoschoenus*, *Spergula arvensis*, *Spergularia bocconeii* and *Spergularia diandra*.

11. Two ponds N of Kipos, situated in depression on a rocky phrygana slope, used as reservoir and for drinking cattle. Typical plants are *Centaurium pulchellum*, *Centaurium tenuiflorum*, *Eleocharis palustris*, *Juncus bufonius*, *Juncus capitatus*, *Linum bienne*, *Mentha pulegium* and *Scirpoides holoschoenus*.
12. Small pond N of Kipos on a rocky slope with phrygana, a drinking supply for cattle (Fig. 8). The rare *Triops cancriformis* (Bosc, 1801-1802), a

large branchiopod crustacean (Notostraca) was observed on 15 May 2022. There were 40-50 individuals attaining a size of 10 cm in this muddy pond but not in any other body of water on the island. This is the first report of its occurrence in the Kiklades, there seem to be very few observations from Greece although the distribution ranges from Europe to SW Asia. It is considered an indicator species of muddy vernal pools. We know of one report from the Axios River delta in northeastern Greece (Kazantzidis & Goutner 1996). *Triops* survives desiccation by laying egg cysts resistant to drought and temperature extremes; these hatch when in contact with water. Typical plants at this pool are *Eleocharis palustris*, *Isoetes histrix*, *Juncus capitatus*, *Lythrum tribracteatum*, *Ranunculus paludosus* and *Ranunculus peltatus* subsp. *peltatus*.

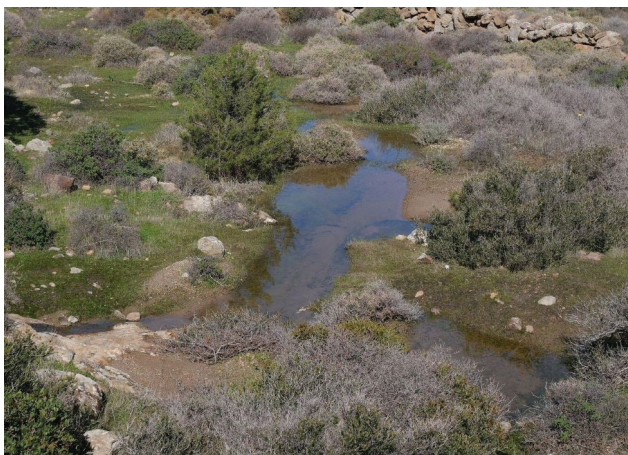


Fig. 9. Small stream with temporary pools ENE of Ag. Marina (locality 13).



Fig. 10. Estuary of small stream with temporary pools (Vromolimni) behind Agathia beach (locality 16).

Stream valleys with temporary pools

13. Small stream with temporary pools ENE of Ag. Marina, on a rocky phrygana slope (Fig. 9). Typical plants are *Briza minor*, *Callitriche brutia*, *Centaureum maritimum*, *Centaureum pulchellum*, *Cicendia filiformis*, *Eleocharis multicaulis*, *Illecebrum verticillatum*, *Isoetes histrix*, *Isolepis cernua*, *Juncus capitatus*, *Juncus pygmaeus*, *Linum bienne*, *Lotus conimbricensis*, *Lythrum hyssopifolia*, *Lythrum tribracteatum*, *Mentha pulegium*, *Plantago coronopus*, *Polypogon maritimus*, *Ranunculus paludosus* and *Solenopsis laurentia*.
14. Small stream with temporary pools in a valley near ancient quarries, NW of Embourios. Typical plants are *Callitriche cophocarpa*, *Centaureum maritimum*, *Centaureum pulchellum*, *Cicendia filiformis*, *Isoetes histrix*, *Juncus capitatus*, *Mentha pulegium*, *Myrtus communis*, *Polypogon maritimus* subsp. *maritimus*, *Ranunculus paludosus*, *Scirpoides holoschoenus*, and *Solenopsis laurentia*.
15. Wet, seasonally flooded stream valley with shrubs below Favas 'mountain', WSW of Embourios. Typical plants are *Blackstonia perfoliata*, *Carex divisa*, *Geranium dissectum*, *Juncus heldreichianus*, *Mentha pulegium*, *Myrtus communis*, *Nerium oleander*, *Polypogon viridis*, *Scirpoides holoschoenus*, *Smilax aspera*, *Typha domingensis* and *Vitex agnus-castus*.

Estuaries at the outflow of the larger streams

This is a selection of the more species rich and less disturbed sites. Characteristic species are *Juncus* spp. and *Polypogon maritimus*.

16. Estuary of stream with temporary pools ('Vromolimni') behind the broad Agathia beach, W of Embourios (Fig. 10). Typical plants are *Juncus maritimus*, *Phleum exaratum*, *Polypogon maritimus* subsp. *maritimus*, *Ruppia spiralis* and *Schenkia spicata*.
17. Triades beach with two small estuaries and temporary pools, WSW of Embourios. Typical plants are *Bolboschoenus glaucus*, *Centaureum pulchellum*, *Cutandia maritima*, *Elytrigia juncea*, *Inula viscosa*, *Juncus heldreichianus*, *Myrtus communis*, *Nerium oleander*, *Polypogon maritimus* subsp. *maritimus*, *Polypogon maritimus* subsp. *subspathaceus*, *Schenkia spicata* and *Scirpoides holoschoenus*.
18. Estuary with temporary pools at sandy Agios Ioannis bay, NW of Xilokeratia. Typical plants are *Centaureum pulchellum*, *Juncus bufonius*, *Juncus heldreichianus*, *Juncus maritimus*, *Lotus angustissimus*, *Mentha pulegium*, *Nerium oleander*, *Polypogon maritimus* subsp. *maritimus* and *Vitex agnus-castus*.

Table 1. Phenology to indicate taxa of early or late soil desiccation (localities indicated in Fig. 2, in parentheses)

Flowering time in early to late spring (March to May)	
<i>Bellis annua</i> L. subsp. <i>annua</i> (1)	<i>Limonium roridum</i> (Sm.) Brullo & Guarino (7)
<i>Callitriche brutia</i> Petagna (1, 13)	<i>Limonium virgatum</i> (Willd.) Fourr. (7)
<i>Callitriche cophocarpa</i> Sendtn. (1, 14)	<i>Lotus angustissimus</i> L. (1, 6, 9, 10, 18)
<i>Cicendia filiformis</i> (L.) Delarbre (13, 14)	<i>Lythrum borysthenticum</i> (Schrank) Litv. (1, 6, 8, 9, 10)
<i>Crassula tillaea</i> Lest.-Garl. (1, 7)	<i>Lythrum hyssopifolia</i> L. (1, 5, 13)
<i>Cutandia maritima</i> (L.) Barbey (17)	<i>Lythrum tribracteatum</i> Spreng. (1, 2, 3, 5, 9, 10, 12, 13)
<i>Geranium dissectum</i> L. (15)	<i>Medicago littoralis</i> Rohde ex Loisel. (1)
<i>Illecebrum verticillatum</i> L. (10, 13)	<i>Mentha pulegium</i> L. (1, 5, 11, 13, 14, 15, 18)
<i>Juncus bufonius</i> L. (1, 7, 8, 11, 18)	<i>Mesembryanthemum nodiflorum</i> L. (7)
<i>Linum bienne</i> Mill. (6, 10, 11, 13)	<i>Ononis diffusa</i> Ten. (3, 4, 5)
<i>Lotus conimbricensis</i> Brot. (13)	<i>Phalaris aquatica</i> L. (2)
<i>Lotus halophilus</i> Boiss. & Spruner (1)	<i>Phalaris minor</i> Retz. (2, 10)
<i>Myosotis incrassata</i> Guss. (1)	<i>Phalaris paradoxa</i> L. (2, 6, 9)
<i>Ophioglossum lusitanicum</i> L. (1, 9)	<i>Phleum exaratum</i> Hochst. ex Griseb. (16)
<i>Poa infirma</i> Kunth (7)	<i>Plantago coronopus</i> L. (1, 2, 8, 13)
<i>Populus alba</i> L. (6)	<i>Poa trivialis</i> L. (1)
<i>Ranunculus muricatus</i> L. (1, 8)	<i>Polypogon maritimus</i> Willd. subsp. <i>maritimus</i> (2, 6, 10, 13, 14, 16, 17, 18)
<i>Sagina maritima</i> D. Don (7)	<i>Polypogon maritimus</i> subsp. <i>subspathaceus</i> (Req.) K. Richt. (8, 17)
<i>Solenopsis laurentia</i> (L.) C. Presl (13, 14)	<i>Polypogon monspeliensis</i> (L.) Desf. (3, 4, 5)
<i>Spergula arvensis</i> L. (10)	<i>Polypogon viridis</i> (Gouan) Breistr. (1, 15)
<i>Teesdalia coronopifolia</i> (Bergeret) Thell. (1)	<i>Potamogeton schweinfurthii</i> A. Benn. (3, 4)
	<i>Ranunculus paludosus</i> Poir. (12, 13, 14)
	<i>Ranunculus peltatus</i> Schrank subsp. <i>peltatus</i> (1, 2, 6, 8, 9, 10, 12)
	<i>Ranunculus tripartitus</i> DC. (1)
	<i>Rumex conglomeratus</i> Murray (6)
	<i>Ruppia maritima</i> L. (1)
	<i>Ruppia spiralis</i> L. ex Dumort. (1, 16)
	<i>Schenkia spicata</i> (L.) Mansion (2, 3, 4, 5, 16, 17)
	<i>Scirpoides holoschoenus</i> (L.) Soják (1, 6, 10, 11, 14, 15, 17)
	<i>Sedum litoreum</i> Guss. (1)
	<i>Spergularia bocconei</i> (Scheele) Graeb. (10)
	<i>Spergularia diandra</i> (Guss.) Heldr. (10)
	<i>Typha domingensis</i> Pers. (2, 3, 4, 5, 15)
Flowering time in summer (June to August)	
<i>Aeluropus littoralis</i> (Gouan) Parl. (1)	
<i>Blackstonia perfoliata</i> (L.) Huds. (3, 4, 5, 15)	
<i>Bolboschoenus glaucus</i> (Lam.) S. G. Smith (6, 17)	
<i>Bolboschoenus maritimus</i> (L.) Palla (2)	
<i>Briza minor</i> L. (1, 13)	
<i>Carex divisa</i> Huds. (1, 6, 15)	
<i>Centaurium maritimum</i> (L.) Fritsch (1, 7, 10, 13, 14)	
<i>Centaurium pulchellum</i> (Sw.) Druce (2, 5, 11, 13, 14, 17, 18)	
<i>Centaurium tenuiflorum</i> (Hoffmanns. & Link) Fritsch (2, 3, 5, 9, 11)	
<i>Chara</i> spp. (8)	
<i>Corrigiola litoralis</i> L. (1, 10)	
<i>Crassula vaillantii</i> (Willd.) Roth (1)	
<i>Cyperus badius</i> Desf. (1)	
<i>Cyperus longus</i> L. (1)	
<i>Eleocharis palustris</i> (L.) Roem. & Schult. (6, 8, 9, 11, 12)	
<i>Elytrigia juncea</i> (L.) Nevski (17)	
<i>Imperata cylindrica</i> (L.) Raeusch. (6)	
<i>Isoetes histrix</i> Bory (1, 6, 12, 13, 14)	
<i>Isoetes phrygia</i> (Boiss.) Hausskn. (8, 9)	
<i>Isolepis cernua</i> (Vahl) Roem. & Schult. (1, 13)	
<i>Juncus capitatus</i> Weigel (1, 8, 11, 12, 13, 14)	
<i>Juncus heldreichianus</i> Parl. (1, 5, 7, 10, 15, 17, 18)	
<i>Juncus maritimus</i> Lam. (16, 18)	
<i>Juncus pygmaeus</i> Rich. (10, 13)	
Flowering time in autumn to winter (September to February)	
<i>Arundo donax</i> L. (1, 6)	
<i>Caroxylon aegaeum</i> (Rech. f.) Akhani & Roalson (7)	
<i>Glinus lotoides</i> L. (10)	
<i>Heliotropium supinum</i> L. (6)	
<i>Inula viscosa</i> L. (2, 3, 4, 5, 17)	
<i>Phragmites australis</i> (Cav.) Trin. ex Steud. (2, 3, 4, 5)	
<i>Phragmites frutescens</i> H. Scholz (1)	
<i>Sarcocornia fruticosa</i> (L.) A.J. Scott (7)	
<i>Sarcocornia perennis</i> (Mill.) A.J. Scott (7)	
<i>Symphotrichum squamatum</i> (Spreng.) G.L.Nesom (3, 6)	
<i>Zostera marina</i> L. (1)	

Discussion and conclusions

The wetlands listed above probably occur on other Aegean islands (Bergmeier & Raus 1999) but they have never been documented in a similar manner, perhaps due to little botanical research during the wet months of winter and spring, a time when they are most obvious.

The unusually numerous and diverse wetland-types are related to the underlying substrate-type, i.e., there are various kinds of impermeable ground with in common, at least a small depression or catchment area. An impermeable clay or silt layer, or volcanic rock, allows water retention by reducing percolation and drainage into lower soil layers. Water evaporates slowly instead of draining and this allows the development of vernal pool plant communities as the soil at the water's edge is kept moist enough for plants to flourish while those nearer the centre of the pool remain more inundated. There is a fine balance when the water level recedes since surrounding terrestrial or aquatic species are prevented from dominating. Shading from taller surrounding vegetation also restricts drying out. Small and shallow pools represented by numbers 2, 6–8 exist temporarily and seasonally, ponds such as numbers 5, 9–10 keep water for a longer time while the deeper lakes numbered 1, 3 and 4 usually have water throughout or for most of the year.

Table 1 shows the flowering periods of various taxa in the wetland communities. These provide an indication of early, medium to late soil desiccation, and that flowering does not occur simultaneously even when suitable conditions are met. The data was obtained with reference to our own field notes and herbarium vouchers, as well as from the *Flora Hellenica Database*. A wet spring obviously favours germination and development of more plants than a dry spring season, especially in areas at the edge of dirt roads not on steep slopes.

In comparison with other natural sites on Milos the wetlands have a rather high percentage of annuals. Only ruderal and agricultural sites have a higher percentage. In our investigation the number of typical species (excluding non-herbaceous taxa) was 89

of which 52 (c. 58%) are annuals, thus comprising more than half the typical wetland flora. Most species are cosmopolitan, none are Greek endemics. *Anthemis rigida* subsp. *runemarkii* Biel & Kit Tan (Biel & Tan 2020), a local endemic (on Milos and the small neighbouring islands of Kimolos, Prasonisi and Poliegos), has been observed preferring seasonally wet places but it was not recorded from the categorized wetlands. *Trifolium ornithopodioides* L., a significant constituent of vernal pool vegetation elsewhere in its distribution range (Madeira to south Aegean) has been reported for Greece only from Crete but was found by Runemark on Milos (*Runemark* 51780, LD).

All wetlands on Milos are of great importance for migratory birds during spring and autumn as Milos lies on a southeastern migration route from Central Europe to Cyprus and onwards to Africa or SW Asia. More than a hundred bird species pass through, using the wetlands as stopovers to rest and refuel, the rich invertebrate population in the pools providing an ample source of food.

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