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Source: Willdenowia, 52(1) : 91-101

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: https://doi.org/10.3372/wi.52.52106

Willdenowia
Annals of the Botanic Garden and Botanical Museum Berlin

The unnoticed northward expansion of *Najas marina* subsp. *armata* (*Hydrocharitaceae*) in the Mediterranean area: an effect of climate change?

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Version of record first published online on 5 April 2022 ahead of inclusion in April 2022 issue.

Abstract: Recent reports of *Najas marina* L. (*Hydrocharitaceae*) from Sicily have been interpreted as a confirmation of its presence on the island, where it was earlier mentioned in the 1800s. However the recent finds do not represent "*N. marina*" (currently *N. major* All.) but *N. marina* subsp. *armata* Horn (= *N. delilei* Rouy), a different taxon, previously not recorded from Sicily. According to those reports and several new finds presented here, it appears to be invading reservoirs and lakes in southern Sicily and seems to be naturally expanding its range. Climate change is suggested as possible cause of this shift. The same trend appears to be taking place across the whole N Mediterranean area, from Portugal to Cyprus. The old Sicilian record of "*N. marina*" (i.e. *N. major*) remains unconfirmed: the only site where it was collected was completely destroyed to make space for houses and touristic exploitation.

Keywords: aquatic flora, climate change, European flora, *Hydrocharitaceae*, lakes, Mediterranean flora, *Najas*, *Najas delilei*, *Najas major*, *Najas marina*, range expansion, reservoirs, Sicily

Article history: Received 2 February 2022; peer-review completed 7 March 2022; received in revised form 13 March 2022; accepted for publication 17 March 2022.

Citation: Troia A. 2022: The unnoticed northward expansion of *Najas marina* subsp. *armata* (*Hydrocharitaceae*) in the Mediterranean area: an effect of climate change? – Willdenowia 52: 91–101. https://doi.org/10.3372/wi.52.52106

Introduction

Najas L. (*Hydrocharitaceae*) "is a taxonomically problematic genus, making it difficult at times to associate published research reports with the correct taxon" (Les 2020). *Najas marina* L. (the type of the genus) in its broad sense is a dioecious submerged plant with wide distribution and variability (Triest 1988).

Studies in recent years have shown that the name *Najas marina* hides two distinct species in Europe, *N. major* All. and *N. marina*, which are distinct also as to karyotypes and genetic markers (Bräuchler 2015). The former corresponds to "karyotype A" of Viinikka (1976) and to what was previously known as *N. marina* subsp. *marina*, and the latter to "karyotype B" of Viinikka (1976) and to what was previously referred to as *N. marina* subsp. *intermedia* (Wolfg. ex Gorski) Casper. The delimitation of these two taxa is important because they are used as water quality indicator organisms within the European Water Framework Directive (Rüegg & al. 2019).

A third taxon present in S Europe, and more abundant in the subtropical and tropical areas of the Old World (as far as Australia), is *Najas marina* subsp. *armata* Horn. Although morphologically and geographically separate, this taxon certainly appears linked to what is currently known as *N. marina* subsp. *marina* (Triest 1989; Rüegg & al. 2017). In support of subspecific rank there are several pieces of evidence: for example, it shows the "karyotype B" (Viinikka & al. 1987) like *N. marina* subsp. *marina*, while molecular markers seem to be unable to distinguish the two subspecies (e.g. Ito & al. 2017). On the other hand, in support of specific rank (an option adopted in recent times, for example by Feinbrun-Dothan 1991), the chromosome number $2n = 24$, counted for plants from Israel (Viinikka & al. 1987), might indicate *N. marina* subsp. *armata* as a tetraploid, compared to the diploid taxa *N. major* and *N. marina* subsp. *marina.* However, C African plants of *N. marina* subsp. *armata* were also diploid (Viinikka & al. 1987). Further investigations on the chromosome numbers of *N. marina* subsp. *armata* will certainly be useful in clarifying the situation. Subspecific rank, adopted here, reflects the separability of *N. marina* subsp. *armata* from similar taxa but also its affinity with subsp. *marina* (and not with *N. major*).

Apparently unknown in Sicily until the end of the 19th century (but see note on Cupani below), the first to report the presence of *Najas marina* s.l. in Sicily was Lojacono-Pojero (1908–1909), under *N. major* (long considered a synonym of *N. marina*). Because there were no further confirmations after this report and the

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only wetland in which the species was found (Mondello) was destroyed, the species was considered extinct at the regional level (Raimondo & al. 1994; Conti & al. 1997). The discovery of populations of "*N. marina*" around the 2000s (Barone & al. 2007; Galesi in Giardina & al. 2007; Sciandrello 2009) was regarded as a confirmation of the presence of the species in Sicily, so that it reappeared in the regional Red List as Vulnerable (Raimondo & al. 2011). Actually, Barone & al. (2007), who highlighted the confirmation, mentioned generally "*N. marina* L.", while other botanists (*Galesi*, CAT 011688 & CAT 011696, see Appendix; Sciandrello 2009) were more precise and referred the Sicilian populations that they found (in various locations in SE Sicily) to *N. marina* var. *delilei* (Rouy) Maire, which corresponds to *N. marina* subsp. *armata*.

The recent finds (reported here) of other Sicilian populations confirm that two taxa of *Najas* have been reported for Sicily: *N. major*, present until the end of the 19th century in Mondello, and which is the only taxon of this genus reported for the island in the latest regional (Raimondo & al. 2010), national (Bartolucci & al. 2018) and European (Uotila 2009) checklists; and *N. marina* subsp. *armata*, which seems to have arrived recently, being now present in the broad hottest hilly belt between Trapani and Gela, along the S side of the island.

In this contribution, the distribution in space and time of *Najas marina* subsp. *armata* in Sicily is analysed, making use of both field and bibliographic data, to hypothesize its recent and autonomous arrival in Sicily. The scope is also broadened to the situation in the whole N Mediterranean area.

Material and methods

Recent literature on the taxonomy, systematics and nomenclature of *Najas marina* s.l. was examined, from Viinikka (1976) to Rüegg & al. (2019). Data on the geographic distribution of *N. marina* subsp. *armata* were assembled through a literature search as well as through floristic and herbarium surveys. Field investigations were made in Sicily, in 2017–2021.

For herbarium investigations, PAL was consulted personally, other herbaria online (AMD, B, BM, BR, BRNU, CAT, G, GJO, GZU, JE, K, LD, LZ, MA, MJG, MW, P, PI, PRC, UPS, W, WU, Z, ZT) or by asking for help from their curators (COI, FI, FT, LISI, MPU); herbarium codes according to Thiers (2021+).

Results

Najas marina subsp. *armata* as a separate taxon

Najas marina subsp. ***armata*** Horn in Kew Bull. 7: 29. 1952 ≡ *Najas muricata* Delile, Descr. Egypte, Hist. Nat.: 281. 1813, nom. illeg. [non *Najas muricata* Thuill., Fl. Env. Paris, ed. 2: 509. 1799] ≡ *Najas delilei* Rouy in Rouy & Foucaud, Fl. France 13: 294. 1912 ≡ *Najas armata* H. Lindb. in Acta Soc. Sci. Fenn., Ser. B, Opera Biol. 1(2): 8. 1932, nom. illeg. ≡ *Najas marina* var. *delilei* (Rouy) Maire, Fl. Afrique N. 1: 205. 1952. – Protologue citation: "au bord d'un lac d'eau saumâtre avec le *Zannichellia palustris*, près de Fâreskour, dans la basse Égypte". – Lectotype (designated by Triest 1987: 29): Egypt, *Delile* in Herb. Delile (MPU 007340 [image!]). – Notes: the type was indicated as "holotype" by Triest (l.c.), to be corrected to lectotype (McNeill 2014) under Art. 9.10 of the *Code* (Turland & al. 2018). I was unable to find duplicates of MPU 007340 or other relevant specimens, but the illustration published as part of the protologue is another element of original material (Art. 9.4(b)). Both *N. delilei* and *N. armata* are replacement names for *N. muricata* Delile, which is a later homonym of *N. muricata* Thuill. and therefore illegitimate (Art. 53.1); *N. armata* was nomenclaturally superfluous when published and is therefore illegitimate (Art. 52.1); consequently *N. marina* subsp. *armata* is not a new combination but rather a replacement name (Art. 58.1).

Najas marina subsp. *armata* is the name and rank adopted by Triest in his revisions of the genus *Najas* in Africa (Triest 1987) and the Old World (Triest 1988). Before him, the taxon was variously treated: as a variety (Rendle 1899; Fiori 1923; Maire 1952; Cirujano & Lopez Alberca 1984), subspecies (Horn af Rantzien 1952) or species (Delile 1813–1814; Braun 1864; Rouy 1912; Lindberg 1932; Taeckholm & Drar 1941). After Triest, the taxon has been generally accepted at infraspecific rank (Uotila 2009), sometimes doubtfully (Pignatti 1982; Bartolucci & al. 2018), but sometimes it was merged with *N. marina* subsp. *intermedia* (POWO 2022) or not mentioned at all (Pignatti & al. 2017). Rarely it is accepted as a separate species, and in that case the correct name is *N. delilei* (Feinbrun-Dothan 1991).

Najas marina subsp. *armata* is a well-separated taxon and, according to the available knowledge, subspecific rank seems to be the most appropriate. Diagnostic characters were already identified by Triest (1988, 1989), but they are summarized below in a new key also to update the nomenclature (with seed length measurements modified according to Rüegg & al. 2019).

1. Seeds (3.3–)4–6(–7.5) mm long; ovary (3–)4–6 × 2–2.5 mm; style and stigma 2–3 mm long; anther 3.8–4 mm long . . . . . ***Najas major***
– Seeds 2.5–4(–5.1) mm long; ovary 0.7–3.4 × 0.4–1.7 mm; style and stigma 0.2–1.4 mm long; anther 1–3.3 mm long **2**
2. Stems and back of midrib not very spiny, (0–)2–10 (–15) spines in 2 cm; seeds 3.7–4.3 mm long . . . . . ***Najas marina*** subsp. ***marina***
– Stems and back of midrib very spiny, (10–)15–30 (–50) spines in 2 cm; seeds 2.5–3.5 mm long . . . . . ***Najas marina*** subsp. ***armata***

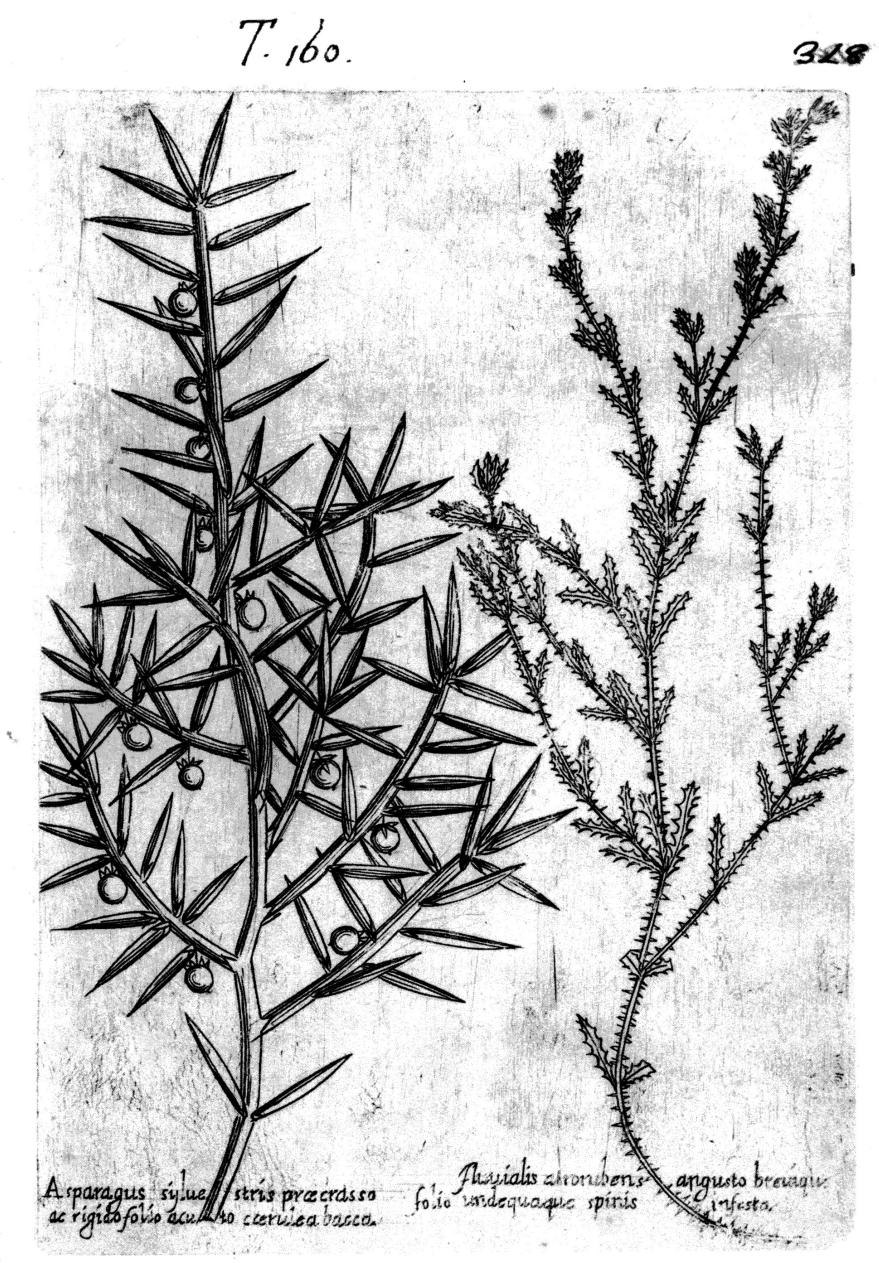

Fig. 1. "*Fluvialis atrorubens, angusto brevique folio, undequaque spinis infesto*" in Cupani (1713: t. 160), clearly showing *Najas marina* subsp. *armata* (on the right).

Najas marina subsp. *armata* seems to differ from subsp. *marina* also in ecology (see below) and distribution. They are allopatric: subsp. *marina* is restricted to cold and temperate areas from Europe to C Asia, whereas subsp. *armata* is distributed in tropical and subtropical Africa, Sri Lanka (but see Silva & al. 2020) and Australia (Triest 1988). The only critical area seems to be in Turkey, where it is difficult to separate the two taxa (Triest 1988: 64; Triest & Uotila 1988).

It is interesting to report that, in addition to being eaten by wild birds such as waterfowl (Aves: Anatidae) (Les 2020), in Egypt *Najas marina* subsp. *armata* is collected and dried to be used as fodder for sheep and goats (Yousif & al. 2020).

Najas marina subsp. *armata* in Sicily

Although *Najas marina* subsp. *armata* was not reported from Sicily in the checklists and floras of Lojacono-Pojero (1908–1909), Uotila (2009), Pignatti & al. (2017) and Bartolucci & al. (2018), its presence on the island was reported in some 20th century works, namely Fiori (1923), Maire (1952), Horn af Rantzien (1952) and Pignatti (1982). Also Triest (1987) had some doubts: "whether subsp. *armata* occurs in Sicily could not be stated here". Owing to the lack of specific reports and specimens, it can be hypothesized that these references are based on occasional casual populations (and misidentifications cannot be excluded, at least in the first case).

Even before Fiori (1923), the taxon was clearly drawn in the pre-Linnaean work of Francesco Cupani (1657–1710), under the polynomial "*Fluvialis atrorubens, angusto brevique folio, undequaque spinis infesto*" (Cupani 1713: t. 160; Fig. 1). It can be assumed that the collection site was in Sicily, but it is impossible to know if the depicted plant was cultivated, escaped from cultivation or casual. Even though the full details are not known, this is a very interesting report, deserving further investigation, also because the period 1675–1715 has been said to denote the climax of the "Little Ice Age" in Europe (Luterbacher & al. 2001).

The oldest herbarium specimens found are dated between 2005 and 2008 (Barone & al. 2007; Galesi in Giardina & al. 2007; Sciandrello 2009; see above in Introduction). In addition to the records mentioned above, new populations were found during the present investigations (see Table 1 and Appendix), all of them in the thermomediterranean bioclimatic belt (Bazan & al. 2015).

Most of the sites where *Najas marina* subsp. *armata* occurs in Sicily (Fig. 2) are reservoirs or farm ponds (Table 1), which are artificial habitats of different sizes (from 0.001 to 0.9 km^2). There are two important excep-

tions in coastal, natural, shallow lakes within protected areas. The first is Lago Murana, within the Reserve "Lago Preola e Gorghi Tondi"; this lake was dry for 23 years owing to reduced rainfall and illegal wells but returned to being a lake in 2005 (Andreotti 2007); in 2012 a submerged meadow with *Chara* sp. was present (Salvatore Pasta pers. comm.), and only in 2018 was *N. marina* subsp. *armata* found there instead of the *Chara* meadow (Troia & al. 2018). The second is Biviere di Gela, also a shallow lake within a reserve; *N. marina* subsp. *armata* was not reported there in 2006 (Brullo & Sciandrello 2006) but was collected there in 2008 (*Minissale & Sciandrello*, CAT 031869, see Appendix). In both cases, it is clear that *N. marina* subsp. *armata* recently arrived and colonized those sites.

According to the available data, the taxon in Sicily grows in permanent waters (but in Spain it was reported also in temporary waters; Cirujano & Lopez Alberca 1984).

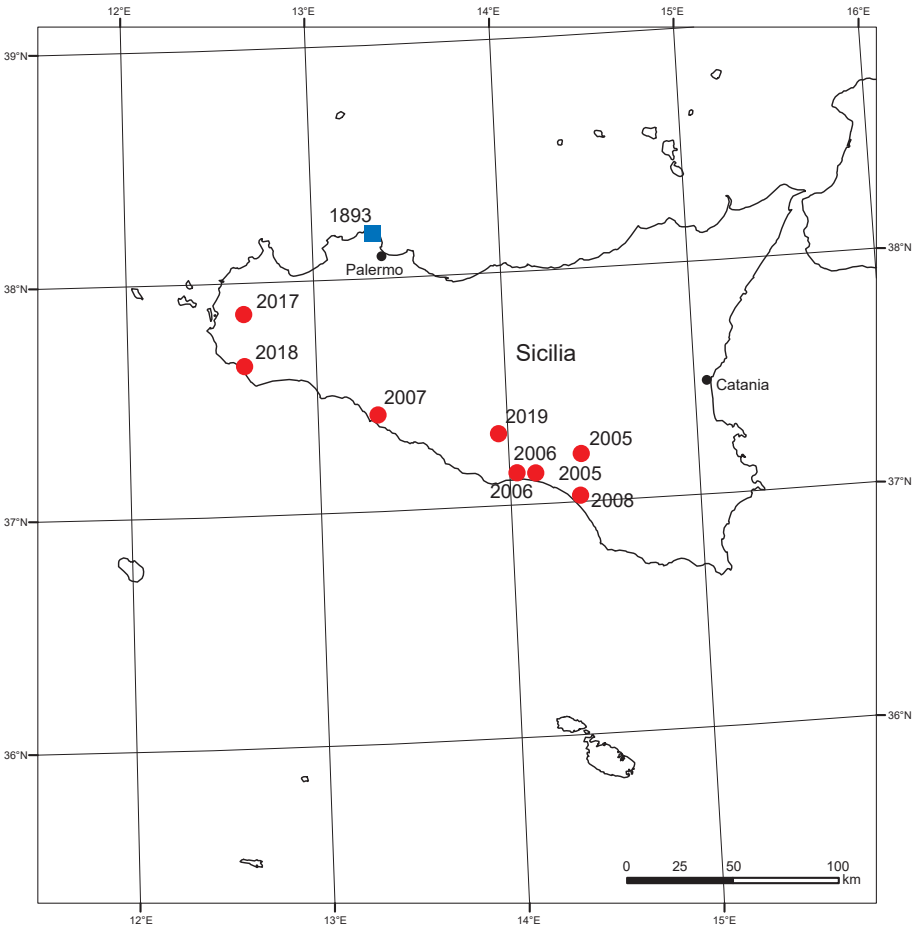

Fig. 2. Distribution of *Najas marina* subsp. *armata* in Sicily (red dots) and unique (extinct) location of *N. major* at Mondello (blue square). For each population, the year of first finding is shown (see also Table 1 and Appendix).

Data for Sicilian populations seem to confirm the ecology of *Najas marina* subsp. *armata*, which according to the literature prefers waters rich in Cl^-, Ca^{2+} and SO_4^{2-} (Cirujano & Lopez Alberca 1984; Triest 1989), with conductivities ranging from 1.45 to 9 mS/cm^{-1} (Triest 1989). *Najas marina* subsp. *marina* seems to be different, with results showing it to be absent in waters rich in Ca^{2+} and HCO_3^- but with a similar range of conductivities (Triest 1988, 1989, under *N. marina* subsp. *intermedia*). *Najas major* grows mainly in waters rich in Ca^{2+} and HCO_3^- with a conductivity of 0.34–1.25 mS/cm^{-1} (Triest 1989, under *N. marina* subsp. *marina*).

Najas marina subsp. *armata* in the N Mediterranean

It seems that the taxon has extended its range northward in the Mediterranean area (Fig. 3) until c. 40°N. Note that it was not mentioned for Europe by Dandy (1980). Details of its finds in the main geographical (or political) units of the N Mediterranean are as follows.

Portugal – Even though not reported in local or European floras and checklists (e.g. Sequeira & al. 2011), specimens were found in COI and LISI that show the typical spiny stem of this taxon.

Spain – Spain hosts one of the oldest populations of *Najas marina* subsp. *armata* in Europe, already reported by Triest (1988). Cirujano & Lopez Alberca (1984) correctly identified the taxon (as *N. marina* var. *delilei*) and documented its colonization in an artificial wetland in 1980–1982, hypothesizing the role of waterfowl.

Balearic Islands – Recently found in Minorca (Fraga Arguimbau & al. 2020).

Corsica – The only confirmed record was made by Lambinon and Triest (in Jeanmonod & Burdet 1989) from a single pond in 1988. The conductivity of the pond was 5.7 mS/cm^{-1}. The taxon was neither collected before nor confirmed after from Corsica (Alain Delage pers. comm.).

Sardinia – Recently found in S Sardinia (Lazzeri & al. 2013).

Crete – Collected in Crete, and for the first time in Europe, in 1974 (Triest 1988). The taxon was considered

Table 1. Geographical and ecological data for Sicilian lakes/reservoirs currently hosting *Najas marina* subsp. *armata*, listed in order of year of first report. N/A: A = artificial; N = natural; (A) = artificial but on a previous (smaller), natural wetland/pond. Original data denotes the author's data newly reported in the present paper.

Locality	**N/A**	**Coordinates**	**Construction year**	**Surface (km^2)**	**Maximum depth (m)**	**pH**	**Conductivity (mS/cm^{-1})**	**Ca (mEq/l^{-1})**	**Cl (mEq/l^{-1})**	**SO_4 (mEq/l^{-1})**	**Data source (data collection date)**	**First report of *Najas marina* subsp. *armata***
Cimia reservoir	A	37.192999°N, 14.352599°E	1975–1980	0.9	31.0	8.0	2.3	10.8	7.8	15.4	Calvo & al. 1993 (summer 1987)	2005 (*Galesi*, CAT 011696, see Appendix)
Cimia reservoir	A					7.9	2.6	13.0	12.0	19.0	Sciandrello 2009	
Comunelli reservoir	A	37.157471°N, 14.154759°E	1961–1968	0.9	31.4	9.1	2.8	8.1	13.8	17.1	Calvo & al. 1993 (summer 1987)	2006 (Sciandrello 2009)
Comunelli reservoir	A					9.0	3.5	12.0	20.5	22.5	Sciandrello 2009	
Lago Gorgo	(A)	37.408431°N, 13.324812°E	1956–1972	0.5	10.5	8.0	5.2	12.2	39.6	14.3	Calvo & al. 1993 (summer 1987)	2007 (*Marrone & Sicilia*, PAL 70286, see Appendix)
Lago Biviere di Gela	N	37.019145°N, 14.344726°E		1.2	8.5	7.8–8.3	2.7	7.2	16.4	8.9	Calvo & al. 1993 (summer 1987)	2008 (*Minissale & Sciandrello*, CAT 031869, see Appendix)
Lago Biviere di Gela	N						2.4–7.3				http://www.riservabiviere.it/biviere_monitoraggi/ (spring–summer 2010)	
Zaffarana reservoir	A	37.850763°N, 12.626465°E	1974–1978	0.2							original data	2017 (original data)
Lago Murana	N	37.626267°N, 12.634307°E	2005*	0.1	1.0	8.7	3.3				Palumbo 2018 (September 2017)	2018 (Troia & al. 2018)
Lago Murana	N			0.078		8.6	3.0				original data (July 2018)	
Gibbesi farm pond	(A)	37.296117°N, 13.950898°E	?	0.025							original data	2019 (original data)
Desusino farm pond	A	37.149532°N, 14.081352°E	2002–2005**	0.001							original data	2019 (original data)

* see text
** information derived from Google Earth imagery

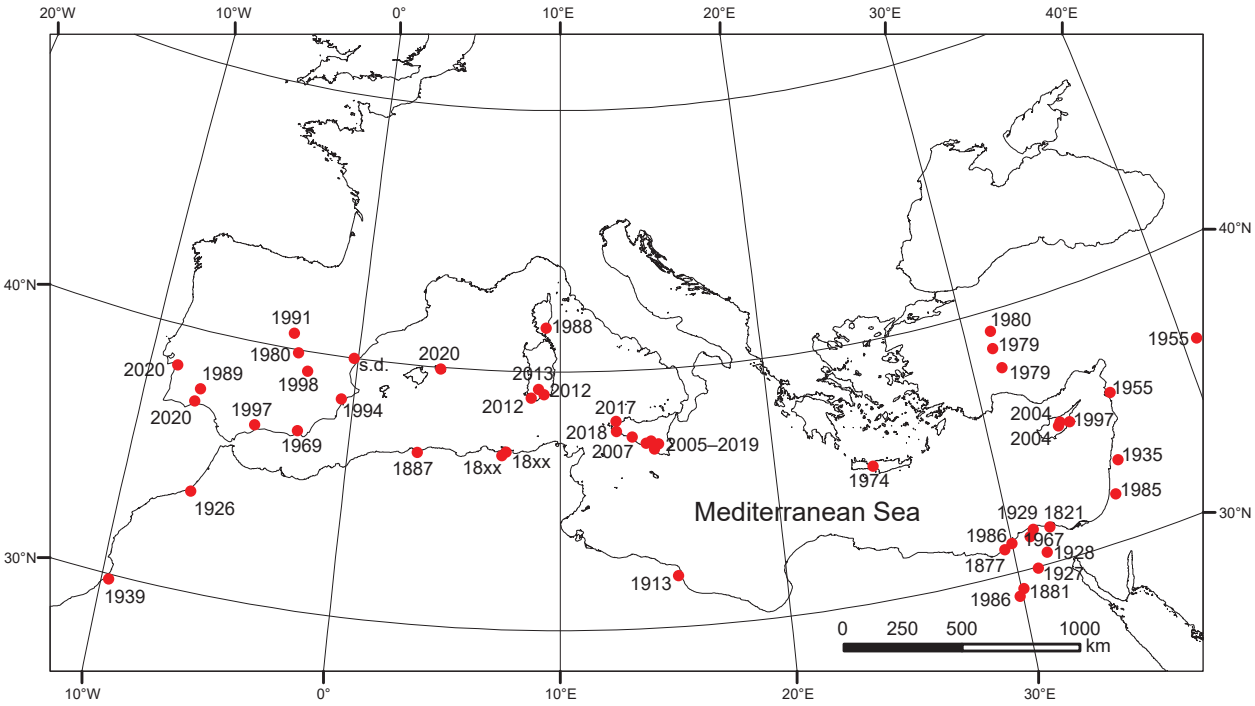

Fig. 3. Distribution of *Najas marina* subsp. *armata* in the Mediterranean area (red dots), on the basis of herbarium specimens (see text and Appendix) and selected bibliographic records, with the year of each specimen/finding shown; in case of more records for the same locality, only the first year of occurrence is shown. The taxon has been reported also from Tunisia (Dobignard & Chatelain 2010), but no herbarium specimen or specific locality was found, and from Libya (Baayo 2021). 18xx denotes 19th century but year unknown.

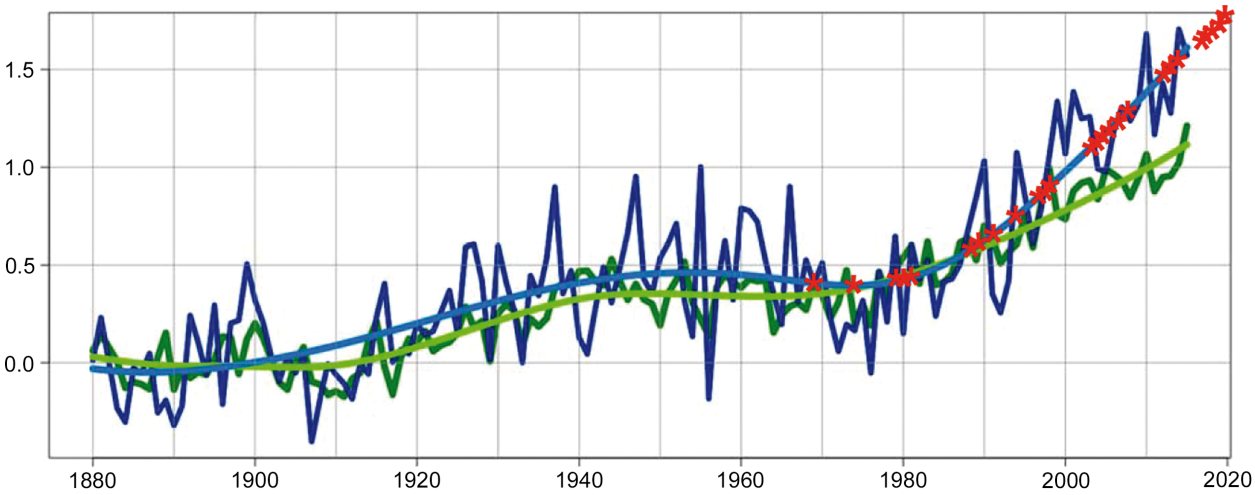

Fig. 4. Historic warming of the atmosphere (annual mean temperature anomalies with respect to the period 1880–1899), in the Mediterranean basin (blue lines) and for the globe (green lines), with and without smoothing (from Cramer & al. 2018), with red asterisks indicating the first year of occurrence of all known N Mediterranean populations of *Najas marina* subsp. *armata* (see Fig. 3).

native in Crete by Dimopoulos & al. (2020) but alien by Korakaki & al. (2021).

Cyprus – Recently found in Cyprus (Hand 2006).

Turkey – Uotila (1984) did not report *N. marina* subsp. *armata* in his treatment, but Triest (1988) and Triest & Uotila (1988) listed five herbarium specimens of this subspecies, collected in Turkey between 1979 and 1981.

Discussion

The role of birds in the dispersion of aquatic organisms is well known (Figuerola & Green 2002), and specific data are available for *Najas marina* s.l. (Agami & Waisel 1986; Les 2020), so it seems very reasonable to hypothesize the role of migrating birds (as was already done by Cirujano & Lopez Alberca 1984), and specifically waterfowl, in the northward shifting of *N. marina* subsp. *armata* in the Mediterranean area.

To explain why this northward shifting happened in recent years but not before, it is reasonable to relate it to increasing temperatures in the same years. In the Mediterranean area, the annual mean temperature of the atmosphere started to increase since 1980 (Cramer & al. 2018; Fig. 4), and in detail the water temperature of a studied Mediterranean lake showed an increasing trend in the years 1984–2019, more evident from 2000 onward (De Santis & al. 2022). Both trends fit well with the spread of *Najas marina* subsp. *armata* (Fig. 2 and 3). Probably the first occurrences in S Europe (Crete 1974, Spain 1980, Sicily between Fiori 1923 and Pignatti 1982) can be interpreted as colonization attempts, as was evident in Cirujano & Lopez Alberca (1984), where *N. marina* subsp. *armata* first colonized an artificial wetland (in 1980) but disappeared few years later.

Although the present analysis highlights changes over the last 40 years, correlations with water temperature should be made to confirm the effect of climate change, but this is beyond the scope of this paper.

However, in addition to the hypothesized thermal stresses, aquatic species face a variety of anthropogenic constraints such as water contamination and habitat change (Nicolas & al. 2011), and also ecological preferences have to be taken into account (Hoffmann & al. 2013). As a consequence, the northward expansion of *Najas marina* subsp. *armata* is a combination of global- and local-scale processes. Relevant to the latter are changes in water quality and the construction of (large and small) reservoirs. The massive creation of reservoirs and farm ponds, started in the 1950s, evidently helps the colonization of *N. marina* subsp. *armata* not only in Sicily but also elsewhere (e.g. Spain, Cirujano & Lopez 1984; Cyprus, Christodoulou & al. in Hand 2006) and could be listed as one of the negative effects of these waterbodies (Rahel & Olden 2008; Bolpagni & al. 2018), even if they could have positive effects on environment and biodiversity (Panzeca & al. 2021).

Interestingly, a similar northward migration is reported for *Najas marina* s.l. in North America (Freeman & Pfingsten 2021).

Another case of a non-marine aquatic species expanding northward in the Mediterranean region is *Chara zeylanica* J. G. Klein ex Willd. in Sardinia (Becker & al. 2021), and maybe some crustaceans follow the same pattern (Jaume 1989; Marrone & al. 2020).

After the (too many) cases of alien species colonizing Italian and European waterbodies (e.g. Troia & al. 2020), *Najas marina* subsp. *armata* is probably the first recognized case of a "range shifter" (using the definitions of Wallingford & al. 2020) naturally expanding its range northward, the first of the projected or expected species migrations (Bolpagni & al. 2018). This expansion is "natural" because it starts from autochtonous populations and is helped by wild dispersers (waterfowl), but it is now clear that the new (warmer) climatic conditions, which are supposed to make the colonization of new northern regions possible, are due to human activity.

"The movement of populations in response to climate change is, in many ways, similar to the invasion of introduced species" (Wallingford & al. 2020), although a shared evolutionary history should decrease the potential negative impacts. Species with major or massive impacts, however, might need to be actively managed (Wallingford & al. 2020). According to the criteria proposed in Blackburn & al. (2014), *Najas marina* subsp. *armata* could have a major impact, at least according to what was seen in Lago Murana, where it today covers the lake bottom with monospecific meadows, instead of the *Chara* meadows reported few years earlier. However, probably there are too scarce data (also considering turnover and dynamics in aquatic habitats), and monitoring is the first action that needs to be applied in inland waters in Sicily and in all the N Mediterranean countries.

Acknowledgements

Thanks are due to: the staff of the PAL herbarium for their assistance; Udo Schwarzer (Aljezur) and Pedro Arsenio (Lisboa), Caroline Loup (MPU), Rosario Galesi (CAT) and the staff of the FI herbarium for supplying images of herbarium specimens; Salvatore Pasta (Palermo) for sharing information about the flora of Lago Murana; Stefania D'Angelo and the staff of the reserve "Lago Preola e Gorghi Tondi" (Mazara del Vallo) for permissions and support during field investigations in their reserve; David Draper (Lisboa), Teresa Vasconcelos (Lisboa), Pablo Garcia Murillo (Sevilla), Stephen Mifsud (Malta), Khadija Ali Baayo (Flora of Libya project), Alain Delage and Letitia Hugot (Corte) for useful information on the genus in different regions of the Mediterranean area; Annalisa Santangelo (Napoli), Riccardo M. Baldini and Lia Pignotti (FT) and Bruno Massa (Palermo) for helping to find some bibliographic sources; Teresa Napolitano (Palermo) and Francesco Napolitano (Riesi) for sharing some field investigations; Giuseppe Bazan (Palermo) and Michael Rodewald (Berlin) for preparing the maps (Fig. 2 and 3). Finally, thanks to Pertti Uotila (Helsinki) and another anonymous reviewer for their remarks and suggestions that significantly improved the manuscript.

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Appendix

Selected specimens examined. Those in PAL were examined physically, all others were examined as images.

Najas major

Italy: Sicilia: Mondello, s.d., *Ross & Riccobono* (PAL 74301) (cited by Lojacono-Pojero 1908–1909); ibidem, Jul 1884, *Ross* (AMD 76304); fosse di Mondello, Jul 1893, *Ross* (AMD 76303, AMD 76313); Calabria: Roggiano Gravina (Cosenza), Lago dell'Esaro (WGS84: 39.638220°N, 16.160279°E), 135 m, sponde, 23 Aug 2018, *Peruzzi* (FI065581).

Najas marina subsp. *armata*

Portugal: Ag. Vila Real de Santo António, Pontão da foz do Rio Guadiana 37.17346°N, 07.40605°W, 4 Mar 2020, *Rita Pina & Paes* (LISI032726); Ervideira, Oct 2020, *Palhas 22* (COI 00100975).

Spain: Andalucía, Almería, Adra, estanque de agua para riego, albufera y salinas viejas, 25 Oct 1969, *Sagredo* (MA-01-00382393); Castilla-La Mancha, Toledo Quero, Laguna Chica del Taray, 4 Sep 1980, *Santos Cirujano* (MA-01-00229648, P02108900); Andalucía, Huelva, Puebla de Guzmán, represa cercana al pueblo, 20 Jul 1989, *Silvestre* (MA-01-00490893); Comunidad de Madrid, Madrid, Arganda del Rey, laguna de las Madres, 8 Sep 1991, *Cirujano & Gil Pinilla* (MA-01-00501439, BR0000027288436V); Comunidad Valenciana, Alicante, Elche, El Hondo, Charca Norte de Levante, 22 Jun 1994, *Cirujano & Medina* (MA-01-00548194); Andalucía, Málaga, desembocadura del Guadalhorce, 4 Jun 1997, *Conde Alvarez & Orozco* (MA-01-00593733); Castilla-La Mancha, Albacete, Ossa de Montiel, lagunas de Ruidera, laguna Lengua, 13 Aug 1998, *Cirujano & Medina* 113898 (MA-01-00639760); Comunidad Valenciana, Castellón, Almenara, *Pardo* (MA-01-00432942).

Italy: Sicilia: calanchi a monte dell'invaso Cimia

(Mazzarino), 4 Sep 2005, *Galesi* (CAT 011688); invaso Cimia (Mazzarino), 4 Sep 2005, *Galesi* (CAT 011696); Diga Cimia (Gela-Mazzarino), 15 Dec 2006, *Sciandrello* (CAT 008700); Diga Cimia, tra Gela e Mazzarino, 2 Aug 2008, *Sciandrello* (CAT 008699); Biviere di Gela, 16 Oct 2008, *Minissale & Sciandrello* (CAT 031869); lago Gorgo pressi Montallegro (AG), 27 Jul 2007, *Marrone & Sicilia* (PAL 70286); laghetto presso Gibbesi Nuovo, c. 3.5 km NW da Ravanusa (AG), 37.296117°N, 13.950898°E, c. 350 m, 16 Aug 2019, *Troia* (PAL); ibidem, 13 Nov 2021, *Troia* (PAL).

Greece: Kriti (Crete): Prov. Rethimno, Kournas-See, 17 Jul 2009, *Mrkvicka* (photos at https://flora.nhm-wien.ac.at/seiten-arten/najas-marina-armata.htm).
Cyprus: Achna dam, 2 Oct 2016, *Konstantinou* (photos at http://biodiversitycyprus.blogspot.com/2016/10/najas-marina-l-cyprus.html).
Egypt: Egypt, *Delile* in Herb. Delile (MPU 007340 lectotype); Envir. De Darniette, *Sieber* (P01756902).
Algeria: Alger, 1878, *Battandier* (P01756797).
Morocco: In aquis substagnantibus ad ostium omnis Ait-Amer, 15 Jun 1939, *Maire & Weiller* (P01756898).

Willdenowia
Open-access online edition bioone.org/journals/willdenowia
Online ISSN 1868-6397 · Print ISSN 0511-9618 · 2020 Journal Impact Factor 0.985
Published by the Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin