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**First record of *Pancratium maritimum* L. (Amaryllidaceae)
for the Friuli Venezia Giulia region, Italy**

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Abstract - We report the first observation of the psammophyte plant species *Pancratium maritimum* L. (Amaryllidaceae) in the Friuli Venezia Giulia region, Italy. Four adult individuals were observed in spring 2023 on the residual dunes of Lignano Sabbiadoro municipality behind a beach resort. Although we lack genetic analysis to determine its provenance, considering the absence of locally cultivated individuals and the expansion of the species in the neighboring region of Veneto, with individuals located ca. 20 km from this reported observation, we believe that its arrival in Friuli Venezia Giulia should be considered a spontaneous spread of a new native species for the region. This finding indicates that the species now has a distribution extending along the entire Italian coastline.

Keywords: Amaryllidaceae, beaches and coastal sand dunes, sea daffodil.

Riassunto - Prima segnalazione di *Pancratium maritimum* (L.) (Amaryllidaceae) per la regione Friuli Venezia Giulia, Italia.

Si segnala la prima osservazione della specie psammofita *Pancratium maritimum* L. (Amaryllidaceae) nella regione Friuli Venezia Giulia, Italia. Quattro individui adulti sono stati osservati nella primavera del 2023 nel comune di Lignano Sabbiadoro sulle dune residue retrostanti a uno stabilimento balneare. Sebbene manchino analisi genetiche per determinarne la provenienza, considerando l'assenza di individui coltivati localmente e l'espansione della specie nella regione vicina del Veneto, con individui situati a circa 20 km da questa osservazione, si ritiene che l'arrivo della specie in Friuli Venezia Giulia debba essere considerato come una diffusione spontanea di una nuova specie autoctona per la regione. Questo ritrovamento indica che la distribuzione della specie si estenda ora lungo tutta la costa italiana.

Parole chiave: Amaryllidaceae, giglio di mare, spiagge e dune costiere.

Pancratium maritimum L., commonly known as the 'sea daffodil', 'sea lily', or 'sand lily', is a perennial geophyte plant of the Amaryllidaceae family found along the coastline of the Mediterranean region, extending from the Black Sea to parts of the Atlantic Ocean (Euro+Med, 2006). This steno-Mediterranean psammophyte typically inhabits coastal environments, particularly “grey” or “white” dunes (i.e. shifting dunes along the shoreline with marram grass *Ammophila arenaria* of the Annex I of the Habitats Directive habitat type (code 2120); fixed coastal dunes with herbaceous vegetation (grey dunes) of the Annex I of the Habitats Directive habitat types (code 2130; priority habitat); *Crucianellion maritimae* fixed beach dunes of the Annex I of the Habitats Directive habitat types (code 2210)) and it is considered a valuable bioindicator of these threatened habitats (Biondi et al., 2009; Giovino et al., 2015). Despite its abundance and widespread distribution, and therefore not being considered a threatened species in recent IUCN assessments (“Least Concern”: Juan-Vicedo, 2018; Rossi et al., 2020), observations from Mediterranean countries suggest that the species faces threats from overcollection for ornamental and pharmaceutical purposes, urbanization, intensification of tourist pressure (Giovino et al., 2015), and in the mid-term, the expected effects of global warming, including associated rises in sea level. As a consequence, several Mediterranean countries consider this species vulnerable to extinction (i.e. Lebanon, Turkey: Zahreddine et al., 2004; Nayim, 2020), with some populations experiencing significant decreases in population size (i.e. Italy, France, Spain and Crete: Zahreddine et al., 2004). To overcome this issues, certain regions in Italy have prohibited the collection of this species (i.e. Tuscany: Legge Regionale (LR) 39/2000 Allegato C, LR 56/2000 Allegato C; Molise: LR 9/1999; Marche: LR 52/1974 Decreto n. 95/PRES; Lazio: LR 61/1974; Basilicata: LR 28/1994 Decreto n. 55; Calabria: LR 30/2001 e LR 47/2009).

The sea daffodil features a large tunicate bulb, typically buried in the sand up to 140 cm, a stem that can grow up to 30-60 cm, and large linear leaves that emerge at various times of the year (hysteranthous: Sanaa et al., 2014; De Castro et al., 2020). Its white flowers bloom in summer or early autumn (July-October) and are united in an umbrella-like inflorescence with an intense scent, which can be easily perceived especially during windless summer nights. It is under these favourable conditions that the flower is pollinated, mostly by moths of the Sphingidae family, but also lizards (Eisikowitch & Galil, 1971; Perez-Mellado et al., 2000). The fruits are capsules containing shiny black seeds with a slightly irregular shape that germinate at low temperatures, in spring and autumn when the sand is moister (Balestri & Cinelli, 2004); seed dispersal occurs via wind (anemochory) and water (hydrochory) with

genetic breaks observed in the Mediterranean population being concordant with the direction of the major sea currents (De Castro et al., 2020).

Giovino et al. (2015) observed morphological and genetic variability in *P. maritimum* populations of the Mediterranean basin consistent with the fragmentation of a source population and the geographical isolation of the sub-populations. For this, the authors highlighted the importance of preserving as many sites as possible where the species is found, in order to maintain a large gene pool (Giovino et al., 2015). Ideally, conservation efforts should aim at protecting the dunal ecosystems as a whole, for their high ecological diversity and their importance at European level (Pinna et al., 2015).

Until the present study, the distribution of *P. maritimum* in Italy has been reported in all coastal regions, with the exception of Friuli Venezia Giulia, the most north-eastern region in Italy (Martini et al., 2023; Portal to the Flora of Italy, 2024). Here, we report the first observation of the species for Friuli Venezia Giulia on a residual dune behind a beach resort in Lignano Sabbiadoro municipality (Fig. 1; 45.6686° N, 13.1041° E). The first individual was observed in spring 2023, followed by the discovery of three more plants located approximately 4 meters away from the first one found. All the plants produced flowers, fruits, and seeds (Fig. 2). On a larger scale, the area represents the remnants of an extensive system of dunes and wetlands. Today, only small, fragmented pockets of coastal dune habitats remain, with some designated under the EU Habitats Directive Annex I, while others lack protection due to their small size. These fragments are characterized by a mixture of different habitats, such as coastal dunes with *Juniperus* spp. (Annex I of the Habitats Directive habitat type (code 2250)), wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (Annex I of the Habitats Directive habitat type (code 2270)), and fixed coastal dunes with herbaceous vegetation (grey dunes) (Annex I of the Habitats Directive habitat type (code 2130)). At a finer scale, the flora in the immediate vicinity of the sea lily specimens (within a 20 m radius) cannot be attributed to a single species and includes a mixture of different psammophilous species, such as marram grass *Calamagrostis arenaria* (L.) Roth, sea holly *Eryngium maritimum* L., juniper *Juniperus* spp., wayfarer *Viburnum lantana* L., hawthorn *Crataegus monogyna* Jacq., some maritime pine *Pinus pinaster* Aiton, and some Austrian black pine *Pinus nigra* J.F.Arnold. Some wild orchid species are also present nearby, including green-winged orchid *Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase, early spider-orchid *Ophrys sphegodes* Mill., and long-leaved helleborine *Cephalanthera longifolia* (L.) Fritsch.

The site where *P. maritimum* was found is not protected and is close to a walkway built to make it easier for tourists to cross the dunes to reach the beach resort (Figure 1b). Despite

the presence of signs warning tourists not to climb the dunes and to stay within the designated walkway, the high anthropic pressure during the summer months likely poses a threat to the persistence of the species. We recommend the implementation of stronger conservation measures and call for regional laws, like those in force in other Italian regions, to protect the species.

Although genetic analysis are needed to completely rule out the possibility that the presence of this species in the region is due to human action, whether intentional (e.g. planting) or unintentional (e.g. propagation from cultivated plants), current evidence supports the hypothesis of a spontaneous spread from neighbouring regions where it is native. In support of this thesis, while it is true that some people cultivate the species for ornamental purposes in other parts of Italy (G. Bacaro, *pers. comm.*), neither in the study area nor in the wider Friuli Venezia Giulia region does this plant appear to be cultivated (the authors: *pers. obs.*). In addition, since 2008, records of *P. maritimum* have been documented at various sites along the coast of the neighbouring Veneto region (where the plant is naturally expanding) and the species is shown to be spreading along the coast to the north-east (Masin et al., 2009; Masin et al., 2010; Masin & Scortegnana, 2011; Camuffo et al., 2013; Argenti et al., 2019). This expansion is likely aided by the high dispersal capacity of the plant, with seeds adapted to be transported by both sea currents and winds, including the strong Libeccio, which typically blows from the west or south-west in the autumn and winter months, and which has increased in frequency and intensity in recent years. The increasing number of reports of *P. maritimum* in the vicinity of our observation site, with the nearest record only 20 km away (sandy beach of Caorle, Venice: Camuffo et al., 2013), together with other nearby observations from citizen science records (available at www.inaturalist.org), support our hypothesis of a natural expansion of the species and the idea that *P. maritimum* may be considered a new native species for the Friuli Venezia Giulia region. From a biological and ecological perspective, our study holds significance for three main reasons. Firstly, this observation is notable for completing the species' presence along the coastal areas of the entire Italian peninsula, thereby establishing a geographical continuum for the species. Secondly, it marks the northernmost observation in the Mediterranean basin for this species. Lastly, although it is premature to draw conclusions due to the limited data available, this record may indicate potential effects of climate change, leading to the appearance of this steno-Mediterranean species (which are generally rare in the northernmost section of the Mediterranean basin, representing only 2.1% of the chorological spectrum of all plants in Friuli Venezia Giulia; Poldini, 1991) this far north of the Adriatic Sea.

Genetic analysis to determine *P. maritimum* provenance, along with monitoring of other steno-Mediterranean plant species in the region, will be crucial in confirming this hypothesis.

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Fig. 1 - The bottom-left panel (a) shows the location of the study area in Italy (Friuli Venezia Giulia region). The enlarged area (b), shown as a white-shaded rectangle in the main map, indicates the dune where *Pancratium maritimum* was observed. The red square indicates the plant's location. The Pineta di Lignano Natura 2000 site (ZSC IT332003), which encompasses habitats listed in Annex I of the Habitats Directive, is highlighted with a yellow line. These habitats include fixed coastal dunes with herbaceous vegetation (Annex I of the Habitats Directive habitat type (code 2130)), coastal dunes with *Juniperus* spp. (Annex I of the Habitats Directive habitat type (code 2250)), and wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (Annex I of the Habitats Directive habitat type (code 2270)). The Natura 2000 Marano and Grado Lagoon systems are highlighted in red. / Nel pannello in basso a sinistra (a) è mostrata la posizione dell'area di studio in Italia (regione Friuli Venezia Giulia). L'area ingrandita (b), mostrata come un rettangolo ombreggiato di bianco nella mappa principale, indica la duna dove è stato osservato il *Pancratium maritimum*. Il quadrato rosso indica la posizione della pianta. Il sito Natura 2000 Pineta di Lignano (ZSC IT332003), che comprende gli habitat elencati nell'Allegato I della Direttiva Habitat, è evidenziato con una linea gialla. Questi habitat includono dune costiere fisse con vegetazione erbacea (codice habitat Direttiva Habitat Natura 2000 2130), dune costiere con *Juniperus* spp. (codice habitat Direttiva Habitat Natura 2000 2250) e dune boschive con *Pinus pinea* e/o *Pinus pinaster* (codice habitat Direttiva Habitat Natura 2000 2270). In rosso è indicato il sistema lagunare Natura 2000 di Marano e Grado (maps from Google Maps (n.d.) and Ortofoto AgEA 2020).



Fig. 2 - (a) Wide-angle view of one of the four specimens of *Pancratium maritimum* found in a public beach in Lignano Sabbiadoro, Friuli Venezia Giulia, Italy, along an unprotected walkway used by tourists to climb the dune and reach the seafront. (b, c) Flower details of the specimens of *P. maritimum*. (d) Details of the capsules containing the seeds and (e) of the seeds of *P. maritimum*. / (a) Veduta grandangolare di uno dei quattro esemplari di *Pancratium maritimum* rinvenuti in una spiaggia pubblica di Lignano Sabbiadoro, Friuli Venezia Giulia, Italia, lungo una passerella non protetta utilizzata dai turisti per scalare la duna e raggiungere il lungomare. (b, c) Dettagli dei fiori degli esemplari di *P. maritimum*. (d) Dettagli delle capsule contenenti i semi e (e) dei semi di *P. maritimum*.