

A Study of an Extensive Biotope of the Aromatic Sea Daffodil (*Pancratium maritimum*) near Aphytos, Kassandra Peninsula, northern Greece

Dimitrios Voliotis and Elisseos Drossos, Thessaloniki

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Introduction

Pancratium maritimum L. (Family Amaryllidaceae, Tribus Eucharideae) is a bulbous geophyte with large white, funnel-shaped, very fragrant, short-lived flowers with concrescent stamens. At one time the plant, called lily of the sea, lily of the coast or white lily, a native species of the sandy coasts of the Mediterranean Sea, abounded on the Greek coasts but today, it is rather rare. Its bulb is probably the wool-carrier of Theophrastos which "... grows on the seashores but has wool under the first tunics" (History of Plants, 7, 13, 8 in KAVVADAS 1956–1964, 6, 2963).

Awareness of *Pancratium maritimum* dates from the darkness of prehistory. The first drawing of the plant was revealed by EVANS during his excavations of the Palace of Knossos in Kriti (1896). On the famous fresco of the Palace, with the blue bird just on the bottom right corner can be seen a drawing of this plant considered by archaeologists as the first one known in the world (16th cent. b. C.). Later it was found – an indication of the religious character of the plant – together with the double axe on the sacred horns in a sarcophagus in Kriti. Also, amphoras of royal style were decorated with the lily of the sea. During the excavations that were made in Thira (1967–1972), just across the sea from Knossos, by the archaeologist MARINATOS, a fresco with wonderful representations of the Sea Daffodil was discovered. In the "Ladies chamber" as it was called by MARINATOS, the whole western wall and a part of the southern one are covered by four enormous clusters of lilies of the sea. In the "Lilies Room", the western wall of the fresco of Spring bears very beautiful representations of the plant (Fig. 1). Also, in a miniature drawing found in Thira, a fleet can be seen, sailing towards the island. All the ships have as a labarum this preeminently sacred plant of the Aegean Sea as a symbol of Minos' powerful state. In this way the unique character of the Aegeis and the immutability of the ecological conditions there are represented from the mesolithic period to the present day (DIAPOULIS, 1979).

The aim of this paper, presented at the International Symposium on "Aromatic plants" at Kallithea-Kassandra, Chalkidiki on 14–19 September 1981, is to present the results of our research on *Pancratium maritimum* concerning several botanical as well as environmental protection aspects.



Fig. 1: Wall-painting of the "Lilies Room" of *Pancratium maritimum* in island Thira (Santorini).

Material and methods

Geomorphological and climatological data as well as information on the chemical substances of *Pancratium maritimum* are mainly derived from literature. Field work was carried out in a station of *Pancratium maritimum* near Aphytos on the Kassandra peninsula of Chalkidiki (see fig. 2). Climatic data for this area covering the years 1956–1971 were taken at the meteorological station of Agios Mamas (N of Aphytos) and are contained in the work of PAVLIDIS (1975) and BALAFOUTIS (1977).

Plant material was collected from the investigated area on 15 May, 3 June and 4 September 1981, determined according to "Flora Europaea" (TUTIN et al., 1964–1980) and lodged in the Herbarium of Aristotelian University of Thessaloniki (HUTH).

Ecological-synecological observations were made on the whole area, of greater extent than the biotope, over one hectare in area, while the phytosociological data were recorded in 12 selected 30 m² relevés.

The processing of the data and the composition of the phytosociological list follow the classical method of BRAUN-BLANQUET (1964). Nomenclature of species follows TUTIN et al. (1964–1980).

The distribution of *P. maritimum* in Greece is mapped by means of dots representing individual localities.

In order to attack the problem of the preservation of this biotope, and more generally of the protection of the population of the sea-lily from further destruction, protection of the biotopes by law is proposed as a first step.

Chemical substances

Phytochemical investigation has shown the presence of carbohydrates, lipids, proteins and alkaloids in *Pancretium maritimum*. The fragrant substances of the plant are limited to the flowers. Among the carbohydrates, the presence of glucose, fructose, sucrose, melibiose, raffinose, stachyose and probably manninotriose and verbascose was revealed. The mucilage corresponds to the β -D-glucan type.

AHMED et al. (1964) isolated ten alkaloids: lycorine, tazettine, lycorenine, galanthamine, sickenberginine, homolycorine, haemanthidine, pancratine, de-methylhomolycorine and an unidentified base, while according to HUTCHINSON in HEGNAUER (1963) the main alkaloids (>0.01% fresh weight) are: galanthamine, haemanthidine, lycorine, tazettine and vittatine.

SANDBERG and MICHEL (1963) dealt with different parts of *Pancretium maritimum* (roots, bulbs, stems and leaves) from different localities around the Mediterranean Sea with two-dimensional thin-layer chromatography technique for separation of the alkaloids, and they succeeded in separating fifty-two alkaloids. The maximum of the isolated alkaloids from one organ of the plant was 37 and the minimum 14. In particular, they separated and crystallized nine alkaloids: lycorine, haemanthidine, tazettine, vittatine, chondrenine and four new ones.

In another investigation SANDBERG and MICHEL (1968) identified four phenolic alkaloids: norpluvine, pseudolycorine, tyramine, N-methyltyramine, and two non-phenolic ones: haemathiomine and dihydrolycorine (the last for the first time from a vegetative material).

The above investigators found that different parts of the plants and specimens from various habitats of this plant show qualitative and quantitative differences in alkaloid content, and the existence of chemical races within this species has been demonstrated.

Geomorphology – Climatology

Kassandra (Pallini of the Ancient Greeks) is the most westerly of the three smaller peninsulas of the Chalkidiki region (Fig. 2). The northern half of the peninsula is flatter than the southern half, the coast with narrow, sandy flats of an average width of mostly 10–15 m, of the quaternary age, in front of abrupt cliffs of generally 10 m in height (in some areas up to 30 m). On the eastern coast of the peninsula towards the gulf of Kassandra (or Toronaeos) was the ancient town of Aphyis, the village today being called Aphytos or Athytos. The investigated biotope of the sea-lily is situated directly in front of the village on the sandy coast near cape Bounta, an area of more than one hectare.

The air temperatures of the meteorological station of Agios Mamas are:

| | |
|--|------------------|
| Average air temperature of the hottest month | 25.3° C (July) |
| Maximal air temperature of the hottest month | 31.6° C (July) |
| Average air temperature of the coldest month | 7.2° C (January) |
| Minimal air temperature of the coldest month | 3.2° C (January) |

The annual temperature range (18.1° C) is less than at the total 100 meteorological stations of Greek Macedonia and Thraki. Phenomena of partial or total frost

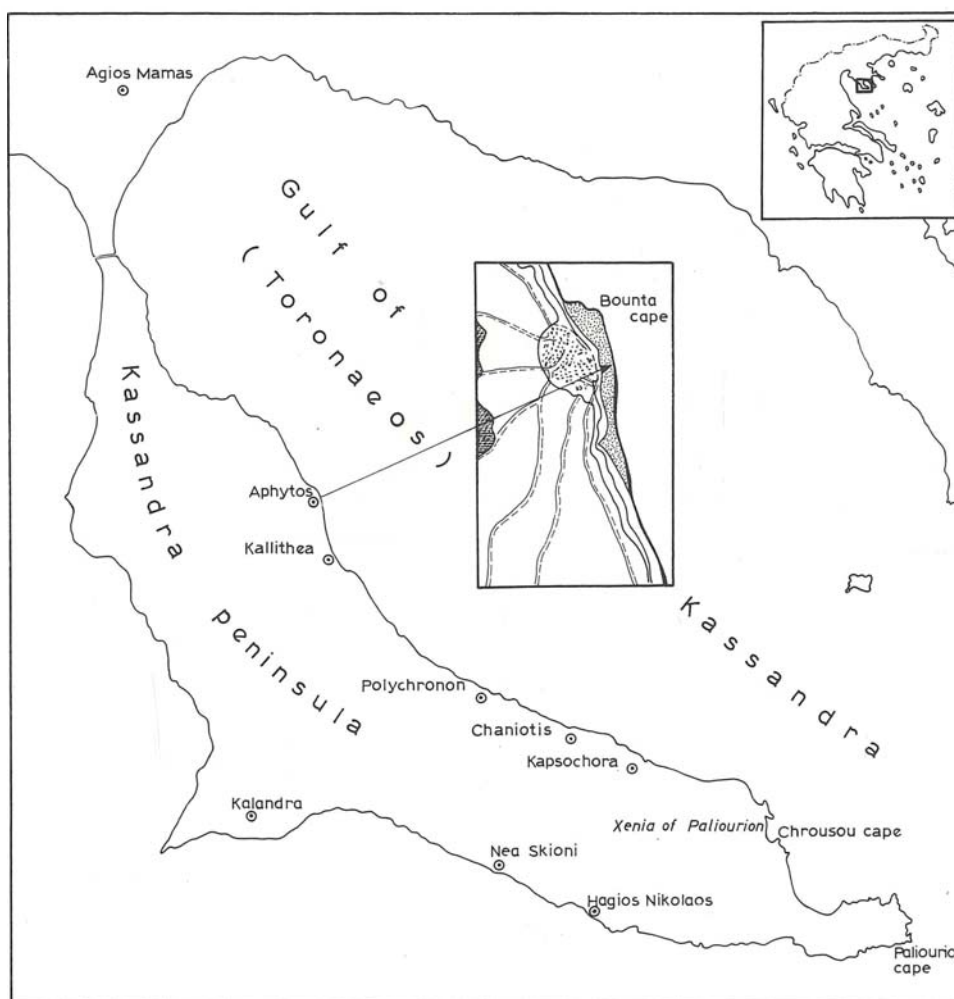


Fig. 2: The investigated biotope of Kassandra Peninsula.

with temperatures lower than 0°C appear during the months of January and February. The average annual humidity of the air reaches 79.2%. The percentages of the rains distribution in the four seasons, in the cold (November–April) and in the warm (May–October) period, the maximum, minimum and average annual rains falling are respectively:

| Winter (%) | Spring (%) | Summer (%) | Fall (%) | Cold period (%) | Warm period (%) | Annual rainfall (mm) | | |
|------------|------------|------------|----------|-----------------|-----------------|----------------------|-------|---------|
| | | | | | | Max. | Min. | Average |
| 29.62 | 21.46 | 16.91 | 32.00 | 55.40 | 44.60 | 614.7 | 160.7 | 457.08 |

In comparison with Ag. Mamas, which is about 2–3 km from the coast, the influence of the sea on the coastal biotope of *Pancreatium maritimum* increases. This

keeps the local temperatures higher in the winter and can moderate them in the summer, due the blowing of sea-breeze. Consequently, a lower annual temperature range and a lower continentality value in relation to Ag. Mamas (continentality degree 26%) may be expected.

The Aphytos beach is situated in the zone of minimal cloudiness in Greek territory. The annual sunshine exceeds 2600 hours; this corresponds, as already indicated for the creek of the Thermaikos gulf (LIVADAS, 1969) to the type of the Mediterranean Riviera.

Conclusively, the type of the climate for the area, according to Köppen's classification is Csa, which means Mediterranean climate type, i.e. essentially a mesothermic climate with dry and warm summers. According to Emberger's system, it belongs to the semi-dry Mediterranean bioclimatical zone, characterized by mild winters, with a few frosts, and intense summer dryness.

Chorology

The general distribution of *Pancratium maritimum* was given by RIKLI (1943, map No. 55, 1, 317). In "S. Europe extending northwards to 47°30' in W. France. Al ?Az Bl Bu Co Cr Ga Gr Hs It Ju Lu Sa Si Tu" according to abbreviations in Flora Europaea 5, 84 of TUTIN et al. (1980). In the rest of the mediterranean area it is native (RIKLI 1946, 989) on the shores of Libya, N. Egypt, Palestine, S. Syria and East Marmaras.

We give the distribution of the plant in Greece in a dot map, based on literature references, on records known to us, and on our observations (Fig. 3).

Thus, the known stations of this plant, some of which are today considerably limited or completely extinct, are:

- Thraki: Porto Lagos coasts (LAVRENTIADES 1975, 370). – Westlich der Mündung des Fl. Evros (BABALONAS, 1980).
- Makedonia: Effaced from the touristic beach of Thessaloniki (VOLIOU). – Fischteich des Dorfes Agiasma, östlich der Stadt Kavala (LAVRENTIADES and BABALONAS 1976). – Nea Hiraklitsa beach (HMG). – Weisse Düne am Stand bei Amphipolis (Gulf Orphanou) (OBERDORFER 1952). –
- Ins. Thasos: Near Skala Prinou (Kazaviti), 6. 5. 1942 and near Skala Potamia, 23. 8. 1943 (STOJANOFF and KITANOFF 1945, 43).
- Athos peninsula: "frequens (!) sec. Sibthorp ..." (GRISEBACH 1844, 377).
- Islet of Ammouliani: Hagios Georgios coast (DROSSOS, 29. 7. 1975).
- Sithonia peninsula: Kastri of Nikiti; rocky coasts Kastrou of Toroni, Tripotamos and Sykea; Artemistis cape; sandy beach in Vourvourou and coasts of Mesopanagia (PAVLIDIS 1976 and unpubl.).
- Kassandra peninsula: small roadstead of Daphni (VOLIOU and DROSSOS). – Aphytos coast (VOLIOU 15. 5. 1981; VOLIOU and DROSSOS 3. 6. 1981 and 4. 9. 1981). – Kalithea, Kapsokhara and near "Xenia" of Paliourion (VOLIOU 27. 7. 1981). – Near Kalandra, Posidion coast (DROSSOS 29. 7. 1975).
- Litochoron beach (SINTENIS in HALÁCSY 1904, 201).
- Pilion peninsula: Sandstrand von Kastri 2 km östlich Plataniá, fr., 29. 10. 1974, RAUS 3389, und Paralia Potistiká 5 km nordöstlich Xinóvrysi, Sandstrand, zusammen mit *Cyperus capitatus*, bl., 15. 8. 1977, RAUS 3451. Herb. RAUS (in litt.).
- Ins. Limnos (DUMONT D'URVILLE), bei Myrina (Kastron) (RECHINGER and RECHINGER-MOSER 1951).
- Ins. Lesvos (Mytilini): Eressós, Sigrion etc. (CANDARGY in RECHINGER 1943). – Pacheia Ammos (RECHINGER and RECHINGER-MOSER 1951).
- Ins. Skyros: an der Bucht Achili (Ostküste) (THEOCHARIS in RECHINGER 1943).
- Ins. Skiathos: Roadstead of Elia; Koukounaries; Aselinos; Troullos (ECONOMIDOU 1969).
- Ins. Euboea: Artemision (Kurbatzi) (WILD in RECHINGER 1943).



Fig. 3: Distribution of *Pancratium maritimum* in Greece.

Attiki: Thorikon (GOULIMIS in STEARN and GOULIMIS 1968). – Laurion, Sounion (HAUSSKNECHT in HALÁCSY 1904). – Ad Phaliron (ORPHANIDES in HALÁCSY 1904).

Ins. Aegina et in scopulo adjacente Metopi (HELDREICH in HALÁCSY 1904).

Kyklades: Ins. Andros: Batsi (GOULIMIS in STEARN and GOULIMIS 1968). – Ins. Syros (ORPHANIDES, OCTAVE and DENIS in RECHINGER 1943). – Ins. Rhineia (HELDREICH in HALÁCSY 1904). – Ins. Dilos (HELDREICH in HALÁCSY 1904). – Ins. Serifos: sandy beaches (PHITOS, UPA). – Ins. Naxos (CHAUBARD in HALÁCSY 1904); W-Küste südlich am Kap. Kouroupia (RECHINGER and RECHINGER-MOSER 1951). – Ins. Milos (CHAUBARD in HALÁCSY 1904); Südost-Adamas (RECHINGER and RECHINGER-MOSER 1951). – Ins. Thira (Santorini): Südküste (HELDREICH in HALÁCSY 1904), Strand bei Perissa (HANSEN obs.); Monolithos Strand (RUNEMARK and BENTZER, obs. in HANSEN 1971).

Ins. Samos: Beaches of Glyfada (Drakaeoi), Seitani and Karlovasi (PHITOS, UPA).

Dodekanisos: Ins. Astypalaea (DAWKINS). – Ins. Kos: Kephalos (DESIO in RECHINGER 1943). – Ins.

Rhodos: beach south of town of Rhodos, 4. 9. 1948; close to village of Lindos, 30. 9. 1955 (GOULIMIS in STEARN and GOULIMIS 1968); an der Sandküste bei Afandou, ca. 20 km südöstlich und ca. 3 km westlich der Stadt Rhodos (SANDBERG and MICHEL 1963).

Ins. Kriti: Chania pr. Platanias (REVERCHON); Rethymnon, Heraklion (RAULIN in HALÁCSY 1904); Rethymnon, pr. Stauromenos (GREUTER, HMG); Merabellou beach (FRANGAKI 1969). – North coasts of villages: Chersonisos Malia and Elounta and South coasts of villages: Plakias, Ag. Galini, Kato Viannos and Arvi (PHITOS and KAMARI, pers. inform.).
 Islets of Grambousa and Elaphonisi (RECHINGER 1943, 170).
 Ins. Kythira: Paleopolis (obs.) sterile (GREUTER and RECHINGER 1967); Moudarion roadstead, Diakofti (obs.) (YANNITSAROS 1969).
 Islet of Elaphonisos: Lefki (obs.) rare (YANNITSAROS 1971).
 Peloponnisos: North coastal Patrae area (LAVRENTIADES 1976). – Kalogria area between Achaia and Elia (PHITOS, UPA). – Argolis: pr. Astros (FRAAS). – Lakonia: pr. Helos (CHAUBARD in HALÁCSY 1904). – Neapolis beach (PHITOS, UPA). – W. coasts of Taygetos: Selinita (ZAGANIARIS 1934). – Kaiafas, Zacharo und Petrochorion (LAVRENTIADES 1964).
 Ionian islands: Ins. Kerkyra: beach close to lake Koryssia (GOULIMIS in STEARN and GOULIMIS 1968). – Ins. Leukas: südlich von Hagios Nikitas in Sand zwischen mächtigen Felsblöcken, 26. 7. 1966; kommt auch auf der Düne von Leukas vor (HOFMANN 1968). – Near town of Leukas (PHITOS, UPA). – Ins. Kephallinia: pr. Steno, Lixurion (HELDREICH in HALÁCSY 1904); Lixurion area (PHITOS, UPA). – Ins. Zakynthos: Tsilivi beach (VOLIOITIS; 5. 9. 1979).

Except of the above, *P. maritimum* is known to exist in the Kallipolis peninsula (INGODBY) and in the Troas coasts (WEBB in RECHINGER 1943) and in the Ammochostos beach chiefly and elsewhere in Cyprus (PANARETOS 1967).

Ecology

Panocratium maritimum, a heliophilous psammophyte, grows in tufts near the sea on a easily drained, sandy soil, which is rich in organic substance. Such a soil has, as a rule, a small water-holding capacity, and for this reason it dries out quickly. Although it warms up easily, on the other hand it becomes cold quickly, and the daily soil temperature amplitude can be notable. Not infrequently, the psammophytes are affected by frost. Characteristic adjustments of these plants to such habitats are hairy, rather small leaves and a root system that either penetrates deeply or has the form of extensive rhizomes (cf. *Calystegia soldanella*, for example, in which a rhizome of a length of ca. 2 m has been measured) or bulbs, as in *P. maritimum*.

Propagation of the species occurs vegetatively by bulbs and by stolons, as well as by seeds. In the biotope under study we observed during May black seeds in abundance which would, however, present a small germinative capacity.

The flowering period of the sea-daffodil starts in the middle of July, and reaches its maximum in the second fortnight of August. FRANGAKI (1969) states that during this period the odour of the flowers of *P. maritimum* from the seashores of Merambellos (Kriti) oblige the sheeps to go away, although the leaves of the plant are eaten by goats. The individual flowers of these plants are short-lived. Flowering ends in the middle of September (VOLIOITIS, unpubl.).

At Aphytos, due to the embankment of a part of the area, ecological disturbance resulted in the invasion of ruderal species, for example, *Raphanus raphanistrum* subsp. *raphanistrum*, *Avena sterilis*, *Paronychia echinulata*, *Salvia verbenaca*, *Malva nicaeensis*, *Carlina corymbosa*, *Plantago coronopus* etc.

These environmental changes are especially emphasized by the establishment of the well known invading succulent *Opuntia* cf. *ficus-indica* at the marginal sandy parts and on the vicinal sandstone rocks of the cliff, which gradually destroys the native plant communities.

Table 1: Association *Pancratium maritimum*-*Medicago marina* assoc. nov.

| Lifeforms | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|
| Number of stand examined | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Size of stand, square meters | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| Altitude of sand dune, meters | 70 | 80 | 80 | 60 | 30 | 40 | 70 | 70 | 80 | 60 | 80 | 50 |
| Cover of vegetation % | 22 | 18 | 28 | 15 | 17 | 18 | 16 | 15 | 16 | 17 | 15 | 15 |

Characteristic species of the Association:

| | | | | | | | | | | | | | | |
|-----|-----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| G b | <i>Pancretium maritimum</i> | 4.4 | 3.4 | 2.3 | 2.3 | 3.4 | 3.3 | 2.2 | 4.4 | 3.4 | 4.4 | 1.2 | 3.4 | V |
| Ch | <i>Medicago marina</i> | 2.3 | 3.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 2.2 | 1.2 | 1.2 | 1.2 | V |

Characteristic species of the Alliance and of the Class:

| | | | | | | | | | | | | | | |
|----|---|-----|-----|-----|-----|-----|-----|----|-----|----|----|----|----|----|
| H | <i>Eryngium maritimum</i> | 1.2 | +2 | 1.2 | 1.2 | 2.2 | 1.2 | +2 | 1.2 | +2 | +2 | +2 | +2 | V |
| Th | <i>Anthemis tomentosa</i> ssp. <i>tomentosa</i> | +2 | +2 | . | +2 | . | +2 | +2 | +2 | +2 | +2 | +2 | +2 | V |
| H | <i>Matthiola tricuspidata</i> | 1.2 | 1.2 | +2 | +2 | +2 | +2 | +2 | . | . | . | +2 | +2 | IV |
| Th | <i>Pseudorhiza pumila</i> | +2 | +2 | . | +2 | +2 | +2 | . | +2 | . | +2 | +2 | . | IV |
| H | <i>Chondrilla juncea</i> | +1 | . | . | . | +1 | . | . | . | . | . | . | +2 | II |
| Th | <i>Phleum arenarium</i> | . | . | +2 | . | . | . | . | . | . | . | . | . | I |

Companion species of the Agropyretum mediterraneum Ass:

| | | | | | | | | | | | | | | |
|-----|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|-----|
| G r | <i>Elymus farctus</i> ssp. <i>farctus</i> | +2 | . | . | 2.3 | 1.2 | 3.4 | 2.3 | 3.4 | 2.3 | 1.2 | +2 | . | IV |
| H | <i>Calystegia soldanella</i> | +1 | +2 | 1.2 | 2.1 | 1.2 | +2 | +2 | . | . | . | . | . | IV |
| G r | <i>Ammophila arenaria</i> ssp. <i>arundinacea</i> | 2.2 | 1.2 | 2.2 | +2 | 2.3 | 1.2 | 1.2 | . | . | . | . | . | III |
| Th | <i>Xanthium strumarium</i> ssp. <i>italicum</i> | +1 | . | . | +1 | +1 | . | +2 | . | . | . | . | . | II |
| G r | <i>Cyperus capitatus</i> | 1.2 | 2.3 | 1.2 | 1.2 | . | . | . | . | 1.2 | +2 | 3.4 | . | III |
| Ch | <i>Oenanthus maritimus</i> | . | . | 1.2 | . | +2 | +2 | . | . | . | . | . | . | II |

Companion species of the Ephedra
distachya-Silene subconica Ass:

| | | |
|----|--|---|
| H | <i>Jasione heldreichii</i> | . |
| Ch | <i>Ephedra distachya</i> ssp. <i>distachya</i> | . |
| H | <i>Puccinellia distans</i> ssp. <i>distans</i> | . |
| H | <i>Verbascum pinnatifidum</i> | . |

Companion species of the Cakiletea
maritima Class:

| | | |
|-------|------------------------|----|
| H(Th) | <i>Glaucium flavum</i> | +2 |
| Th | <i>Cakile maritima</i> | . |

Companion species:

| | | |
|-------|--|-----|
| Th | <i>Silene dichotoma</i> | +2 |
| Th | <i>Lagurus ovatus</i> | +2 |
| Th | <i>Hedypnois cretica</i> | +2 |
| G r | <i>Cynodon dactylon</i> | 2.3 |
| H | <i>Seseli tortuosum</i> | . |
| Th | <i>Trifolium scabrum</i> | +2 |
| Th | <i>Medicago littoralis</i> | +1 |
| G b | <i>Allium obtusiflorum</i> | +1 |
| Th | <i>Raphanus raphanistrum</i> ssp. <i>raphanistrum</i> | +1 |
| Th | <i>Avena sterilis</i> ssp. <i>sterilis</i> | . |
| Th | <i>Bromus tectorum</i> | . |
| Th | <i>Papaver dubium</i> | . |
| H | <i>Salvia verbenaca</i> | . |
| Th(H) | <i>Malva nicaeensis</i> | . |
| Th | <i>Asteriscus aquaticus</i> | . |
| Th(H) | <i>Plantago coronopus</i> ssp. <i>coronopus</i> | . |
| H | <i>Cardopatum corymbosum</i> | . |
| Th | <i>Paronychia echinulata</i> | . |
| Th(H) | <i>Cerastium semidecandrum</i> ssp. <i>semidecandrum</i> | . |
| H | <i>Hypericum triquetrifolium</i> | . |
| Th | <i>Lotus halophilus</i> | +1 |



Fig. 4: *Pancratium maritimum* at its last flowering stage, at the borders of moving and permeable sand and in the form of small isolated groups near the investigated biotope (Photo: E. Drossos, 4. 9. 1981).

Phytosociology

The biotope of the phytocommunity *Pancratium maritimum-Medicago marina* ass. nov. (table I), is probably the same in large parts of the Greek sea-shores.

As shown in Table I, in the investigated area two subassociations can be clearly distinguished, one with *Calystegia soldanella*, *Ammophila arenaria* ssp. *arundinacea* and *Xanthium strumarium* ssp. *italicum*, mainly in the mid-littoral zone; and another with *Jasione heldreichii*, *Ephedra distachya* ssp. *distachya* and *Puccinellia distans* ssp. *distans* further inside to the wider biotope, where the association to which we are referring can be found.

This association seawards meets the community of *Calystegia soldanella* and *Euphorbia peplis* (*Ammophiletum*) on the movable and much penetrable sand, which compete with *Eryngium maritimum* (Fig. 4).

The species *Pancratium maritimum*, *Otanthus maritimus* and *Calystegia soldanella* do not occur on the embryonic dunes and are almost completely absent from the transition phases of the *Agropyretum mediterranei*. The presence therefore of such species must always be considered as a significant diagnostic element of the terminal phase of the above community. According to LAVRENTIADES (1964), *Pancratium maritimum* may be considered as indicator of the optimal phase of the *Agropyretum mediterranei* and the initial phase of *Ammophiletum littoralis* (= *arundinaceae*) Br.-Bl. (1921) 1933.

Frequently (RECHINGER and RECHINGER-MOSER 1951; OBERDORFER 1952; LAV-



Fig. 5: *Pancratium maritimum* plant community on a flat space of the internal zone of the grey and stabilized sand dunes in the biotope Aphytos (Photo: E. Drossos, 4. 9. 1981).

RENTIADES 1964, 1971, 1975, 1976; PAVLIDIS 1976; LAVRENTIADES and BABALONAS 1976), the biotopes of *Pancratium maritimum* with the species *Medicago marina*, *Cyperus capitatus* (*Galilea mucronata*) and *Eryngium maritimum* show interruptions due to the occurrence of soft, white, windswept low sand dunes, which are covered by the high *Ammophila arenaria* subsp. *arundinacea* and *Elymus farctus* subsp. *farctus* (*Agropyrum junceum* subsp. *mediterraneum*). The association *Pancratium maritimum*-*Medicago marina* mostly prefers grey and humose sandy dunes stabilized for many years (Fig. 5). These are covered with grasses (usually low growing and mainly annuals, for example *Bromus tectorum*, *B. rigidus*, *Avena sterilis* ssp. *sterilis*, *Hordeum murinum*, *Desmazeria marina*, *Parapholis incurva*, *Piptatherum miliaceum* etc.), together with bushy species: *Tamarix hampeana*, *Vitex agnus-castus*, *Pistacia lentiscus*, *Paliurus spina-christi*, *Pyrus amygdaliformis*, *Rubus ulmifolius*, *Astragalus thracicus*, *Ephedra distachya* ssp. *distachya*, *Inula viscosa* etc.

Such grey sandy dunes were also described by LAVRENTIADES (1964, 1971, 1976). In the Aphytos area succession moves towards zonal forests (HORVAT et al. 1974), since clusters of *Pinus halepensis* and *P. pinaster* have been established in consequence of a private reforestation trial.

On sandy shores as the one described, abundant organic material is built up by vegetable remnants and the existence of clay particles makes the soil more compact and more water-retentive. Such soils favour the establishment of a group of nitrophilous and ruderal species, such as *Raphanus raphanistrum* ssp. *raphanistrum*, *Papaver dubium*, *Avena sterilis* ssp. *sterilis*, *Bromus tectorum*, *Salvia verbenaca*, *Malva*

nicaeensis, *Asteriscus aquaticus*, *Plantago coronopus* ssp. *coronopus*, *Cardopatum corymbosum*, *Paronychia echinulata* etc. (Table I, companion species).

It must be assumed that these plants are introduced in to the investigated biotope, from neighbouring and cultivated habitats, on account of the afore mentioned favourable conditions.

Protection of biotopes

The sea-lily, a preeminently decorative plant with its beautiful odoriferous umbel of flowers must be protected not only for scientific but also for aesthetic reasons. Precisely because of its beauty, this wonderful aromatic lily has attracted the interest of both amateur and professional botanists and has been collected remorselessly, sometimes to an extent which has led to its extinction locally. Another serious reason for the reduction of the plants distribution is the destruction and the alteration of its sandy biotopes due to sand extraction and various construction works or other types of exploitation which are carried out on the coast. As a result of all this, the sea-lily is gradually becoming limited to fewer and fewer sites. For this reason its collection is prohibited by law in Italy.

During the last 100 years the occurrence of *P. maritimum* along the hellenic coasts has been reported by many investigators of the hellenic flora (see page 233), but in many of its documented localities it is no longer present. GRISEBACH (1844, 377), almost one and a half centuries ago, wrote of this plant: "In litorale maris Aegaei: frequens in penins. Hagion Oros ...", but it is doubtful whether it still grows there since no modern investigator mentions this species. HALÁCSY (1904, 201) mentions this plant in Phaliron, Lavrion, Sounion and in other places where the plant has already disappeared, although its popular name "Lily of the Phaliron" remains in Attiki and Cyclades by tradition. Also in the recent past, a great population of sea-lily was destroyed as a result of sand extraction in a district of the Prefecture of Chania, Kriti (YANNITSAROS and ECONOMIDOU 1979). In the investigated biotope of Aphytos the *Panocratium* population has been considerably reduced, due to the embankment of a part of it and by the construction of a sports ground. There is also a real danger that the extensive population of the Sea Daffodil there will be completely destroyed if "official" suggestions are accepted for the touristic development of the area. Such a destruction can be observed in the little sandy gulf of Daphni (north of Aphytos) where the sea-lilies have been destroyed by constant trampling and camping.

The senior author has already suggested repeatedly to the Council for Environment Protection of Northern Greece that they should take measures to protect the until now extensive population of *Panocratium maritimum* on the Aphytos shore.

This locality should be preserved as a conservation site for the natural flora where the balance of nature would not be disturbed and thus attract visitors to the community of this sacred Aegean plant venerated since old ages.

Summary

A biotope of *Pancratium maritimum* L. near the village of Aphytos on the eastern coast of Kassandra peninsula (Chalkidiki) is described. This aromatic Sea Daffodil has been studied ecologically-synecologically. Its distribution, chemistry and ethnobotany in Greece is reviewed. Finally, the phytosociological assemblage of the biotope is studied and a phytosociological table is drawn (*Pancratium maritimum-Medicago marina*-Association ass. nov., *Ammophilion*). In view of the increasing scarcity of the species and the imminent destruction of its habitat in many places, measures for protection of its biotope are suggested.

Zusammenfassung

Ein Standort von *Pancratium maritimum* L. in der Nähe des Dorfes Aphytos an der östlichen Küste der Kassandra-Halbinsel (Chalkidiki) wird dargestellt. Die oben erwähnte Pankrazilie wird ökologisch-synökologisch untersucht. Ihre Verbreitung, chemische Zusammensetzung und Ethnobotanik in Griechenland werden auch beschrieben. Ferner werden die pflanzensoziologische Zusammensetzung des erwähnten Biotops studiert und eine soziologische Tabelle aufgestellt (*Pancratium maritimum-Medicago marina*-Assoziation Ass. nov., *Ammophilion*). Angesichts der zunehmenden Seltenheit der Art und der Gefährdung ihrer Standorte an vielen Stellen werden Massnahmen zum Schutz des untersuchten Biotops gefordert.

Literature

- 1964 AHMED, Z. F., RIZK, A. M., and HAMOUDA, F. M.: Phytochemical studies on Egyptian *Pancratium* species. *Lloydia* 27 (2), 115–134.
- 1980 BABALONAS, D.: Vegetationseinheiten und Vegetationskartierung in dem Mündungsgebiet des Flusses Evros. *Feddes Repertorium* 91 (9/10), 615–627.
- 1977 BALAFOUTIS, CH.: Contribution to the knowledge of the climate of Macedonia and W. Thraki. Thesis Univ. Thessaloniki.
- 1964 BRAUN-BLANQUET, J.: Pflanzensoziologie. Springer-Verlag, Wien/New York.
- 1979 DIAPOULIS, CH.: Prehistoric plants of Aegaeon which are in need of protection. Proceedings Conference on the protection of the flora, fauna and biotopes in Greece. Athens.
- 1969 ECONOMIDOU, E.: Recherches géobotaniques sur l'île de Skiathos. *Phytogéographie des Sporades du Nord*. Thèse Univ. Athènes.
- 1969 FRANGAKI, E.: Contribution to the vernacular terminology of plants. Athens.
- 1967 GREUTER, W., and RECHINGER, K. H. jun.: Flora der Insel Kythera. *Boissiera* 13, 1–206.
- 1844 GRISEBACH, A.: *Spicilegium florum rumelicarum et bithynicarum* 2. Brunsvigae.
- 1904 HALÁCSY, E. VON: *Conspectus florum Graeciae* 3. Lipsiae.
- 1971 HANSEN, A.: Flora der Inselgruppe Santorin. *Candollea* 26 (1), 109–163.
- 1963 HEGNAUER, R.: *Chemotaxonomie der Pflanzen* 2. Birkhäuser-Verlag, Basel/Stuttgart.
- 1968 HOFMANN, U.: Untersuchungen an Flora und Vegetation der ionischen Insel Leukas. *Vierteljahresschr. Naturf. Ges. Zürich* 113, 209–256.
- 1974 HORVAT, I., GLAVAČ, V., and ELLENBERG, H.: Vegetation Südosteuropas. In: TÜXEN R. (ed.): *Geobotanica Selecta* 4. Stuttgart.
- 1956–1964 KAVVADAS, D.: *Illustrated Botanical Lexicon* 6. Athens. (In Greek).
- 1961 LAVRENTIADIS, G.: Floristical, phytogeographical and plantsociological investigation of Kassandra peninsula. Inaug. Diss. Univ. Thessaloniki.

- 1964 LAVRENTIADIS, G.: The ammophilous vegetation of the western Peloponnesos coasts. *Vegetatio* 12 (3/4), 223–287.
- 1971 LAVRENTIADIS, G.: On the vegetation of sand dunes of Greek coasts. *Colloques Phytosociologiques* 1, 91–98.
- 1975 LAVRENTIADIS, G.: On the vegetation of the Porto-Lagos coasts. *Problems of Balkan flora and vegetation. Proceedings of the First International Symposium in Bulgaria*, p. 365–379.
- 1976 LAVRENTIADIS, G.: On the vegetation of Patras area. *Veröff. Geob. Inst. ETH Stift. Rübel, Zürich*, 56, 59–71.
- 1976 LAVRENTIADIS, G., und BABALONAS, D.: Über die Vegetation der östlichen Kavala-Küsten. II. Sandige Küstenstreifenvegetation. *Sci. Annals, Fac. Phys. and Mathem., Univ. Thessaloniki* 16, 309–324.
- 1969 LIVADAS, G.: Sunshine duration in Thessaloniki (I). *Publ. Meteorol. Inst. No. 1, Mathem. Section of Ioannina Campus (A.U.T.)*.
- 1952 OBERDORFER, E.: Beitrag zur Kenntnis der nordägäischen Küstenvegetation. *Vegetatio* 3, 329–349.
- 1967 PANARETOS, A.: The flora of our country [Cyprus]. *Leukosia (Nicosia)*.
- 1975 PAVLIDIS, G.: The climate and the bioclimatic type of the Ayios Mammias area in Chalkidiki. *Klimatologika* 9, 1–19 (*Publ. Meteorol.-Climat. Inst. Univ. Thessaloniki*).
- 1976 PAVLIDIS, G.: On the flora and vegetation of the Sithonia peninsula (Chalkidiki, Greece). *Thesis Univ. Thessaloniki*.
- 1960 PHITOS, D.: *Phytogeographical investigation of Central Euboea island. Thesis Univ. Athens*.
- 1943 RECHINGER, K. H. jun.: *Flora Aegaea. Flora der Inseln und Halbinseln des Ägäischen Meeres. Denkschr. Akad. Wiss. Wien, mathem.-naturw. Kl.* 105 (1).
- 1951 RECHINGER, K. H. jun., und RECHINGER-MOSER, F.: *Phytogeographia Aegaea. Denkschr. Akad. Wiss. Wien, mathem.-naturw. Kl.* 105 (2).
- 1943, 1946 RIKLI, M.: *Das Pflanzenkleid der Mittelmeerländer 1/2. Verlag Hans Huber, Bern*.
- 1963 SANDBERG, F., und MICHEL, K. H.: *Phytochemische Studien über die Alkaloide von *Pancreatum maritimum*. Lloydia* 26 (2), 78–90.
- 1968 SANDBERG, F., and MICHEL, K. H.: *Alkaloids of *Pancreatum maritimum* L. (Amaryllidaceae) II. Acta Pharmac. Suecica* 5, 61–66.
- 1968 STEARN, W. T. (ed.), and GOULIMIS, C. (text): *Wild flowers of Greece. Publ. by the Goulandris Natural History Museum. Kifissia (Greece)*.
- 1945 STOJANOFF, N., und KITANOFF, B.: *Flora der Insel Thasos. Ann. Univ. Sofia, Fac. Phys. Mathem.* 41.
- 1964–1980 TUTIN, T. G. et al. (eds.): *Flora Europaea, vol. 1–5. Cambridge*.
- VOLIOTIS, D.: *Phenological study of the flowering period and the flower colours of the aromatic plants in Greece. Vegetatio (unpubl.)*.
- 1969 YANNITSAROS, A.: *Contribution to the knowledge of the flora and vegetation of the island of Cythera. Thesis Univ. Athens*.
- 1971 YANNITSAROS, A.: *Notes on the flora of Elaphonesos island (Laconia, Greece). Biologia Gallo-Hellenica* 3 (2), 149–162.
- 1979 YANNITSAROS, A., and ECONOMIDOU, E.: *The threatened greek flora and the necessity of creation of a "Red data book" for Greece. Proceedings Conference on the protection of the flora, fauna and biotopes in Greece. Athens*.
- 1934 ZAGANIARIS, D.: *The flora of Mani. Athens*.

Address of the authors:

Prof. Dr. D. Voliotis } Institute of Systematic Botany and Phytogeography,
 Dr. E. Drossos } Aristotelian University, Thessaloniki, Greece