Anthemis scopulorum (Asteraceae), an “islet specialist” endemic to the Aegean islands (Greece)

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Source: Willdenowia, 36(1) : 339-349

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

URL: https://doi.org/10.3372/wi.36.36129

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Abstract

Georgiou, O., Panitsa, M. & Tzanoudakis, D.: *Anthemis scopulorum (Asteraceae),* an "islet specialist" endemic to the Aegean islands (Greece). – Willdenowia 36 (Special Issue): 339-349. – ISSN 0511-9618; © 2006 BGBM Berlin-Dahlem.
doi:10.3372/wi.36.36129 (available via http://dx.doi.org/)

Anthemis scopulorum, which belongs to the *A. tomentosa* group, is one of the species exclusively inhabiting small, low islets and restricted in its distribution to the Aegean. Diagnostic characters and intraspecific variation are treated and illustrated, chromosome number ($2n = 18$) and karyotype, and, based on recent field studies, new data on its distribution, ecology and phytosociology are given.

Key words: *Compositae, Anthemideae, Anthemis tomentosa* group, island biogeography, taxonomy.

Introduction

Anthemis (sect. *Anthemis*) *scopulorum* Rech. f. belongs to the *A. tomentosa* group (Yavin 1972), which includes annual taxa of littoral habitats. This group ranges from the coasts of Asia Minor and Cyprus in the east to S Italy and Malta in the west (Georgiou 1990, Oberprieler & Vogt 1999). A revision of the group in Greece (Georgiou 1990, 1991, 1997) revealed that it is represented by four species, i.e. *A. tomentosa* L., *A. peregrina* L., *A. werneri* Stoj. & Acht. (= *A. flexicaulis* Rech. f.) and *A. scopulorum* Rech. f.

Anthemis scopulorum is endemic to the Aegean islands and a typical "islet specialist". This phenomenon was first described from the Aegean area by Rechinger & Rechinger-Moser (1951), who noted that certain plant taxa occur mainly on small, low islets, preferably the most exposed and isolated ones. The flora of these islets does not represent a random selection from the coastal flora of the neighbouring larger islands, but consists mainly of about 25 well-adapted specialists. This peculiar species composition has attracted the interest of many botanists (Runemark 1969, 1970, 1971a-b, Bothmer 1974, Gustafsson & Snogerup 1974, Greuter & Pieper 1975, Snogerup & Snogerup 1987, 2004, Höner & Greuter 1988, Raus 1990, Christodoulakis & al. 1991, Höner 1991, Panitsa & al. 1994, 2004, Panitsa 1997, Tzanoudakis & al. 1997, Panitsa & Tzanoudakis 1998, 2001, Brullo & Guarino 2000, Bergmeier & Dimopoulos 2001, 2003, Bergmeier & al. 2001). Like all islet specialists, *A. scopulorum* shows an uneven and scattered distribution in the

area, usually being abundant on the islets where it grows, but completely absent from neighbouring islets despite the occurrence of the same suitable habitats. This is supposedly due to a reduced possibility to establish stable populations and a great extinction risk (Runemark 1969).

Although *Anthemis scopulorum* appears strongly specialized to the rather uniform ecological conditions of the islets, it is an extremely polymorphic taxon regarding a number of morphological characters (habit, size of the capitula and ligulate florets, etc.). The strong local differentiation most probably reflects an effective isolation of the individual islet populations. This polymorphism caused disagreement about its taxonomic position. Rechinger (1936) assumed that *A. scopulorum* is closely related to *A. peregrina,* while Runemark (1971a-b) considered it a "species complex" rather than a single species within the *A. tomentosa* group. Grierson (1975) and Georgiou (1990) agreed that *A. scopulorum* is most closely related to *A. tomentosa,* but Grierson (1975) reduced it to a subspecies of the latter, while Georgiou (1990) treated it as a distinct species.

Material and methods

The study is based on field observations and collections made by the authors (vouchers are deposited at UPA), and the study of herbarium specimens received on loan from B, LD, M and W (herbarium abbreviations according to Holmgren & Holmgren 1998-).

The phytosociological survey was done using the approach by Braun-Blanquet (1964). Data processing was carried out using TWINSPAN (Hill 1979). The accompanying plant taxa were identified with "Flora Europaea" (Tutin & al. 1968-80, 1993), the nomenclature follows that Flora and Greuter & al. (1984-89).

Karyotype and chromosome number were studied using the squash technique of Östergren & Heneen (1962) on root tips of seedlings raised in the experimental garden of the Botanical Institute of Patras University. Plant material came from the islet Nisi E of Paros *(Georgiou 1075).*

Results and discussion

1. Main diagnostic characters, variation and taxonomy

According to Georgiou (1990), *Anthemis scopulorum,* despite its strong morphological variation, is a distinct species within the *A. tomentosa* group. It shares with *A. tomentosa* the hemispherical involucres with loosely arranged involucral bracts, the dense indumentum covering stems, peduncles, leaves and involucral bracts, and the leaf segments divided into relatively wide lobes. Its chromosome number of $2n = 18$ is the same as in the other taxa of the *A. tomentosa* group (Georgiou 1990); the karyotype is shown in Fig. 5.

A number of characters serve to distinguish between these two taxa. In *A. scopulorum* the basal leaves have leaf segments diverging at an angle usually equal to or wider than 90º and long petioles without lateral lobes, while in *A. tomentosa* the leaf segments diverge at an acute angle and the petioles are shorter and with lateral lobes (Fig. 1). Moreover, *A. scopulorum* has larger achenes with a rough surface and very long auricles (Fig. 2, 6a, b) and its receptacle is shortly conical (the height/width proportion has the smallest values of all the taxa in the *A. tomentosa* group) (Fig. 4, 7a). *A. scopulorum* is also characterized by the larger involucral bracts (Fig. 7b) and by the different shape of the tubular florets (Fig. 3). These characters distinguish *A. scopulorum* not only from *A. tomentosa* but also from the other taxa of the group.

The great morphological variation observed in *Anthemis scopulorum* allows the recognition of several local variants. However, we believe that it is preferable to restrain from splitting of this polymorphic taxon. Taking into consideration that the morphologically deviating populations do not occupy coherent geographical ranges (see below), and following Stuessy (1990) and Oberprieler (1998), we consider the rank of variety as more suitable. Based on the presence or absence of ligulate florets, and on receptacle, involucre and achene morphology, four varieties can be recognized as follows (Georgiou 1990):

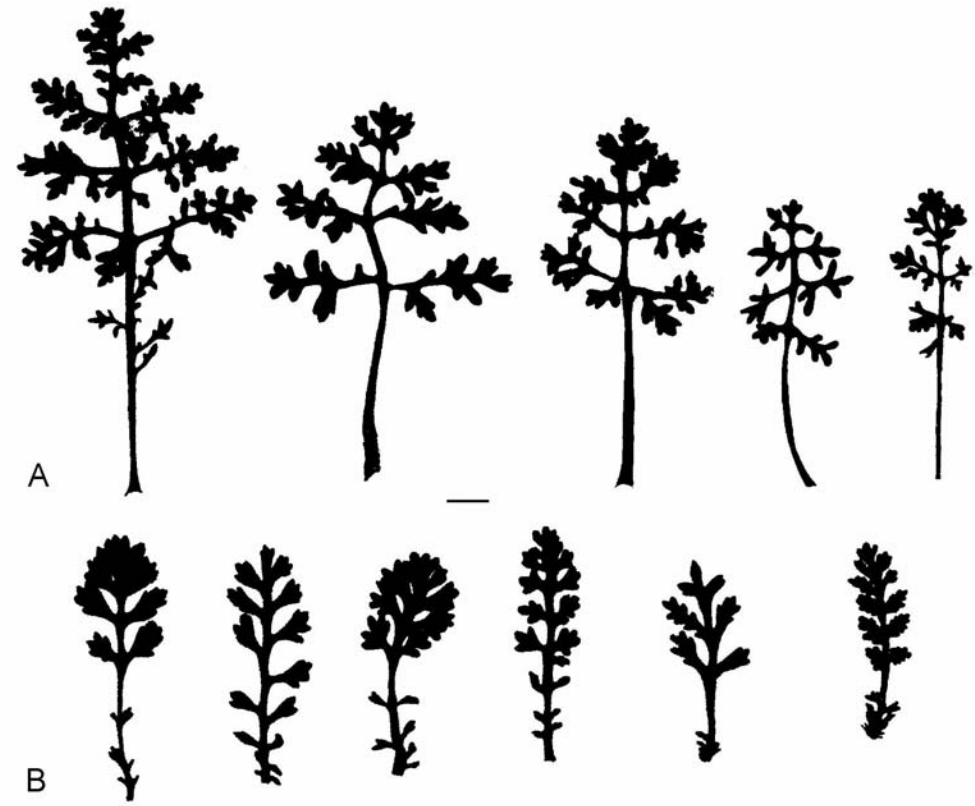

Fig 1. Basal leaves of *Anthemis scopulorum* (A) and *A. tomentosa* (B). – Scale bar = 1 cm.

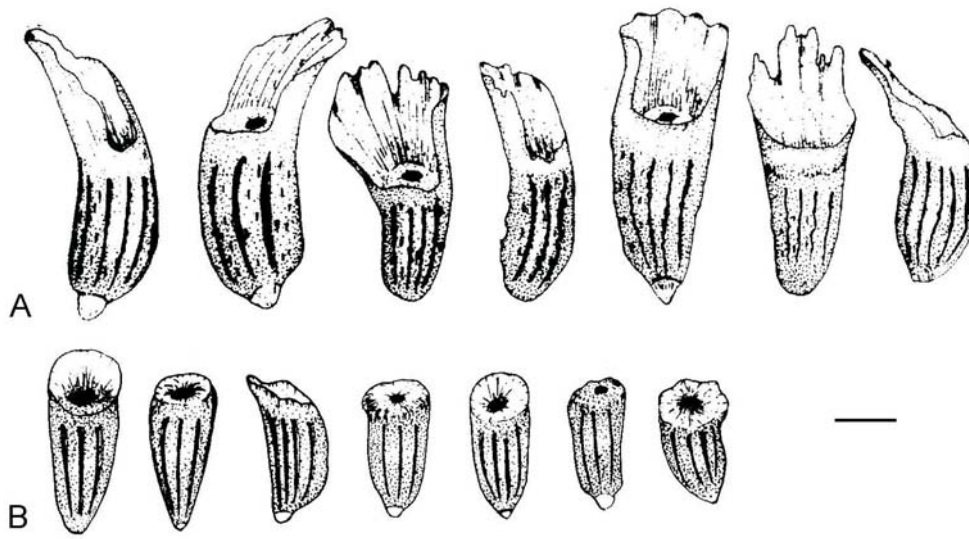

Fig. 2. Achenes of *Anthemis scopulorum* (A) and *A. tomentosa* (B). – Scale bar = 1 mm.

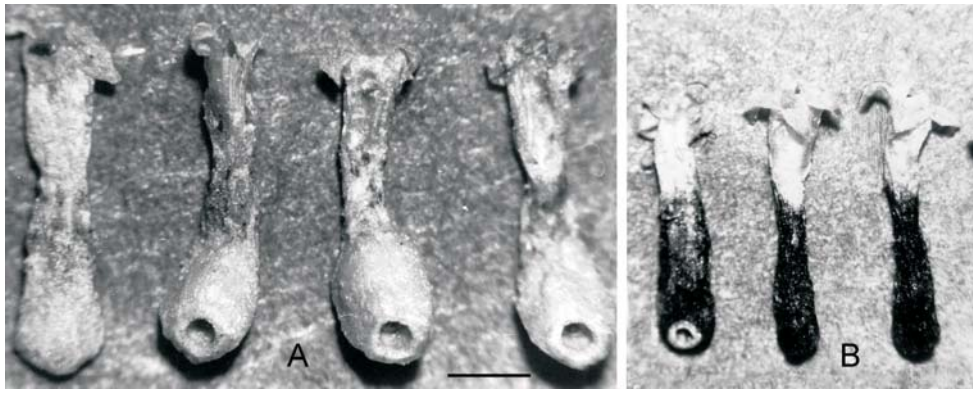

Fig. 3. Tubular florets of *Anthemis scopulorum* (A) and *A. tomentosa* (B). – Scale bar = 1 mm.

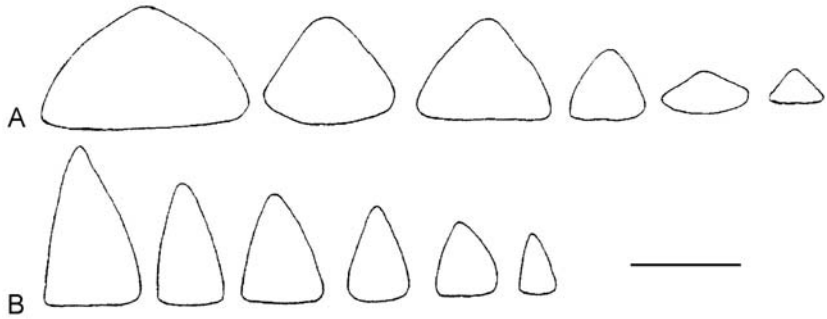

Fig. 4. Shape of the receptacle of *Anthemis scopulorum* (A) and *A. tomentosa* (B). – Scale bar = 5 mm.

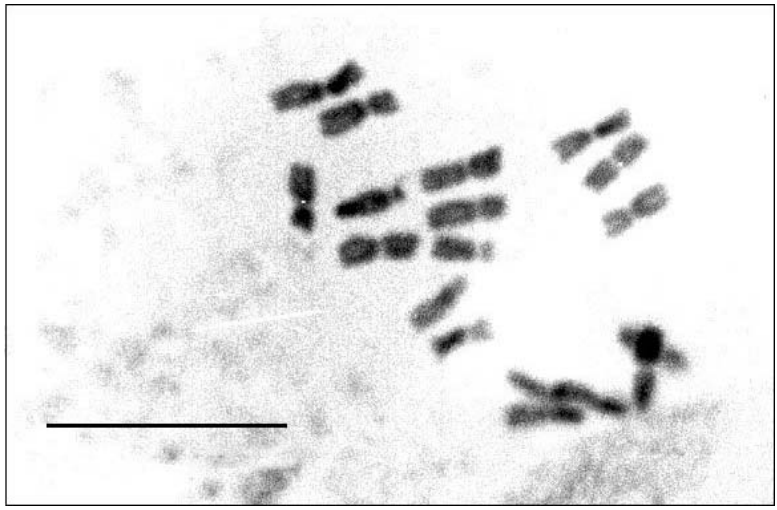

Fig. 5. Microphotograph of mitotic metaphase plate of *Anthemis scopulorum* with $2n = 18$. – Scale bar = 10 µm; material from the islet Nisi east of Paros *(Georgiou 1075)*.

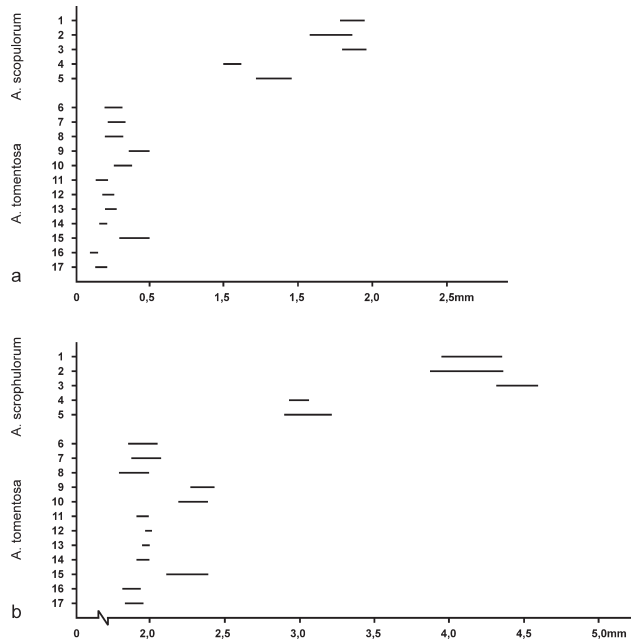

Fig. 6. Diagrams of M±2SE showing the inter- and intra populational variation of *Anthemis scopulorum* (populations 1-5) and *A. tomentosa* (populations 6-17) – a: length of the auricle of the achenes; b: total length of the achenes.

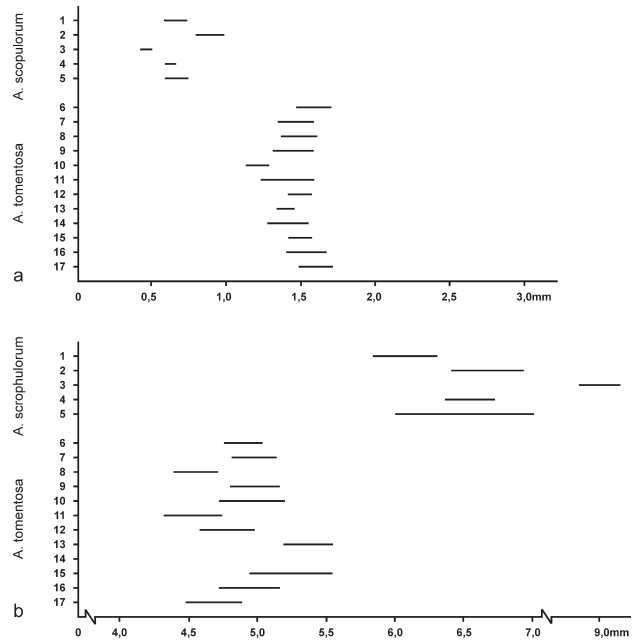

Fig. 7. Diagrams of M±2SE showing the inter- and intra-populational variation of *Anthemis scopulorum* (populations 1-5) and *A. tomentosa* (populations 6-17) – a: proportion of height/width of the receptacle; b: length of the inner bracts.

1 Receptacle swollen at maturity, 2-5 mm high and 3-11 mm wide; achenes persistent at maturity 2
– Receptacle not swollen at maturity, 0.8-2.7 mm high and 2.5-3.5 mm wide; achenes caducous at maturity . . . . . var. *ofidousa*
2 Involucre hemispherical to flat-hemispherical, with 3(-4) series of involucral bracts . . 3
– Involucre obconical, with (4-)5 series of involucral bracts . . . . . var. *conica*
3 Ligulate florets present . . . . . var. *scopulorum*
– Ligulate florets absent . . . . . var. *discoidea*

2. Distribution

Anthemis scopulorum was described by Rechinger (1936) from an islet S of Naxos (Kiklades) and considered a local endemic of the Central Aegean. Later, the species was found to be more common on the Kiklades and was also reported from a few islets of the Dodekanese (Runemark 1969). In the late 1980's, additional data extended the known distribution range of the species, as it was found on the islet Avgo north of Crete [35°36'10"N, 25°34'40"E] (Greuter & Pieper 1975), the islet Stomata west of Karpathos [35°48'00"N, 27°12'50"E] (Pleger unpubl. data 1981, Greuter & al. 1983) and the islets Mailo and Souka west of Rhodes [36°14'N, 27°38'] (Carlström 1987).

Since 1990, our floristic explorations of the Aegean islets and our study of complementary herbarium material have revealed additional localities, extending the known distribution range of the species to the SW and NE Aegean. Its presence in the northern part of the isolated Antikithira Island, situated between Kithira and Crete [35°53'00"N, 22°17'30"E] (Georgiou 1990), on the islet Avgo (or Chitra) south of Kithira [36°06'00"N, 22°59'50"E] (Tzanoudakis & al. 1997, Panitsa & al. 2004), new localities on the islet Prasou (or Porion) between Kithira and Antikithira, 35°58'30"N, 22°14'30"E, *Tzanoudakis & al. 11214, 11552* (UPA!), and the islet Karavi, east of SE Peloponnisos, 36°48'00"N, 23°35'40"E, *Runemark & Bothmer 47172* (LD!) extended its geographical distribution to the SW Aegean. A study of the floristic diversity of the E Aegean islets (Panitsa 1997) revealed its presence on islets near Lipsi [Aspronisi (37°17'03"N, 26°47'35"E), Psonos (37°16'03"N, 26°45'08"E), Saraki (37°14'00"N, 26°42'40"E), Megalo Kalapodi (37°15'23"N, 26°48'47"E), Mikro Kalapodi (37°15'20"N, 26°48'15"E)], islets near Kalymnos [Pitta (37°05'10"N, 27°04'00"E), East Imia (37°02'30"N, 27°08'50"E), West Imia (37°02'10"N, 27°09'05"E)], and on the islet Prassonisi (Diaporia islet group) northeast of Samos Island (37°47'51"N, 26°57'47"E). This latter islet forms the northeastern limit of the known range of *A. scopulorum,* the islet Avgo south of Kithira its western limit (Fig. 8).

These observations confirm that *Anthemis scopulorum* is a typical islet specialist, showing an uneven and scattered distribution (Fig. 8), which does not follow any clear geographical pattern and crosses the phytogeographical boundaries, which, according to Rechinger (1943), separate the Central Aegean region from the E, W and S Aegean. It also crosses the phytogeographical boundaries between the Kiklades (Cyc), East Aegean Islands (EAe), Crete and Karpathos (KK) and Peloponnisos (Pe), adopted by Strid & Tan (1997).

Anthemis scopulorum var. *scopulorum* is the commonest of the four varieties, occurring throughout the geographical range of the species. To the distribution data in Georgiou (1990) and Panitsa (1997), we can add the two above-mentioned new localities in the SW Aegean [Prasou and Karavi], a new locality in the Kiklades on the islet of Kopria, east of Naxos, 36°59'30"N, 25°38'00"E, *Runemark & Snogerup 10303* (LD), and three new localities on Antikithira: at Faros, in the S part of the island, 35°49'50"N, 22°19'30"E, *Tzanoudakis & al. 12336* (UPA), on the shore N of Faros, in the SW part of the island, 35°50'10"N, 22°19'30"E, *Tzanoudakis & al. 11502* (UPA), and at Kamarela, 35°52'20"N, 22°17'20"E, *Tzanoudakis & al. 11792* (UPA).

Var. *discoidea* shows no coherent geographical range, it has been found on islets in the Central, E and SE Aegean (Fig. 8). In the Central Aegean it occurs on the Skaglia islet, northwest of Keros and south of Naxos [36°54'10"N, 25°37'10"E], from where it was described (Georgiou

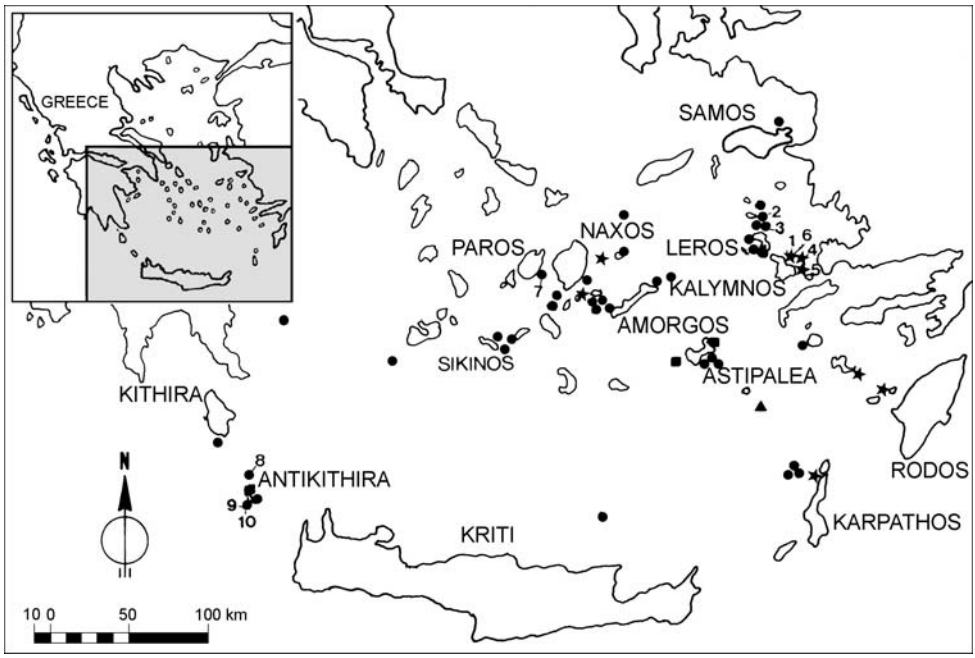

Fig 8. Distribution range of *Anthemis scopulorum:* ● = var. *scopulorum,* ★ = var. *discoidea,* ▲ = var. *conica* and ■ = var. *ofidousa.* – Numbers indicate the localities of the phytosociological relevés, see Table 1.

1990), and is reported here from a new locality on the islet Nikolaos (islet group Makares, east of Naxos), 37°05'10"N, 25°42'00"E, *Runemark & Snogerup 9631* (LD, as *Ammanthus maritimus* Boiss. & Heldr.). In the E Aegean it has been found on the islets East Imia, West Imia and Pitta NE of Kalymnos (Panitsa 1997). In the SE Aegean it occurs on the islet Stomata near Karpathos (Pleger unpubl. 1981), the islets Mailo and Shouka E of Rhodos (Carlstorm 1987), and on a new locality on the islet Antitilos, southeast of Tilos, 36°22'00"N, 27°28'30"E, *Tzanoudakis 12404* (UPA).

Var. *ofidousa* shows equally no coherent geographical range. Georgiou (1990) reports it from both the Central and the SW Aegean. In the Central Aegean it has been found in its "locus classicus", the islet Ofidousa west of Astipalea [36°32'00"N, 26°09'00"E] and on an isolated locality at the E part of Astipalea [35°53'30"N, 26°27'00"E]. In the SW Aegean this variety has been recorded from N Antikithira [35°53'00"N, 22°17'30"E] (Fig. 8). It is noticeable that on Antikithira, apart from var. *ofidousa,* also var. *scopulorum* occurs as mentioned above.

Var. *conica* is known hitherto only from an isolated islet in the Central Aegean [Katsikoula between Sirina and Tria Nisia, southeast of Astipalea (36°19'10N, 26°43'15E)] (Georgiou 1990).

3. Ecology and synecology

Anthemis scopulorum has been found almost exclusively on limestone (rarely schistose or conglomerate) islets. The only exception is its presence on Astipalea island and the remote island of Antikithira.

It forms very rich populations covering a significant area on the islets where it grows. These populations are well-developed in the epilittoral zones; they are resistant to medium or high salinity and can compete successfully with the other species of the littoral and epilittoral zones. As stated by Höner (1991) and Greuter (1995), the number of other plant species growing on the islets is low, a fact also supported by our observations. *A. scopulorum* often coexists with other islet specialists, e.g., *Lavatera arborea* L., *Convolvulus oleifolius* Desr., *Elymus rechingeri* (Runemark)

Table 1. Communities with *Anthemis scopulorum* from the Aegean islets and Antikithira.

Relevé number	1	2	3	4	5	6	7	8	9	10
Altitude (m)	5	8	5	5	5	2	5	20	5	5
Exposition	S	W	W	E	S	W	N	E	E	W
Inclination (%)	10	70	20	45	60	45	10	10	35	40
Coverage (%)	50	80	99	60	70	99	99	70	50	60
Area: 25 m^2										
Anthemidetum scopulori ass. nov. prov.										
Convolvulus oleifolius	–	–	–	1	2	–	–	–	–	–
Anthemis scopulorum	2	2	4	2	3	2	4	2	3	3
Lavatera arborea	–	–	1	2	–	4	2	–	–	–
Elymus rechingeri	–	2	–	1	–	–	–	–	–	–
Silene holzmanii	–	–	2	–	–	–	–	–	–	–
Crithmo-Frankenion Mayer 1995										
Frankenia hirsuta	2	–	–	1	1	–	2	1	1	–
Crithmo-Staticetalia Mol. 1934										
Limonium narbonense	2	1	1	2	2	–	–	–	–	–
Allium commutatum	–	–	–	2	1	2	–	–	–	–
Silene sedoides	+	–	–	–	–	–	–	–	1	1
Sedum litoreum	–	–	–	–	–	–	–	1	1	–
Malcolmia flexuosa	–	–	–	–	–	–	–	–	–	1
Limonium sieberi	–	–	–	–	–	–	–	–	–	2
Crithmo-Staticetea Br.-Bl. 1947										
Lotus cytisoides	–	1	1	–	1	–	–	–	–	1
Parapholis incurva	–	–	–	–	–	–	–	–	1	1
Crithmum maritimum	–	2	–	2	–	2	–	–	–	–
Reichardia picroides	–	1	–	–	–	–	–	–	1	–
Limonium graecum	–	–	–	–	–	–	2	–	–	–
Cichorium spinosum	–	–	–	–	–	–	–	–	–	2
Desmazeria marina	–	–	–	–	–	–	–	–	+	–

Accompanying species: *Arthrocnemum macrostachyum* 1 (1), 2 (1), 3 (1), 7 (2), *Mesembryanthemum nodiflorum* 1 (2), 4 (2), 8 (2), *Rostraria cristata* 2 (1), 6 (1), 7 (1), 8 (1), 9 (1), *Parietaria cretica* 9 (1), 10 (1), *Capparis spinosa* 2 (1), 5 (1), *Dactylis glomerata* 6 (1), 9 (1), *Urospermum picroides* 2 (1), 8 (1), *Taraxacum* sp. 2 (1), *Sonchus oleraceus* 6 (1), *Asphodeline lutea* 6 (3), *Avena barbata 6* (+), *Lagoecia cumminoides* 6 (+), *Lagurus ovatus* 2 (2), *Aeluropus littoralis* 4 (1), *Matthiola incana* 2 (1), *Phleum exaratum* 4 (+), *Mercurialis annua* 6 (1), *Urginea maritima* 6 (1), *Aetheorhiza bulbosa* subsp. *microcephala* 9 (1), *Trigonella balansae* 9 (2), *Crepis multiflora* 9 (1), 10 (1), *Trifolium scabrum* 7 (1), 10 (1).

Relevés (see also Fig. 8): 1 = Pitta islet, southeast side, 37°05'10"N, 27°04'00"E; 2 = Megalo Kalapodi islet, 37°15'23"N, 26°48'47"E; 3 = Mikro Kalapodi islet, 37°15'20"N, 26°48'15"E; 4 = East Imia islet, 37°02'30"N, 27°08'50"E; 5 = West Imia islet, 37°02'1"N, 27°09'05"E; 6 = Pitta islet, west side, 37°05'10"N, 27°04′00"E; 7 = Nisi islet, 37°00'50"N, 25°15'20"E; 8 = Prassou islet, 35°58'30"N, 22°14'30"E; 9-10 = Antikithira Island (Kamarela), 35°52'20"N, 22°17'20"E.

Runemark, *Silene holzmanii* Heldr., *Allium commutatum* Guss., *Atriplex recurva* d'Urv., as well as with other species of the littoral or epilittoral zone, e.g., *Limonium narbonense* Mill., *L. sieberi* (Boiss.) Kuntze, *L. graecum* (Poir.) Rech. f., *Malcolmia flexuosa* (Sm.) Sm., *Frankenia hirsuta* L., *Lotus cytisoides* L., *Crithmum maritimum* L., *Mesembryanthemum nodiflorum* L., *Sedum litoreum* Guss., *Silene sedoides* Poir., *Arthrocnemum macrostachyum* (Moric.) K. Koch, *Capparis spinosa* L. (Runemark 1969, Greuter & Pieper 1975, Pleger (unpubl. data 1981), Georgiou 1990, Panitsa 1997, Tzanoudakis & al. 1997, Panitsa & Tzanoudakis 1998, 2001, Panitsa & al. 2004).

According to our phytosociological data from the entire distribution area (Table 1, Fig. 8), *Anthemis scopulorum* seems to be the dominant member of a particular community (Anthemidetum scopulori ass. nov. prov.) but more islet relevés are needed to characterize this associa-

tion, which is classified in the alliance Crithmo-Frankenion hirsutae Mayer 1995, the order Crithmo-Staticetalia Mol. 1934 and the class Crithmo-Staticetea Br.-Bl. 1947.

The most closely related plant communities in the Aegean are:

i. The association Medicagini littoralis-Anthemidetum tomentosae (Géhu & al. 1992) described from the coast of Rhodes island. This association is classified in the alliance Euphorbion peplis R.Tx. 1950, the order Euphorbietalia peplis R.Tx. 1950, and the class Cakiletea maritimae R.Tx. & Preis. 1950.
ii. The Lavatera arborea-Medicago arborea community (Bergmeier and Dimopoulos 2003) described from thirteen islets of the Aegean area. This community is classified in the order Crithmo-Staticetalia Mol. 1934 and the class Crithmo-Staticetea Br.-Bl. 1947.

Acknowledgements

The authors would like to express their appreciation to the Greek Ministry of the Environment, Regional Planning and Public Works for financial support in the framework of the project "Floristic and phytogeographical investigations in the Aegean" and to the Coast Guard for transportation to the off-shore islets. We are grateful to the curators of the herbaria B, LD, M and W for the loan of the herbarium material used in this work. Thanks are also due to Sandy Coles (M.Sc.) for linguistic revision of the manuscript.

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