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Authors: Kougioumoutzis, Konstantinos, Tiniakou, Argyro, Georgiou, Ourania, and Georgiadis, Theodoros

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KONSTANTINOS KOUGIOUMOUTZIS[1*], ARGYRO TINIAKOU[1], OURANIA GEORGIOU[1] & THEODOROS GEORGIADIS[1]

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Abstract

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The island of Anafi, located in the southern Kiklades in Greece, constitutes together with the Santorini island group the central part of the South Aegean Volcanic Arc. The flora of Anafi consists of 635 taxa, 128 of which are under a protection status, 37 are Greek endemics and 181 are reported here for the first time. We show that Anafi has the highest percentage of Greek endemics in the South Aegean Volcanic Arc. The known distribution of the endemics *Sedum littoreum* var. *creticum* and *Sternbergia greuteriana* is expanded, being reported for the first time for the phytogeographical region of the Kiklades, and the indigenous presence of *Phoenix theophrasti* in Anafi is confirmed. Calculating the floristic cross-correlation between Anafi and the other parts of the South Aegean Volcanic Arc by means of Sørensen's index revealed that phytogeographical affinities are somewhat stronger to Milos than to the neighbouring Santorini.

Additional key words: volcanic flora, biodiversity inventory, phytogeography, migration routes, habitat diversity, Mediterranean region

Introduction

The island of Anafi (Fig. 1) has a special geographical, biogeographical and ecological position in the Aegean area. It is located in the southern part of the phytogeographical area of the Kiklades and is well isolated from the neighbouring larger islands of Amorgos, Santorini and Astipalea, because it was never connected to the Cardaegean Peninsula (Anastasakis & Dermitzakis 1990; Anastasakis & al. 2006; Lykousis 2009). Despite its small size (c. 38 km^2) it is characterised by a great variety of geological substrates (Philippson 1959; Melidonis 1962, 1963, 1983; Reinecke & al. 1982; Böger 1983; Leichmann & Hejl 2006).

Together with Santorini, Anafi constitutes the central part of the South Aegean Volcanic Arc (SAVA), irrespective of the differences in geological structure of Anafi as compared with other parts of the SAVA (Leichmann & Hejl 2006).

The SAVA (Fig. 1) is one of the most important geological structures of the Mediterranean area and forms a belt of volcanic centres, consisting of products ranging in composition from basaltic, andesitic, dacitic to rhyolitic, all of them displaying a typical calc-alkaline chemical character (Innocenti & al. 1981). The Pliocene-Quaternary SAVA is a result of the subduction of the African plate beneath the Aegean-Anatolian microplate (Anastasakis & Piper 2005) and is located about 130–150 km above the seismically defined Benioff zone (Makropoulos & Burton 1984).

Anafi is built up by four major tectono-stratigraphic units (Reinecke & al. 1982; Böger 1983): (a) paleogene

1 Division of Plant Biology, Department of Biology, University of Patras, Rion 26500, Patras, Greece; *e-mail: konkougioumou@upatras.gr (author for correspondence).

flysch, (b) a series of greenschists, (c) high temperature metamorphic rocks with associated granitoid intrusions of latest Cretaceous age and (d) the sedimentary Theologos formation, which comprises mainly fluvial and lacustrine deposits of Plio- to Pleistocene age (Vorwerk, unpublished diploma thesis, University of Kiel 1979). Leichmann & Hejl (2006) state that the volcanism of Anafi Island is of Plio-Pleistocene age and produced felsic, most probably rhyolitic magmas and suggest that the volcanism on Anafi has been developed in a similar geotectonic environment as in other volcanic centres of the arc.

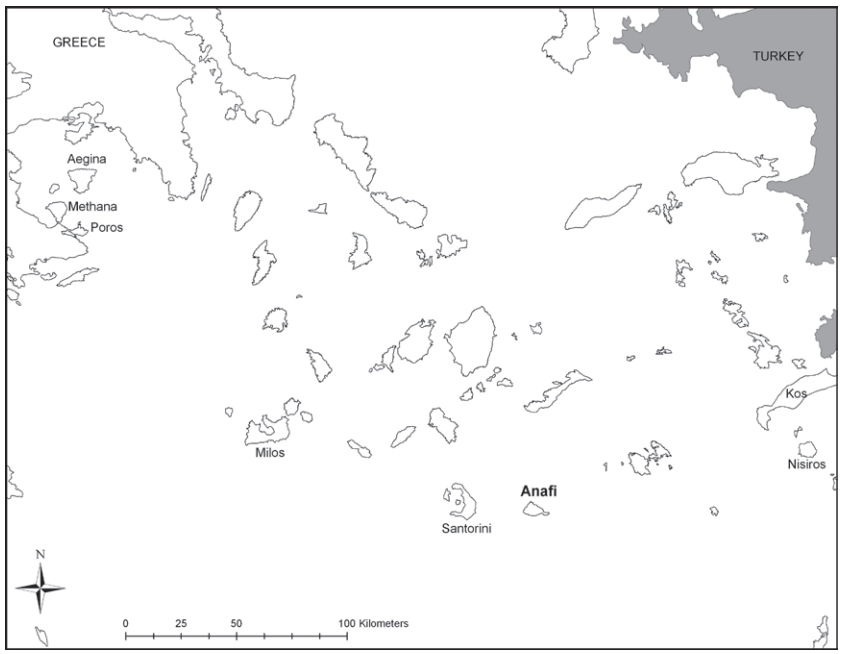

Fig. 1. The South Aegean Volcanic Arc.

The study area is mainly mountainous with an intense relief, the highest peak being Mt Vigla (580 m). Several sandy beaches can be found by the coast. The hydrographical network is relatively well developed. There are numerous springs feeding runoff in some streams for several months, due to the easterly rain-bringing winds.

Anafi Island is situated in an arid part of Greece (Kotini-Zampakas 1983; Lienau 1989; Ministry of Development, 2003). The climatic diagram of Emberger (1952) and Sauvage (1961) places the study area into the arid bioclimatic zone with a mild winter. The xerothermic index (Bagnouls & Gaussen 1953) indicates that it belongs to the pronounced thermo-Mediterranean zone, with a long dry period from early May to mid-September.

The first botanists who reported on plants from Anafi Island were Renz in 1927 and von Wettstein in 1934 (Rechinger 1943). Most records, however, are from Rechinger (1943), and in more recent times from Snogerup (1994), Runemark (1996, 2000, 2006), Phitos & al. (1995, 2009), Strid & Tan (1997, 2002), Biel (2005) and Thanopoulos (2007). Several taxa were also reported in the frame of the Natura 2000 research program. Arne Strid (Ørbæk, Denmark) put an unpublished floristic checklist of the study area to our disposal. Information on some endemic taxa occurring in the area is given by Tan & Iatrou (2001).

Phytogeographical aspects of the flora of the island of Anafi have, however, not yet received the attention they deserve. Therefore, the present study aims at a thorough investigation of the flora of Anafi and its affinities to the large islands and peninsulas of the South Aegean Volcanic Arc, namely Aegina (Vallianatou 2005), Methana Peninsula (Kougioumoutzis & al. 2012), Milos (Rechinger 1943; Strid & Tan 1997, 2002; Browicz 1997; Tan & Iatrou 2001, Raus 2012), Santorini (Hansen 1971; Raus 1986, 1988; Tan & Iatrou 2001) and Nisiros (Papatsou 1974; Burton 1991; Strid & Tan 1997, 2002).

Material and methods

Several field trips into the study area were carried out in spring and autumn of 2010 and 2011 in order to acquire an integrated knowledge of the flora and vegetation of Anafi. The collected specimens are deposited in the Herbarium of the Botanical Museum of the University of Patras (UPA). For the list of new records (see Results), the collection sites on Anafi are coded as follows:

1. 64 m, 36°21'15.9"N, 25°45'45.2"E
2. 64 m, 36°21'17.4"N, 25°45'46"E
3. 119 m, 36°22'21.5"N, 25°44'46.7"E
4. 81 m, 36°22'32.2"N, 25°44'59.7"E
5. 50 m, 36°22'46.7"N, 25°45'19.7"E
6. 4 m, 36°22'41.4"N, 25°44'30.1"E
7. 22 m, 36°21'31.4"N, 25°44'15.2"E
8. 45 m, 36°20'59.9"N, 25°47'35.1"E
9. 220 m, 36°21'45.6"N, 25°48'6.5"E
10. 259 m, 36°21'41.9"N, 25°47'56.9"E
11. 210 m, 36°21'45.6"N, 25°48'6.5"E
12. 263 m, 36°21'44.6"N, 25°48'39.1"E
13. 130 m, 36°21'41.5"N, 25°49'30.5"E
14. 455 m, 36°20'55.3"N, 25°50'40.1"E
15. 260 m, 36°21'34.3"N, 25°46'16.1"E
16. 327 m, 36°22'18.9"N, 25°45'52.1"E
17. 222 m, 36°21'19.8"N, 25°46'35.2"E
18. 118 m, 36°22'53.8"N, 25°47'22.3"E
19. 46 m, 36°21'40.6"N, 25°49'40.1"E
20. 51 m, 36°21'47.6"N, 25°49'36.8"E
21. 167 m, 36°21'8.6 "N, 25°46'0.6"E
22. 255 m, 36°21'26.0"N, 25°46'25.3"E
23. 349 m, 36°22'23.7"N, 25°45'49.4"E
24. 20 m, 36°21'25.2"N, 25°44'6.1"E
25. 142 m, 36°22'40.8"N, 25°45'6.6"E

26. 110 m, 36°22'46.9"N, 25°45'11.0"E
27. 129 m, 36°22'49.0"N, 25°45'14.6"E
28. 5 m, 36°22'41.8"N, 25°45'28.8"E
29. 322 m, 36°21'36.0"N, 25°47'54.4"E
30. 244 m, 36°21'42.8"N, 25°47'58.9"E
31. 271 m, 36°21'48.9"N, 25°48'27.8"E
32. 134 m, 36°21'41.8"N, 25°49'29.4"E
33. 180 m, 36°21'15.9"N, 25°50'16.6"E
34. 209 m, 36°21'20.7"N, 25°46'32.4"E
35. 128 m, 36°22'43.7"N, 25°47'2.6"E
36. 120 m, 36°22'53.6"N, 25°47'24.4"E
37. 11 m, 36°23'5.2"N, 25°47'50.3"E
38. 50 m, 36°21'40.9"N, 25°49'39.4"E
39. 40 m, 36°21'45.6"N, 25°49'38.4"E
40. 0 m, 36°21'17.1"N, 25°49'29.4"E
41. 12 m, 36°22'17.8"N, 25°44'7.0"E
42. 42 m, 36°20'45.9"N, 25°46'46.9"E
43. 11 m, 36°21'13"N, 25°49'1.7"E
44. 277 m, 36°21'27.8"N, 25°46'23.4"E
45. 361 m, 36°22'28.7"N, 25°45'43.3"E
46. 96 m, N36°22'31.4"N, 25°45'0.5"E
47. 16 m, N36°22'42.4"N, 25°44'29.2"E
48. 22 m, 36°22'10.4"N, 25°44'7.6"E
49. 112 m, 36°21'15.9"N, 25°48'4.1"E
50. 275 m, 36°21'8.23"N, 25°50'22.6"E
51. 13 m, 36°21'20"N, 25°49'26.5"E
52. 133 m, 36°22'44.3"N, 25°47'2.7"E
53. 8 m, 36°20'57.6"N, 25°47'44.5"E
54. 47 m, 36°20'58.3"N, 25°47'15.7"E
55. 26 m, 36°20'42.4"N, 25°46'30"E
56. 57 m, 36°22'2.5"N, 25°44'20.3"E
57. 27 m, 36°22'10.8"N, 25°44'7.2"E
58. 79 m, 36°22'30.7"N, 25°45'1.5"E
59. 1 m, 36°22'42.5"N, 25°44'29.9"E
60. 331 m, 36°22'13.2"N, 25°45'52.5"E
61. 289 m, 36°21'5.0"N, 25°50'24.6"E

The collecting dates are coded in the list of new records by small letters, denoting: a = 26.3.–30.3.2011; b = 26.4.–30.4.2011; c = 28.5.–31.5.2011; d = 19.11.–20.11.2011.

Species identification and nomenclature in general follow Tutin & al. (1968–80, 1993), Davis (1965–85), Pignatti (1982), Tan & Iatrou (2001), Greuter & al. (1984–89), Greuter & Raab-Straube (2008) and Strid & Tan (1997, 2002). Species identification and nomenclature of the genera *Bupleurum, Centranthus, Cynara, Tordylium* and *Anchusa* are, however, according to Snogerup & Snogerup (2001), Richardson (1975), Wiklund (1992), Al-Eisawi & Jury (1988) and Selvi & Bigazzi (2003), respectively. For family delimitation we follow APG III (2009). The nomenclature and status of the endemic taxa recorded from Anafi is based on Tan & Iatrou (2001) and Georghiou & Delipetrou (2010). The status of the alien taxa occurring in the study area is according to Arianoutsou & al. (2010). The life-form categories follow Raunkiaer (1934), while Pignatti's (1982) classification was used for the chorological analysis.

Sørensen's index (Sørensen 1948) and the statistical software SPSS 19 were used to calculate the cross-correlation between the islands.

Results

1. New records for the flora of Anafi

Our literature survey and evaluation revealed 454 vascular plant taxa so far reported for Anafi island (Rechinger 1943; Snogerup 1994; Runemark 1996, 2000, 2006; Phitos & al. 1995, 2009; Strid & Tan 1997, 2002; Tan & Iatrou 2001; Biel 2005; Thanopoulos 2007; Strid pers. comm.). Our own field investigations added further 181 taxa as new to Anafi, which are listed in the following and raise the number of vascular plants of Anafi island to 635 taxa, belonging to 314 genera and 79 families (Table 1). Seventeen alien taxa are included in the plant list, but have not been considered in the floristic analysis. Names of taxa not native to the area are given in square brackets.

Abbreviations: *KK* = observation or collection by K. Kougioumoutzis; *obs.* = field observation; *phot.* = photograph; collections sites are coded with the numbers and followed by the letter coding the collecting period as indicated in the lists of collecting sites and dates in the Material and Methods section.

Life forms are coded as follows: *therophytes* (T): Tcaesp = caespitose t., Tpar = parasitic t., Trept = reptant t., Tscap = scapose t., Tsucc = succulent t.; *geophytes* (G) Gbulb = bulbose g., Grhiz = rhizomatous g.; *hydrophytes* (I): Irad = radicose h.; *hemicryptophytes* (H): Hbienn = biennial h., Hcaesp = caespitose h., Hrept = reptant h., Hros = rosulate h., Hscap = scapose h.; *chamaephytes* (Ch): Chsuffr = suffruticose c., Chfrut = fruticose c.; *phanerophytes* (P): Pcaesp = caespitose p., Pscap = scapose p.; *Megaphanerophytes* (MP); *Nano-phanerophytes* (NP).

Chorological types are coded as follows (where appropriate, the types are further narrowed by the abbreviated geographic direction): (1) *Widespread:* Cosmop., Subcosmop. = Cosmopolitan, Paleosubtrop. = Paleosubtropical, Paleotrop. = Paleotropical, Pantrop. = Pantropical, Subtrop. = Subtropical, Palaeotemp. = Palaeotemperate, Subatl. = Subatlantic, Euras. = Eurasian, Eurosib. = Eurosiberian, Europ.-Caucas. = European-Caucasian, Europ. = European, Cont. = Continental; (2) *Mediterranean:* Med. = Mediterranean, Eurymed. = Eurymediterranean, Stenomed. = Stenomediterranean, Med.-Atl. = Mediterranean-Atlantic, Med.-Subatl. = Mediterranean-Subatlantic, Med.-Turan. = Mediterranean-Turanian, Eurymed.-Pont. = Eurymediterranean-Pontic, Eurymed.-Turan. = Eurymediterranean-Turanian, Stenomed.-Turan. = Stenomediterranean-Turanian, Stenomed.-Atl. = Stenomediterranean-Atlantic; (3) *Others:* Endem. = endemic, Adv. = adventive, Cult. = cultivated.

Ferns

Pteridaceae

Adiantum capillus-veneris L. – Grhiz, Pantrop.; 55, c, *KK 1724*.

Gymnosperms

Cupressaceae

Cupressus sempervirens L. – MPscap, E-Med.; 21, a, *KK obs.*

Angiosperms

Amaryllidaceae

Allium ampeloprasum L. – Gbulb, Eurymed.; 55, c, *KK phot.*

Allium hirtovaginatum Kunth – Gbulb, Eurymed.; 48, c, *KK 1669;* 49, c, *KK 1847;* 57, d, *KK 1870.*

Sternbergia greuteriana Kamari & Artelari – Gbulb, Endem.; 61, d, *KK 1879*.

Apiaceae

Bupleurum semicompositum L. – Tscap, Med.-Turan.; Strid, pers. comm.; 49, c, *KK 1852*.

Ferula communis L. subsp. *communis* – Hscap, S-Eurymed.; 22, b, *KK 1046.*

Scandix pecten-veneris L. – Tscap, Subcosmop.; Strid, pers. comm.; 18, a, *KK 210;* 11, a, *KK 244;* 10, a, *KK 562;* 1, a, *KK 617, 623;* 23, b, *KK 872;* 36, b, *KK 1572.*

Smyrnium olusatrum L. – Hbienn, Med.-Atl.; 16, a, *KK 499.*

Torilis leptophylla (L.) Rchb. f. – Tscap, Med.-Turan.; Strid, pers. comm.; 45, c, *KK 1682.*

Torilis nodosa (L.) Gaertn. – Tscap, Eurymed.-Turan.; Strid, pers. comm.; 4, a, *KK 731;* 27, b, *KK 1481.*

Asparagaceae

Muscari neglectum Guss. – Gbulb, Eurymed.; 18, a, *KK 225.*

[*Ornithogalum arabicum* L.] – Gbulb, S-Med.; 25, b, *KK 1252.*

Ornithogalum narbonense L. – Gbulb, Eurymed.; Strid, pers. comm.; 29, b, *KK 1235;* 26, b, *KK 1248;* 24, b, *KK 1305.*

Prospero autumnale (L.) Speta – Gbulb, Eurymed.; 61, d, *KK 1883.*

Asteraceae

Achillea maritima (L.) Ehrend. & Y. P. Guo – Chsuffr, Stenomed.-Atl.; 53, c, *KK 1753.*

Bellium minutum (L.) L. – Tscap, E-Med.; Strid, pers. comm.; 24, b, *KK 1144.*

Carduus pycnocephalus subsp. *albidus* (M. Bieb.) Kazmi – Tscap, Med.-Turan.; 3, a, *KK 73;* 19, a, *KK 360;* 1, a, *KK 600;* 23, b, *KK 859;* 22, b, *KK 1036;* 34, b, *KK 1522.*

Carthamus lanatus L. – Tscap, Eurymed.; Strid, pers. comm.; 10, a, *KK 560.*

Cichorium intybus L. – Hscap, Cosmop.; 55, c, *KK 1729;* 49, c, *KK 1858.*

Echinops spinosissimus subsp. *bithynicus* (Boiss.) Greuter – Hscap, E-Med.; 48, c, *KK 1670;* 55, c, *KK 1727.*

[*Erigeron canadensis* L.] – Tscap, Cosmop.; 4, a, *KK 728.*

Filago aegaea Wagenitz subsp. *aegaea* – Tscap, Endem.; Strid, pers. comm.; 28, b, *KK 1147.*

Filago aegaea subsp. *aristata* Wagenitz – Tscap, E-Med.; Strid, pers. comm.; 9, a, *KK 328;* 22, b, *KK 986, 1015, 1031;* 31, b, *KK 1331;* 32, b, *KK 1404;* 34, b, *KK 1511.*

Hedypnois rhagadioloides (L.) F. W. Schmidt – Tscap, Stenomed.; Strid, pers. comm.; 18, a, *KK 178;* 9, a, *KK 304;* 10, a, *KK 589;* 23, b, *KK 843, 828, 841;* 26, b, *KK 933, 953;* 22, b, *KK 997;* 22, b, *KK 1005;* 24, b, *KK 1088;* 31, b, *KK 1346;* 32, b, *KK 1399;* 29, b, *KK 1213, 1226;* 30, b, *KK 1421, 1430.*

Hypochaeris radicata L. – Hros, Europ.-Caucas.; 10, a, *KK 565.*

Notobasis syriaca (L.) Cass. – Tscap, Stenomed.; Strid, pers. comm.; 22, b, *KK 1037.*

Reichardia intermedia (Sch. Bip.) Samp. – Tscap, Med.; 13, a, *KK 108;* 2, a, *KK 250;* 22, b, *KK 998;* 24, b, *KK 1098;* 31, b, *KK 1347;* 32, b, *KK 1401.*

Rhagadiolus stellatus (L.) Gaertn. – Tscap, Eurymed.; Strid, pers. comm.; 24, b, *KK 1078;* 26, b, *KK 1245;* 49, c, *KK 1845.*

Senecio leucanthemifolius Poir. – Tscap, Stenomed.; Strid, pers. comm.; 2, a, *KK 285;* 26, b, *KK 952;* 22, b, *KK 1007.*

Sonchus asper (L.) Hill subsp. *asper* – Tscap, Euras.; 29, b, *KK 1199.*

Sonchus bulbosus subsp. *microcephalus* (Rech. f.) N. Kilian & Greuter – Tscap, E-Med.; Strid, pers. comm.; 22, b, *KK 1009.*

Taraxacum aleppicum Dahlst. – Hros, E-Med.; 23, b, *KK 854;* 59, d, *KK 1876;* 60, d, *KK 1878.*

Tolpis umbellata Bertol. – Tscap, Stenomed.; Strid, pers. comm.; 35, b, *KK 795.*

Tragopogon porrifolius subsp. *longirostris* (Sch. Bip.) Greuter – Hbienn, Eurymed.; Strid, pers. comm.; 11, a, *KK 240;* 16, a, *KK 504;* 10, a, *KK 573;* 22, b, *KK 782;* 26, b, *KK 1241, 1242;* 34, b, *KK 1523;* 50, c, *KK 1717.*

Tyrimnus leucographus (L.) Cass. – Tscap, Stenomed.; Strid, pers. comm.; 44, c, *KK phot.*

Boraginaceae

Anchusa azurea Mill. – Hscap, Eurymed.; Strid, pers. comm.; 51, c, *KK phot.*

Buglossoides arvensis (L.) I. M. Johnst. – Tscap, Med.-Submed.; Strid, pers. comm.; 10, a, *KK 574;* 23, b, *KK 886;* 29, b, *KK 1217.*

Cynoglossum columnae Ten. – Tscap, E-Med.; Strid, pers. comm.; 9, a, *KK 330;* 26, b, *KK 919.*

Echium diffusum Sm. (= *E. arenarium* Guss.) – Tscap, Stenomed.; 53, c, *KK 1740*.
Echium parviflorum Moench – Tscap, Stenomed.; Strid, pers. comm.; 9, a, *KK 329, 333;* 12, a, *KK 455*.
Echium plantagineum L. – Tscap, Eurymed.; Strid, pers. comm.; 11, a, *KK 238;* 12, a, *KK 434;* 35, b, *KK 812*.

Brassicaceae
Capsella bursa-pastoris (L.) Medik. – Hbienn, Cosmop.; 38, b, *KK obs.*
Matthiola incana (L.) R. Br. – Chsuffr, Stenomed.; 55, c, *KK 1728.*
Sisymbrium officinale (L.) Scop. – Tscap, Paleotemp.; 34, b, *KK 1526.*

Campanulaceae
Campanula erinus L. – Tscap, Eurymed.; Strid, pers. comm.; 35, b, *KK 797;* 22, b, *KK 990, 1014;* 24, b, *KK 1069, 1071, 1072, 1070, 1306;* 29, b, *KK 1200;* 25, b, *KK 1258;* 31, b, *KK 1324, 1325;* 44, c, *KK 1770*.

Capparaceae
Capparis orientalis Veillard – NPcaesp, Med.; Strid, pers. comm.; 53, c, *KK 1802*.

Caryophyllaceae
Cerastium semidecandrum L. – Tscap, Euras.; 19, a, *KK 378.*
Silene gallica L. – Tscap, Med.-Atl.; Strid, pers. comm.; 16, a, *KK 515;* 23, b, *KK 829;* 22, b, *KK 985, 1034, 1035;* 31, b, *KK 1341, 1343*.
Silene sartorii Boiss. & Heldr. – Tscap, Endem.; 53, c, *KK 1735*.
Spergularia marina (L.) Griseb. – Tscap, Subcosmop.; 3, a, *KK 67, 71, 75;* 35, b, *KK 803*.
Stellaria pallida (Dumort.) Piré – Tscap, Paleotemp.; 16, a, *KK 474.*

Chenopodiaceae
Suaeda maritima (L.) Dumort. – Tscap, Cosmop.; 20, a, *KK 338.*

Crassulaceae
Sedum caespitosum (Cav.) DC. – Tsucc, Med.; 27, b, *KK 1484.*
Sedum litoreum var. *creticum* ‘t Hart – Tscap, Endem.; 9, a, *KK 299;* 19, a, *KK 344;* 22, b, *KK 1025;* 24, b, *KK 1142;* 33, b, *KK 1355*.

Cyperaceae
Carex flacca subsp. *serrulata* (Spreng.) Greuter – Grhiz, Europ.; Strid, pers. comm.; 23, b, *KK 820;* 25, b, *KK 1288;* 46, c, *KK 1825*.
Carex halleriana Asso – Hcaesp, Eurymed.; Strid, pers. comm.; 33, b, *KK 1376.*
Carex illegitima Ces. – Hcaesp, E-Med.; 33, b, *KK 1374*.

Euphorbiaceae
Euphorbia dendroides L. – Pcaesp, Stenomed.; Strid, pers. comm.; 22, b, *KK obs*.
Euphorbia exigua L. – Tscap, Eurymed.; Strid, pers. comm.; 9, a, *KK 331;* 14, a, *KK 428;* 32, b, *KK 1385*.
Euphorbia peplus L. – Tscap, Cosmop.; Strid, pers. comm.; 17, a, *KK 150;* 19, a, *KK 171;* 18, a, *KK 220, 231;* 1, a, *KK 666;* 28, b, *KK 1146;* 29, b, *KK 1186;* 25, b, *KK 1264;* 49, c, *KK 1856.*
Mercurialis annua L. – Tscap, Paleotemp.; Strid, pers. comm.; 2, a, *KK 282;* 16, a, *KK 475;* 1, a, *KK 628, 640;* 23, b, *KK 837;* 29, b, *KK 1214.*

Fabaceae
Astragalus boeticus L. – Tscap, S-Stenomed.; Strid, pers. comm.; 18, a, *KK 166, 167, 168, 169, 173, 175;* 36, b, *KK 1578.*
Astragalus hamosus L. – Tscap, Med.-Turan.; Strid, pers. comm.; 20, a, *KK 339;* 1, a, *KK 618, 620;* 23, b, *KK 860;* 39, b, *KK 1450*.
Astragalus pelecinus (L.) Barneby – Tscap, Stenomed.; Strid, pers. comm.; 10, a, *KK 547, 580*.
Astragalus sinaicus Boiss. – Tscap, Med.; Strid, pers. comm.; 29, b, *KK 1164*.
Hippocrepis multisiliquosa L. – Tscap, Eurymed.; 29, b, *KK 1165*.
Lotus ornithopodioides L. – Tscap, Stenomed.; Strid, pers. comm.; 19, a, *KK 172;* 1, a, *KK 631;* 24, b, *KK 1085;* 28, b, *KK 1148;* 30, b, *KK 1416;* 37, b, *KK 1561;* 38, b, *KK 1598.*
Medicago constricta Durieu – Tscap, E-Med.; 33, b, *KK 1351.*
Medicago monspeliaca (L.) Trautv. – Tscap, Eurymed.; 2, a, *KK 271;* 10, a, *KK 548;* 1, a, *KK 616.*
Medicago praecox DC. – Tscap, Stenomed.; 1, a, *KK 630;* 42, b, *KK 1626, 1635;* 36, b, *KK 1574;* 40, b, *KK 1631.*
Medicago rigidula (L.) All. – Tscap, Eurymed.; 23, b, *KK 882;* 33, b, *KK 1356*.
[*Medicago sativa* L.] – Hscap, Cont.; 9, a, *KK 306*.
Melilotus altissiumus Thuill. – Grhiz, Eurosib.; 23, b, *KK 858.*
Melilotus indicus (L.) All. – Tscap, Med.-Turan.; Strid, pers. comm.; 25, b, *KK 1249;* 46, c, *KK 1836*.
Melilotus messanensis (L.) All. – Tscap, S-Med.; 1, a, *KK 611*.
Melilotus neapolitanus Ten. – Tscap, Med.; 1, a, *KK 610;* 23, b, *KK 839;* 30, b, *KK 1427, 1440;* 42, b, *KK 1627*.
Onobrychis aequidentata (Sm.) d’Urv. – Tscap, Stenomed.; Strid, pers. comm.; 3, a, *KK 65;* 7, a, *KK 84;* 11, a, *KK 239;* 23, b, *KK 823;* 23, b, *KK 825;* 29, b, *KK 1208;* 31, b, *KK 1316*.
Ononis natrix L. subsp. *natrix* – Chsuffr, Eurymed.; 26, b, *KK 922;* 29, b, *KK 1216;* 31, b, *KK 1319;* 34, b, *KK 1519;* 36, b, *KK 1581;* 45, c, *KK 1703*.
Spartium junceum L. – Pcaesp, Eurymed.; 46, c, *KK 1821.*

Trifolium angustifolium L. – Tscap, Med.-Subatl.; 26, b, *KK 925;* 34, b, *KK 1512*.
Trifolium spumosum L. – Tscap, Med.; 22, b, *KK 783*.
Trifolium tomentosum L. – Trept, Med.; Strid, pers. comm.; 22, b, *KK 1003*.
Trigonella balansae Boiss. & Reut. – Tscap, E-Med.; Strid, pers. comm.; 1, a, *KK 663*.
Trigonella rechingeri Širj. – Tscap, Endem.; Strid, pers. comm.; 1, a, *KK 644, 657;* 23, b, *KK 838;* 26, b, *KK 938, 946;* 25, b, *KK 1260;* 41, b, *KK 1471;* 37, b, *KK 1558;* 42, b, *KK 1625*.
Vicia cretica subsp. *aegaea* (Halácsy) P. W. Ball – Tscap, Endem.; 18, a, *KK 191, 219;* 1, a, *KK 635, 645;* 35, b, *KK 792;* 30, b, *KK 1438, 1441;* 45, c, *KK 1680*.
Vicia lathyroides L. – Tscap, Eurymed.; 25, b, *KK 1271*.
Vicia sativa subsp. *nigra* (L.) Ehrh. – Tscap, Cosmop.; 1, a, *KK 613*.

Frankeniaceae
Frankenia hirsuta L. – Chsuffr, Med.-Turan.; Strid, pers. comm.; 41, b, *KK 1465;* 48, c, *KK 1894*.
Frankenia pulverulenta L. – Tscap, Med.-Turan.; Strid, pers. comm.; 41, b, *KK 1475*.

Gentianaceae
Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch subsp. *tenuiflorum* – Tscap, Med.; Strid, pers. comm.; 24, b, *KK 1081;* 29, b, *KK 1193;* 25, b, *KK 1262;* 31, b, *KK 1328;* 41, b, *KK 1456;* 38, b, *KK 1593*.

Geraniaceae
Erodium botrys (Cav.) Bertol. – Tscap, Stenomed.; Strid, pers. comm.; 19, a, *KK 174*.
Erodium ciconium (L.) L'Hér. – Tscap, Eurymed.-Pont.; 8, a, *KK 402;* 12, a, *KK 436;* 45, c, *KK 1700.*
Erodium cicutarium (L.) L'Hér. subsp. *cicutarium* – Tcaesp, Subcosmop.; Strid, pers. comm.; 17, a, *KK 153;* 10, a, *KK 584;* 22, b, *KK 991*.
Erodium laciniatum (Cav.) Willd. – Tscap, Stenomed.; 1, a, *KK 642*.
Erodium malacoides (L.) L'Hér. – Tscap, Stenomed.; Strid, pers. comm.; 17, a, *KK 154;* 18, a, *KK 180, 218;* 1, a, *KK 637, 642*.
Geranium molle L. – Tscap, Subcosmop.; Strid, pers. comm.; 16, a, *KK 520*.
Geranium pusillum L. – Tscap, Euras.; 19, a, *KK 371*.
Geranium rotundifolium L. – Tscap, Paleotemp.; Strid, pers. comm.; 18, a, *KK 180;* 1, a, *KK 641*.

Iridaceae
Crocus cartwrightianus Herbert – Gbulb, Endem.; 58, d, *KK 1871;* 61, d, *KK phot.*

Juncaceae
Juncus heldreichianus T. Marsson ex Parl. – Hcaesp, E-Med.; Strid, pers. comm.; 35, b, *KK 787*.
Juncus maritimus Lam. – Grhiz, Subcosmop.; 40, b, *KK 1649.*
Juncus subulatus Forssk. – Grhiz, S-Med.; 25, b, *KK 1300.*

Lamiaceae
Salvia viridis L. – Tscap, Stenomed.; Strid, pers. comm.; 2, a, *KK 248, 261, 264;* 12, a, *KK 449;* 10, a, *KK 583;* 5, a, *KK 712*.
Sideritis romana subsp. *curvidens* (Stapf) Holmboe – Tscap, E-Med.; Strid, pers. comm.; 10, a, *KK 568;* 30, b, *KK 1413*.

Linaceae
Linum bienne Mill. – Hscap, Med.-Atl.; Strid, pers. comm.; 23, b, *KK obs*.

Moraceae
[*Morus nigra* L.] – NP, Cult.; 51, c, *KK 1707*.

Myrtaceae
[*Eucalyptus camaldulensis* Dehnh.] – P, Adv.; Strid, pers. comm.; 21, a, *KK obs*.

Orchidaceae
Anacamptis pyramidalis (L.) Rich. – Gbulb, Eurymed.; 33, b, *KK 1367;* 50, c, *KK 1715*.
Ophrys ferrum-equinum Desf. – Gbulb, E-Med.; 9, a, *KK 295, 291, 292, 294, 296;* 19, a, *KK 353;* 14, a, *KK 414;* 16, a, *KK 514, 512;* 23, b, *KK 1315;* 33, b, *KK 1364.*
Ophrys ferrum-equinum × *O. mammosa* Desf. – Gbulb, E-Med.; 33, b, *KK phot*.
Ophrys lutea Cav. subsp. *lutea* – Gbulb, Stenomed.; Strid, pers. comm.; 38, b, *KK phot.*
Ophrys lutea subsp. *galilaea* (H. Fleischm. & Bornm.) Soó – Gbulb, Stenomed.; Strid, pers. comm.; 17, a, *KK 122;* 9, a, *KK 293;* 19, a, *KK 345;* 14, a, *KK 413;* 33, b, *KK 1365*.
Ophrys omegaifera H. Fleischm. – Gbulb, E-Med.; Strid, pers. comm.; 16, a, *KK 513*.
Ophrys tenthredinifera Willd. – Gbulb, Stenomed.; Strid, pers. comm.; 17, a, *KK 123;* 16, a, *KK 511*.
Serapias lingua L. – Gbulb, Stenomed.; 23, b, *KK 1312*.
Serapias orientalis (Greuter) H. Baumann & Künkele subsp. *orientalis* – Gbulb, NE-Stenomed.; Strid, pers. comm.; 14, a, *KK 406;* 16, a, *KK 495;* 33, b, *KK 1370*.
Serapias vomeracea (Burm. f.) Briq. – Gbulb, Eurymed.; 14, a, *KK phot.*

Orobanchaceae
Orobanche cernua Loefl. – Tscap, Paleotemp.; 8, a, *KK 381;* 22, b, *KK 778;* 33, b, *KK 1372.*
Orobanche crenata Forssk. – Tpar, Med.-Turan.; 9, a, *KK 305;* 8, a, *KK 381;* 22, b, *KK 780;* 35, b, *KK 798*.
Orobanche mutelii F. W. Schultz – Tpar, Paleotemp.; Strid, pers. comm.; 14, a, *KK 410;* 31, b, *KK 1342;* 36, b, *KK 1657*.
Orobanche nana (Reut.) Beck – Tpar, Paleotemp.; 19, a, *KK 355;* 22, b, *KK 1024;* 24, b, *KK 1364.*

Orobanche pubescens d'Urv. – Tpar, Eurymed.; Strid, pers. comm.; 18, a, *KK 164;* 22, b, *KK 779;* 24, b, *KK 1116;* 29, b, *KK 1233.*

Orobanche sanguinea C. Presl – Tpar, Stenomed.; 23, b, *KK 866;* 32, b, *KK 1388;* 40, b, *KK 1633*.

Papaveraceae

Fumaria bastardii Boreau – Tscap, Subatl.; 37, b, *KK 1546.*

Fumaria densiflora DC. – Tscap, Subcosmop.; 5, a, *KK 404;* 1, a, *KK 634, 632*.

Glaucium flavum Crantz – Hscap, Med.-Atl.; 29, b, *KK 1238.*

Papaver rhoeas L. var. *rhoeas* – Tscap, E-Med.; 17, a, *KK 129;* 1, a, *KK 627;* 5, a, *KK 720, 721;* 26, b, *KK 943;* 22, b, *KK 1026;* 24, b, *KK 1061;* 26, b, *KK 1246;* 34, b, *KK 1514;* 36, b, *KK 1570;* 45, c, *KK 1701;* 53, c, *KK 1746, 1754.*

Papaver rhoeas var. *strigosum* Boenn. – Tscap, Paleotemp.; 19, a, *KK 376;* 10, a, *KK 586;* 1, a, *KK 626;* 38, b, *KK 1585, 1588, 1609, 1610.*

[*Papaver somniferum* L.] – Tscap, Cult.; 44, c, *KK obs*.

Plantaginaceae

Plantago bellardii All. subsp. *bellardii* – Tscap, Eurymed.; Strid, pers. comm.; 26, b, *KK 948*.

Plantago lanceolata L. – Hros, Cosmop.; Strid, pers. comm.; 16, a, *KK 492*.

Platanaceae

Platanus orientalis L. – Pscap, SE-Europ.; 35, b, *KK obs*.

Plumbaginaceae

Limonium ocymifolium (Poir.) Kuntze – Chsuffr, Endem.; Strid, pers. comm.; 7, a, *KK 85, 86, 103;* 20, a, *KK 336, 337;* 28, b, *KK 1150, 1153;* 33, b, *KK 1373.*

Limonium palmare (Sm.) Rech. f. – Chsuffr, Endem.; Strid, pers. comm.; 6, a, *KK 537, 538;* 28, b, *KK 1151, 1152, 1154;* 41, b, *KK 1468, 1463, 1464;* 40, b, *KK 1647*.

Limonium roridum (Sm.) Brullo & Guarino – Chsuffr, E-Med.; Strid, pers. comm.; 47, c, *KK 1813.*

Limonium virgatum (Willd.) Fourr. – Chsuffr, Eurymed.; Strid, pers. comm.; 7, a, *KK 80, 81, 85, 86, 87, 102;* 51, c, *KK 1706;* 53, c, *KK 1765;* 48, c, *KK 1839*.

Poaceae

Aira caryophyllea L. – Tscap, Subtrop.; 18, a, *KK 197*.

Aira elegantissima Schur – Tscap, Eurymed.; Strid, pers. comm.; 35, b, *KK 806.*

Alopecurus myosuroides Huds. – Tscap, Subcosmop.; 45, c, *KK 1679*.

Andropogon distachyos L. – Hcaesp, Paleotrop.; Strid, pers. comm.; 2, a, *KK 247, 270.*

Anisantha diandra (Roth) Tutin – Tcaesp, Med.; Strid, pers. comm.; 14, a, *KK 426, 425*.

Anisantha madritensis (L.) Nevski – Tscap, Eurymed.; Strid, pers. comm.; 24, b, *KK 1131;* 38, b, *KK 1616*.

Anisantha rigida (Roth) Hyl. – Tscap, Paleosubtrop.; 35, b, *KK 817*.

Anisantha sterilis (L.) Nevski – Tscap, Paleotemp.; Strid, pers. comm.; 23, b, *KK 903*.

Avena fatua L. – Tscap, Euras.; 23, b, *KK 899;* 29, b, *KK 1198;* 34, b, *KK 1540.*

Bromus alopecuros Poir. – Tscap, Stenomed.; 23, b, *KK 901;* 33, b, *KK 1381*.

Cynosurus echinatus L. – Tscap, Eurymed.; Strid, pers. comm.; 14, a, *KK 417;* 35, b, *KK 801;* 22, b, *KK 1047;* 45, c, *KK 1680*.

Hordeum bulbosum L. – Hcaesp, Subtrop.; 4, a, *KK 731, 737, 738.*

Hordeum marinum Huds. – Tscap, W Eurymed.; Strid, pers. comm.; 3, a, *KK 64;* 14, a, *KK 427;* 1, a, *KK 595;* 35, b, *KK 809;* 25, b, *KK 818;* 23, b, *KK 898, 902;* 26, b, *KK 939;* 24, b, *KK 1472;* 34, b, *KK 1527, 1541*.

Imperata cylindrica (L.) Raeusch. – Grhiz, Cosmop.; 55, c, *KK 1730*.

Lamarckia aurea (L.) Moench – Tscap, Stenomed.-Turan.; Strid, pers. comm.; 3, a, *KK 68*.

Ochlopoa annua (L.) H. Scholz – Tcaesp, Cosmop.; 33, b, *KK 1380*.

Phalaris minor Retz. – Tscap, Subtrop.; 23, b, *KK 895, 897;* 22, b, *KK 1057;* 24, b, *KK 1135;* 25, b, *KK 1296;* 33, b, *KK 1382;* 34, b, *KK 1532;* 37, b, *KK 1559;* 45, c, *KK 1694;* 41, b, *KK 1473;* 44, b, *KK 1778, 1791*.

Poa timoleontis Heldr. ex Boiss. – Hcaesp, E-Med.; 24, b, *KK 1127*.

Polypogon monspeliensis (L.) Desf. – Tscap, Subtrop.; 48, c, *KK 1895*.

Polypogon viridis (Gouan) Breistr. – Hcaesp, Subtrop.; 46, c, *KK 1815*.

Sporobolus pungens (Schreb.) Kunth – Grhiz, Subtrop.; 37, b, *KK 1552, 1556.*

Polygonaceae

Polygonum maritimum L. – Hrept, Subcosmop.; 47, c, *KK 1870.*

Rumex pulcher L. – Hscap, Eurymed.; Strid, pers. comm.; 36, b, *KK 1565.*

Posidoniaceae

Posidonia oceanica (L.) Delile – Irad, Stenomed.; Strid, pers. comm.; 6, a, *KK 539;* 40, b, *KK 1656*.

Primulaceae

Samolus valerandi L. – Hscap, Subcosmop.; Strid, pers. comm.; 35, b, *KK 786.*

Ranunculaceae

Ranunculus muricatus L. – Tscap, Eurymed.; 35, b, *KK 807, 808.*

Rubiaceae

Crucianella angustifolia L. – Tscap, Eurymed.; 32, b, *KK 1390;* 38, b, *KK 1601.*

Galium spurium L. – Tscap, Euras.; 19, a, *KK 351;* 1, a, *KK 659;* 35, b, *KK 794;* 26, b, *KK 932, 1247.*

Galium tricornutum Dandy – Tscap, Eurymed.; Strid, pers. comm.; 17, a, *KK 127;* 2, a, *KK 284;* 8, a, *KK 398;* 10, a, *KK 550;* 1, a, *KK 609, 658.*

Sherardia arvensis L. – Tscap, Subcosmop.; Strid, pers. comm.; 17, a, *KK 160;* 12, a, *KK 451;* 16, a, *KK 522;* 1, a, *KK 639, 649;* 4, a, *KK 749;* 26, b, *KK 914;* 22, b, *KK 981;* 29, b, *KK 1215;* 25, b, *KK 1259;* 34, b, *KK 1490, 1534;* 46, c, *KK 1823.*

Scrophulariaceae

Linaria micrantha (Cav.) Hoffmanns. & Link – Tscap, Stenomed.; 23, b, *KK 887, 819.*

Linaria simplex (Willd.) DC. – Tscap, Eurymed.; 16, a, *KK 484, 524.*

Parentucellia latifolia (L.) Caruel – Tscap, Eurymed.; Strid, pers. comm.; 23, b, *KK 863.*

Veronica cymbalaria Bodard – Tscap, Eurymed.; 16, a, *KK 488;* 1, a, *KK 652;* 29, b, *KK 1219.*

Solanaceae

Hyoscyamus aureus L. – Hbienn, E-Med.; 24, b, *KK 1143.*

Thymelaeaceae

Thymelaea tartonraira subsp. *argentea* var. *angustifolia* (d'Urv.) Meissn. – NP, E-Med.; Strid, pers. comm.; 14, a, *KK 412;* 24, b, *KK 1125;* 28, b, *KK 1155.*

Valerianaceae

Centranthus calcitrapae (L.) Dufr. – Tscap, Stenomed.; Strid, pers. comm.; 19, a, *KK 357;* 35, b, *KK 790;* 26, b, *KK 915;* 25, b, *KK 1259;* 38, b, *KK 1590.*

Valerianella coronata DC. – Tscap, Eurymed.; 12, a, *KK 465.*

Valerianella discoidea Loisel. – Tscap, Stenomed.; Strid, pers. comm.; 7, a, *KK 93.*

Valerianella echinata (L.) DC. – Tscap, Stenomed.; Strid, pers. comm.; 10, a, *KK 552.*

Valerianella microcarpa Loisel. – Tscap, Stenomed.; Strid, pers. comm.; 23 b, *KK 821.*

Valerianella pumila DC. – Tscap, Stenomed.; 17, a, *KK 116;* 23, b, *KK 884.*

Valerianella vesicaria (L.) Moench – Tscap, E-Stenomed.; Strid, pers. comm.; 5, a, *KK 689;* 22, b, *KK 1002;* 25, b, *KK 1256, 1270;* 31, b, *KK 1321.*

Verbenaceae

Vitex agnus-castus L. – Pcaesp, Stenomed.-Turan.; Strid, pers. comm.; 51, c, *KK 1708.*

2. Flora of Anafi island

Thirty-seven of the 635 vascular plant taxa of Anafi are Greek endemics, nine of which we newly recorded for the study area. Thirty-four of our new records and 128 taxa overall are under a protection status.

The most species-rich families in the flora of Anafi are the *Asteraceae* (91 taxa), followed by the *Fabaceae* (81 taxa) and *Poaceae* (72 taxa). These three families account for more than one third of the total flora (38.4 %). *Apiaceae* (28 taxa), *Caryophyllaceae* (28 taxa), *Brassicaceae* (23 taxa) and *Lamiaceae* (19 taxa) are also well represented.

Therophytes are the dominating life form (Table 2), followed by hemicryptophytes, geophytes, chamaephytes and phanerophytes.

According to the general distribution of its taxa, the local vascular flora of Anafi can be classified into thirteen main chorological groups (Table 3).

The 37 Greek endemics, representing c. 6 % of the total flora, are discussed separately, below. The Mediterranean chorological group predominates, highlighting the geographical position and climatic characteristics of Anafi. Within this group, the Stenomediterranean elements are dominant. The other elements are represented in lower percentages, with a relatively high portion of cosmopolitan and subcosmopolitan, and also of invasive elements, indicating intense human impact in the study area.

The alien flora of Anafi comprises 17 taxa (2.68 %), belonging to 16 genera and 14 families. The neophytes amount to 73.3 % of Anafi's alien flora and the most prominent among the invasive species are *Opuntia ficus-indica* (L.) Mill., *Agave americana* L. and *Oxalis pes-caprae* L. which occupy large areas.

Table 1. Numbers of vascular plant taxa in the flora of Anafi Island; * species and infraspecific taxa.

Systematic unit	Families	Genera	Taxa*	%
Pteridophytes	4	5	5	0.79
Gymnospermae	3	3	3	0.47
Dicotyledones	56	229	482	75.91
Monocotyledones	16	77	145	22.83
Total	**79**	**314**	**635**	**100.00**

Table 2. Life forms in the flora of Anafi Island.

Life forms	Number of taxa	%
Phanerophytes	38	6.15
Chamaephytes	49	7.93
Hemicryptophytes	107	17.31
Therophytes	347	56.15
Geophytes	75	12.14
Hydrophytes	2	0.32
Total	**618**	**100.00**

Table 3. Chorological groups in the flora of Anafi Island.

Chorological group	Number of taxa	%	Total number of taxa	%
1. Widely distributed taxa			**98**	**15.86**
Cosmopolitan	40	6.47		
Tropical	14	2.27		
Temperate	25	4.05		
Eurasian	9	1.46		
European	5	0.81		
African	5	0.81		
2. Mediterranean taxa			**482**	**77.99**
Mediterranean	43	6.96		
Eurymediterranean	115	18.61		
Stenomediterranean	153	24.76		
East Mediterranean	111	17.96		
Mediterranean-Submediterranean	60	9.71		
3. Endemic taxa			**37**	**5.99**
Endemic	37	5.99		
4. Cultivated & adventive taxa	1	0.16	**1**	**0.16**
Total	**618**	100.00	**618**	100.00

East Mediterranean elements — The remarkably high percentage of the East Mediterranean elements (17.96 %) may possibly reflect the unique position of Anafi, as it is found on the borderline of three phytogeographical regions, namely the Kiklades, the East Aegean Islands and Kriti and Karpathos.

Among the many Anatolian elements (111 taxa) found in Anafi, there are three that underline the importance of Anafi as a crossroad for plant taxa migrating further west through multiple routes. *Medicago heyniana* is a species distributed in Kasos, Karpathos, Zafora, Tilos, Rhodos, Amorgos, Anafi and the Marmaris Peninsula in Turkey (Thanopoulos in Phitos & al. 2009) and poses an excellent example of the westward migration route from Anatolia to the central Aegean.

Reseda odorata is a species known only from south-central Kriti, Gavdos, Anafi and Libya (Turland in Phitos & al. 2009); its present distribution indicates a southern migration route of originally Anatolian elements.

A very interesting record is *Phoenix theophrasti,* a species known to occur in southwestern Turkey and in Greece, mainly in Kriti, and in a single locality in the Peloponnese. Its indigenous presence in Anafi has been questioned so far (Thymakis in Phitos & al. 2009). We found several individuals to occupy similar ecological niches as in the locus classicus (stream banks near sea level), which is a strong indication that this species is actually native to Anafi. Therefore we consider *P. theophrasti* an indigenous member of the flora of the Kiklades. It could be argued that in the past the species probably covered a much larger area in Anafi, as it is found in four different and distant locations on the island. A population of *P. theophrasti,* however, found on the island of Milos growing in a small wetland by a watercourse and consisting of 10 mature trees and about the same number of saplings, is yet supposed naturalised from prior human import (Raus 2012).

It is also worth mentioning that *Hyoscyamus aureus* was found for the first time in the phytogeographical region of the Kiklades. Previously it was only known from Kriti and some East Aegean Islands (Zervou 2011).

Another interesting new record from Anafi is *Sonchus bulbosus* subsp. *microcephalus,* a taxon distributed mainly in Cyprus, Syria, Lebanon and Turkey (Lamond 1975), with the Aegean region bridging the total range towards the recently re-

Table 4. Endemism in the phytogeographical area of the Kiklades, Methana Peninsula, Aegina, Milos, Santorini, Nisiros and the study area of Anafi.

Region	No. of Greek endemic taxa	%
Kiklades	157	9.38
Methana Peninsula	35	5.65
Aaegina	24	3.04
Milos	48	5.42
Santorini	20	3.40
Nisiros	14	2.19
Anafi	37	5.99

Table 5. Families with Greek endemic taxa and their degree of endemism.

Family	No. of Greek endemic taxa	%
Asteraceae	10	10.99
Caryophyllaceae	4	14.29
Brassicaceae	3	10.71
Fabaceae	3	3.70
Iridaceae	3	42.86
Orchidaceae	2	11.11
Amaryllidaceae	2	16.67
Plumbaginaceae	2	33.33
Campanulaceae	1	50.00
Chenopodiaceae	1	14.29
Crassulaceae	1	14.29
Ranunculaceae	1	12.50
Scrophulariaceae	1	12.50
Rubiacea	1	6.67
Lamiaceae	1	5.26
Poaceae	1	1.39

Table 6. Greek endemic taxa in Anafi and their geographical distribution. – IoI = Ionian Islands, StE = Sterea Hellas, Pe = Peloponnisos, Kik = Kiklades, KK= Kriti and Karpathos, EAe = East Aegean Islands, NPi = North Pindhos, SPi = South Pindhos, EC = East Central, NC = North Central, NE = North East, NAe = North Aegean Islands, WAe = West Aegean Islands.

Family	Taxon	PE	StE	WAe	IoI	SPi	NPi	EC	NC	NE	NAe	KiK	KK	EAe
Dicots														
Asteraceae	*Anthemis ammanthus* Greuter subsp. *ammanthus*											*		
Asteraceae	*Carthamus leucocaulos* Sm.	*		*						*		*	*	*
Asteraceae	*Centaurea raphanina* subsp. *mixta* (DC.) Runemark	*	*	*								*		
Asteraceae	*Crepis hellenica* Kamari	*	*	*		*		*		?		*		*
Asteraceae	*Filago aegaea* Wagenitz subsp. *aegaea*											*	*	*
Asteraceae	*Filago cretensis* Gand. subsp. *cretensis*	*	*	*								*	*	*
Asteraceae	*Hirtellina fruticosa* (L.) Dittrich											*	*	*
Asteraceae	*Hymenonema graecum* (L.) DC.											*	*	
Asteraceae	*Onopordum caulescens* D'Urv. subsp. *caulescens*											*		
Asteraceae	*Scorzonera araneosa* Sm.											*		
Brassicaceae	*Erysimum candicum* Snogerup subsp. *candicum*											*	*	
Brassicaceae	*Erysimum senoneri* (Heldr. & Sart.) Wettst. subsp. *senoneri*			*								*		
Brassicaceae	*Fibiga lunarioides* (Willd.) Sm.											*	*	*
Campanulaceae	*Campanula laciniata* L.											*	*	
Caryophyllaceae	*Arenaria aegaea* Rech.f.	*										*	*	*
Caryophyllaceae	*Dianthus fruticosus* L. subsp. *fruticosus*											*		*
Caryophyllaceae	*Silene cythnia* (Halácsy) Walters											*		*
Caryophyllaceae	*Silene sartorii* Boiss. & Heldr.	*	*									*	*	
Chenopodiaceae	*Salsola aegaea* Rech.f.	*	*									*	*	*
Crassulaceae	*Sedum litoreum* Guss. var. *creticum*											*	*	
Fabaceae	*Anthyllis splendens* Willd.											*	*	
Fabaceae	*Trigonella rechingeri* Širj.	*		*								*	*	*
Fabaceae	*Vicia cretica* subsp. *aegaea* (Halácsy) P. W. Ball		*									*		
Lamiaceae	*Stachys spinosa* L.											*	*	
Plumbaginaceae	*Limonium ocymifolium* (Poir.) O. Kuntze	*	*									*	*	*
Plumbaginaceae	*Limonium palmare* (Sm.) Rech.f.		*	*								*		*
Ranunculaceae	*Nigella doerfleri* Vierh.	*										*	*	
Rubiaceae	*Asperula tournefortii* Spreng.											*	*	*
Scrophulariaceae	*Scrophularia heterophylla* Willd. var. *heterophylla*	*	*	*	*			*		*	*	*	*	*
Monocots														
Amaryllidaceae	*Allium luteolum* Halácsy											*		
Amaryllidaceae	*Sternbergia greuteriana* Kamari & Artelari											*	*	
Iridaceae	*Crocus cartwrightianus* Herbert	*	*		?							*	*	
Iridaceae	*Crocus laevigatus* Bory & Chaub.	*	*	*						?		*	*	
Iridaceae	*Crocus tournefortii* J. Gay	*										*	*	*
Orchidaceae	*Ophrys cretica* subsp. *ariadnae* (Paulus) H. Kretzschmar	*	?									*	*	?
Orchidaceae	*Ophrys spruneri* Nyman subsp. *spruneri*	*	*	*	*	*	*					*	*	*
Poaceae	*Phleum exaratum* subsp. *aegaeum* (Vierh.) Doğan	*										*	*	*

Table 7. Greek endemic taxa from Anafi Island and their protection – evaluation status according to European and National legislation and lists.

Family	Taxon	Protection status	Natura 2000
Asteraceae	*Anthemis ammanthus* Greuter subsp. *ammanthus*	R (IUCN), WCMC	B
Asteraceae	*Carthamus leucocaulos* Sm.	WCMC	B
Asteraceae	*Centaurea raphanina* subsp. *mixta* (DC.) Runemark	WCMC	B
Asteraceae	*Crepis hellenica* Kamari	WCMC	B
Asteraceae	*Filago aegaea* Wagenitz subsp. *aegaea*	–	B
Asteraceae	*Filago cretensis* Gand. subsp. *cretensis*	WCMC	B
Asteraceae	*Hirtellina fruticosa* (L.) Dittrich	R (IUCN), PD, WCMC	–
Asteraceae	*Hymenonema graecum* (L.) DC.	PD, WCMC	D
Asteraceae	*Onopordum caulescens* d'Urv. subsp. *caulescens*	–	–
Asteraceae	*Scorzonera araneosa* Sm.	–	B
Brassicaceae	*Erysimum candicum* Snogerup subsp. *candicum*	NT (IUCN), PD, WCMC	–
Brassicaceae	*Erysimum senoneri* (Heldr. & Sart.) Wettst. subsp. *senoneri*	WCMC	B
Brassicaceae	*Fibigia lunarioides* (Willd.) Sm.	WCMC	B
Campanulaceae	*Campanula laciniata* L.	R (RDB), PD, WCMC	B
Caryophyllaceae	*Arenaria aegaea* Rech.f.	WCMC	B
Caryophyllaceae	*Dianthus fruticosus* L. subsp. *fruticosus*	DD (IUCN), PD, WCMC	B
Caryophyllaceae	*Silene cythnia* (Halácsy) Walters	R (IUCN), PD, WCMC	–
Caryophyllaceae	*Silene sartorii* Boiss. & Heldr.	WCMC	B
Chenopodiaceae	*Salsola aegaea* Rech.f.	WCMC	B
Crassulaceae	*Sedum litoreum* Guss. var. *creticum*	–	–
Fabaceae	*Anthyllis splendens* Willd.	R (RDB), PD, WCMC	B
Fabaceae	*Trigonella rechingeri* Širj.	R (IUCN), PD, WCMC	B
Fabaceae	*Vicia cretica* subsp. *aegaea* (Halácsy) P. W. Ball	–	–
Lamiaceae	*Stachys spinosa* L.	WCMC	B
Plumbaginaceae	*Limonium ocymifolium* (Poir.) O. Kuntze	–	B
Plumbaginaceae	*Limonium palmare* (Sm.) Rech.f.	–	–
Ranunculaceae	*Nigella doerfleri* Vierh.	R (IUCN), WCMC	B
Rubiaceae	*Asperula tournefortii* Spreng.	R (IUCN), PD, WCMC	B
Scrophulariaceae	*Scrophularia heterophylla* Willd. var. *heterophylla*	–	–
Amaryllidaceae	*Allium luteolum* Halacsy	DD (IUCN), PD, WCMC	B
Amaryllidaceae	*Sternbergia greuteriana* Kamari & Artelari	–	–
Iridaceae	*Crocus cartwrightianus* Herbert	–	–
Iridaceae	*Crocus laevigatus* Bory & Chaub.	WCMC	–
Iridaceae	*Crocus tournefortii* J. Gay	WCMC	B
Orchidaceae	*Ophrys cretica* subsp. *ariadnae* (Paulus) H. Kretzschmar	PD	–
Orchidaceae	*Ophrys spruneri* Nyman subsp. *spruneri*	–	–
Poaceae	*Phleum exaratum* subsp. *aegaeum* (Vierh.) Doğan	–	–

Abbreviations:
IUCN: Red List of Threatened Plants (IUCN 2010), with the following classification system: DD: Data Deficient, NT: the species population is nearly threatened, R: the species population is rare.
P.D.: Greek Presidential Decree 67/1981 (1981), on the protection of the native flora and wild fauna of Greece
RDB: Red Data Book of rare and threatened plants of Greece (Phitos & al. 1995, 2009), with the following classification system: R: the species population is rare.
Natura 2000 (Dafis & al. 1996): the database created after the Directive 43/1992, where the plants are evaluated as: B: Greek endemics, D: Other.
WCMC: the directive for the threatened (Endangered, Vulnerable, Rare or Data Deficient) taxa according to the World Conservation Monitoring Center

corded westernmost occurrence of that taxon by the Yalova lagoon in southwestern Peloponnese (Koutroumpa, unpublished diploma thesis, University of Patras 2011).

Endemism — According to Tan & Iatrou (2001), 1640 taxa are found in the phytogeographical region of the Kiklades, 157 of which are Greek endemics (9.38 %) according to Georghiou & Delipetrou (2010). The number of 37 endemic taxa of Anafi (Table 4), making up c. 6 % of its flora, is low compared to the total, but taking into consideration the small size of the study area (c. 38 km^2), its geographic position not close to known areas of high endemism and the unfavourable semiarid climate, this percentage of endemism is rather significant. Furthermore, compared to the levels of endemism in other parts of the SAVA, yet with much larger size than that of the study area such as Aegina, Methana Peninsula, Santorini, Milos and Nisiros (3.04 %, 5.65 %, 3.40 %, 5.42 % and 2.19 %, respectively; Table 4), the level of endemism in Anafi is remarkably high, actually the highest in the SAVA.

The endemic species belong to sixteen families and thirty genera. The highest degree of endemism is found in the *Campanulaceae* (50 %). Families also rich in endemic species in absolute numbers are the *Asteraceae* and *Caryophyllaceae* (Table 5), their degree of endemism (10.99 % and 14.29 %, respectively) being higher than that of the general flora. These results agree with the trend observed in the whole Greek endemic flora (Georghiou & Delipetrou 2010).

The majority (22) of the Greek endemic taxa found on Anafi are present in three or more phytogeographical areas (Table 6). The remainder of the endemic taxa provide valuable information regarding the phytogeographical position of Anafi, as the existence of biregional endemics is a good indication of phytogeographical connections between regions (Georghiou & Delipetrou 2010). It would be expected that Anafi shows higher affinities with the phytogeographical area of the East Aegean Islands, since, according to Georghiou & Delipetrou (2010), the phytogeographical area of the Kiklades is chorologically closer connected to East Aegean than to Kriti and Karpathos. While this may be true for the majority of the Kiklades islands, our results demonstrate that Anafi is phytogeographically closer to Kriti and Karpathos, as we recorded seven endemic taxa *(Hymenonema graecum, Erysimum candicum* subsp. *candicum, Campanula laciniata, Sedum littoreum* var. *creticum, Anthyllis splendens, Stachys spinosa* & *Sternbergia greuteriana)* that occur exclusively in the Kiklades and Kriti and Karpathos and only two taxa *(Dianthus fruticosus* subsp. *fruticosus* & *Silene cythnia)* that occur exclusively in the Kiklades and East Aegean Islands. Therefore we argue that Anafi seems to be closer connected to Kriti and Karpathos and it would be reasonable to assume that the study area will show higher floristic affinities particularly with eastern Kriti.

Among the 37 Greek endemic taxa, *Sedum littoreum* var. *creticum* and *Sternbergia greuteriana* are the most interesting ones as they are first recorded for the entire phytogeographical area of Kiklades. Previously they were thought to be confined to Kriti and Karpathos.

The nature conservation status of the Greek endemic taxa of Anafi as well as their evaluation status within the Natura 2000 Network is shown in Table 7. Twenty-nine out of thirty-seven endemic taxa are under a protection status.

3. Phytogeographical relationships within the South Aegean Volcanic Arc (SAVA)

The active volcanic arc consists of several centres situated along a west-east extending belt between the Saronic Gulf and the island of Nisiros. Methana Peninsula, together with Aegina, Milos, Santorini and Nisiros constitute a large part of the SAVA and are floristically well known. Therefore, we focus on these five areas in order to examine the phytogeographical affinities of Anafi Island within the SAVA.

Milos and Santorini are in the same bioclimatic zone and phytogeographical region (Kiklades) as the study area. Methana Peninsula and Aegina are in the same bioclimatic zone as Anafi, but in different phytogeographical region, while Nisiros has a more humid climate and is situated in the eastern part of the Aegean Sea.

In Table 8 Sørensen's index values for each island pair show that Milos has the strongest phytogeographical affinity with Anafi.

Table 8. Sørensen's index values for each area compared to Anafi Island.

Pair with Anafi	Sorensen's Index
Milos	61.7
Santorini	58.8
Aegina	53.0
Nisiros	49.5
Methana	46.7

Discussion

The high percentage of therophytes (56.15 %) and of leguminous taxa (12.76 %) indicate disturbance in Mediterranean ecosystems (Naveh 1974; Arianoutsou & Margaris 1981; Barbero & al. 1990; Panitsa & al. 1994, 2003; Panitsa & Tzanoudakis 1998). Although intense stock farming has now ceased in Anafi, the floristic character of the island is clearly altered due to the high local amount of cosmopolitan elements (6.47 %).

According to Arianoutsou & al. (2010), the total number of alien taxa accounts for c. 5 % of the native flora of Greece and is significantly higher than that of Anafi

(2.68 %). Nevertheless, in Anafi where abandoned grazing grounds and farm lands occupy large areas, *Opuntia ficus-indica* and *Agave americana* have heavily contaminated and altered these habitats which would otherwise be colonised by native pioneer herbs and shrubs. This phenomenon is also observed in other Aegean islands (Arianoutsou & al. 2010).

The high percentages of chamaephytes and hemicryptophytes depend on the frequency of limestone cliffs which very often harbour endemic taxa (Kypriotakis 1998; Kypriotakis & Tzanoudakis 2001; Tzanoudakis & al. 2006). Indeed, more than one third (37.84 %) of the endemic flora of Anafi are chamaephytes or hemicryptophytes and located in the Kalamos Peninsula, which, according to Snogerup (in Phitos & al. 1995), is among the most important cliff refugia in the Aegean.

Anafi is floristically more diverse than the other parts of the SAVA, probably because of the increased habitat diversity due to the greater topographic and geological heterogeneity it presents (mountainous relief with many different inclinations and exposures, and numerous geological substrates of different age), factors known to promote species richness (Whittaker & Fernández-Palacios 2007; Sfenthourakis & Triantis 2009), and owing to its geographical position, as in the study area several migration routes of organisms of a south- or eastward origin intersect. Our results are in accordance with Sfenthourakis & Panitsa (2011) who state that diversity at the whole-island scale is shaped mainly by heterogeneity among local communities in small Aegean islands. The number of species per surface unit is an important parameter of Aegean vascular plant diversity, regarding the conservation of the diversity of the Aegean area (Panitsa & Tzanoudakis 2010). Anafi seems to be a biodiversity hotspot, as it hosts nearly twice (17 species/km^2) the number of taxa compared to the Leros islets group (9.31 species/km^2, Panitsa & Tzanoudakis 2010), forty times the taxa compared to the whole East Aegean area (0.4 species/km^2, Panitsa & Tzanoudakis 2010) and thirty times the number of taxa compared to the Kiklades (c. 0.54 species/km^2, Phitos & al. 1995).

According to Strid & Tan (1997), the phytogeographical region of Kriti and Karpathos has strong connections to that of the Kiklades, especially as the dry southeastern islands are concerned. Some of the East Mediterranean and endemic taxa found in the study area provide useful information regarding the biogeographical position of Anafi, as that island seems to harbour the northernmost populations within their total distribution range, hence suggesting a close phytogeographical relationship between Anafi and Kriti. This concerns *Reseda odorata, Phoenix theophrasti, Campanula laciniata, Sedum littoreum* var. *creticum, Erysimum candicum* subsp. *candicum, Sternbergia greuteriana* and *Stachys spinosa*.

Finally, the flora of Anafi is more similar to that of Milos and Santorini (Kiklades) than to that of Aegina and Methana Peninsula, as was to be expected. The historical and recent volcanic eruptions on Santorini probably explain the lower floristic affinities between Santorini and Anafi despite their close proximity. Snogerup & al. (2006) state that all Kiklades islands have their main floristic connections towards the west, i.e. to the European mainland, and that the floristic divide between Europe and Asia ("Rechinger's line") falls between the Kiklades and the East Aegean islands. Anafi has high floristic affinities with Aegina as expected, but then, surprisingly, with the East Aegean island of Nisiros instead of the Methana peninsula on the east coast of the Greek mainland, thus highlighting the special phytogeographical position of Anafi close to Rechinger's line.

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