K. Tan, V. Stevanović & A. Strid

Distribution and centres of diversity for endemic geophytic Monocots in the Balkans

Abstract

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It is well known that the life form of a geophyte is admirably adapted for dwelling in arid and semi-arid habitats and that the ephemeral occurrence or temporal use of ecological niches in such habitats is a specific survival strategy to avoid unfavorable conditions such as drought and competition. The extremely rich endemic flora of the Balkan Peninsula is represented by several life forms and it is estimated that geophytes account for at least 10% of this flora. The majority of taxa (numbers in parentheses) belongs to the Monocot families *Liliaceae* (incl. *Alliaceae*, 124), *Iridaceae* (28), *Orchidaceae* (still unknown), *Amaryllidaceae* (5) and *Araceae* (8) which have all members geophytic. One of the most important centres of a geophytic flora is the Mediterranean region including the adjacent mountainous areas. The Balkan Peninsula is a significant centre of diversity for endemic geophytes both in terms of origin and speciation. The distribution of c. 175 endemic geophytic Monocots (excl. *Orchidaceae*, *Gramineae* & *Cyperaceae*) in the Balkans was mapped using 50x50 km UTM squares. The data permitted correlations of distribution with several interesting topics such as morphology, phenology, altitudinal range, island isolation and centres of diversity.

Introduction

As part of an on-going project: Mapping the endemic flora of the Balkans, initiated and carried out by V. Stevanović, K. Tan & A. Petrova (Stevanović & al. 2003, 2004), together with collaborators, some attention was devoted to an analysis of the life forms of endemics in the Balkans together with their distribution.

The predominant life form of the endemic Balkan flora can be assigned to the 'hemicryptophyte-chamaephyte' category (Mueller-Dombois & Ellenberg 1974) with a significantly high percentage of geophytes. We define the latter as plants with distinctly swollen, enlarged underground storage organs. The recorded number of endemic geophytes is approximately 260, representing c. 10% of the estimated endemic flora. The Monocots dominate, particularly the families *Liliaceae* (incl. *Alliaceae*) and *Iridaceae*. The present analysis caters only for those geophyte families which have been mapped. These families are the *Liliaceae*, *Iridaceae*, *Amaryllidaceae* and *Araceae*, while

Orchidaceae, *Gramineae* and *Cyperaceae* are not included at present. The total number of taxa analyzed is 170 and their distribution are mapped using 50x50 km UTM squares as adopted in the Atlas Florae Europaeae project coordinated at Helsinki.

Results and discussion

We found that the most abundant endemic geophyte is *Allium* with 42 taxa (22), a number nearly double in respect to that recorded by Turrill (1929). Several species have been recently discovered and described as local endemics especially from the Aegean and Ionian islands, Crete and the Peloponnesus. Other genera in descending number of taxa (Turrill's in parentheses) are: *Crocus* 28 (13), *Fritillaria* 2 (15), *Colchicum* 15 (16, result of a recent generic revision), *Tulipa* (10) and *Ornithogalum* 11 each, *Iris* 8 and *Muscari* (12) 8 each, *Bellevalia* 6, *Biarum* and *Scilla* 5 each, *Lilium*, *Galanthus* and *Arum* 3 each, *Hyacinthella*, *Leucojum*, *Narthecium* and *Androcymbium* 1 each.

The increase in taxa in the latter half of the previous century is the result of accurate taxonomic or floristic investigations in the Balkan countries. To mention a few, in Greece: Greuter (1967), Speta (1971, 1990), Bentzer (1973), Zahariadi (1977), Stearn (1981), Zahariadi & al. (1982), Kamari (1982, 1991, 1991a), Mathew (1982, 1983, 2000), Tzanoudakis (1983, 1986), Tzanoudakis & Vosa (1988), Persson (1988, 1991), Landström (1989), Kamari & Artelari (1990), Tzanoudakis & al. (1991), Brullo & al. (1994); in Bulgaria mainly Stefanov (1926) and Delipavlov (1976), in Turkey (European part): Kollmann (1984), Speta (1991), Ozhatay & Tzanoudakis (2000), Ozhatay (2000), etc., and in former Yugoslavia: Pulević (1976, 1978) and Randjelović & al. (1990).

The map showing the total distribution of endemic geophytes in the Balkans (Fig. 1, data obtained from the c. 170 analyzed taxa) reveals several important centres of diversity. These are the island of Crete, in particular Mt. Dikti (35SLU3) and Levka Ori (34SGE4), Taigetos in S Peloponnesus (34SFF1) and the Parnassos-Giona region in Sterea Ellas (34SFH1). Within these UTM 50x50 km squares, more than 18 to 23 endemic taxa have been recorded. Other regions in Crete (34SGE2, 35SKV4, 35SKU3, 35SLV2, 35SLU1, 35SLV4, 35SMV3, 35SMU1), N, C and SW Peloponnesus (34SFF4, 34SFF3, 34SFF2 34SFG2, 34SFG1, 34SFH2, 34SEH4, Attika (34SFH4, 34SGH2), N Evvia (34SGH1), as well as the Ionian island of Kefalonia (34SDH4) are also important centres with at least 13 to17 taxa per UTM square. As we proceed further north the number of taxa decreases and becomes restricted to the high mountains of N Pindos in Greece, mountains in FYR Macedonia and Bulgaria (Orvilos-Slavjanka, S Pirin) and a few of the SC and SW Dinaric Alps close to the Adriatic coast. The larger Aegean and Ionian islands (Kefalonia excluded) are also relatively rich in endemic geophytes despite their small altitudinal range and 6-8 taxa have been recorded from Andros, Paros, Naxos, Amorgos, Kasos, Karpathos, Levkas and Zakinthos. In comparison the Adriatic islands are extremely poor in endemic geophytes and for many of these islands no endemics have even been recorded. The inland areas of W, C and E Balkans, parts of the Black Sea coast in Bulgaria and Romania (Dobrudza) and Turkey-in-Europe have also few or no endemic geophytes. We may mention in particular, the gap in the northern border regions adjoining the Pannonian and Vlaška plains.

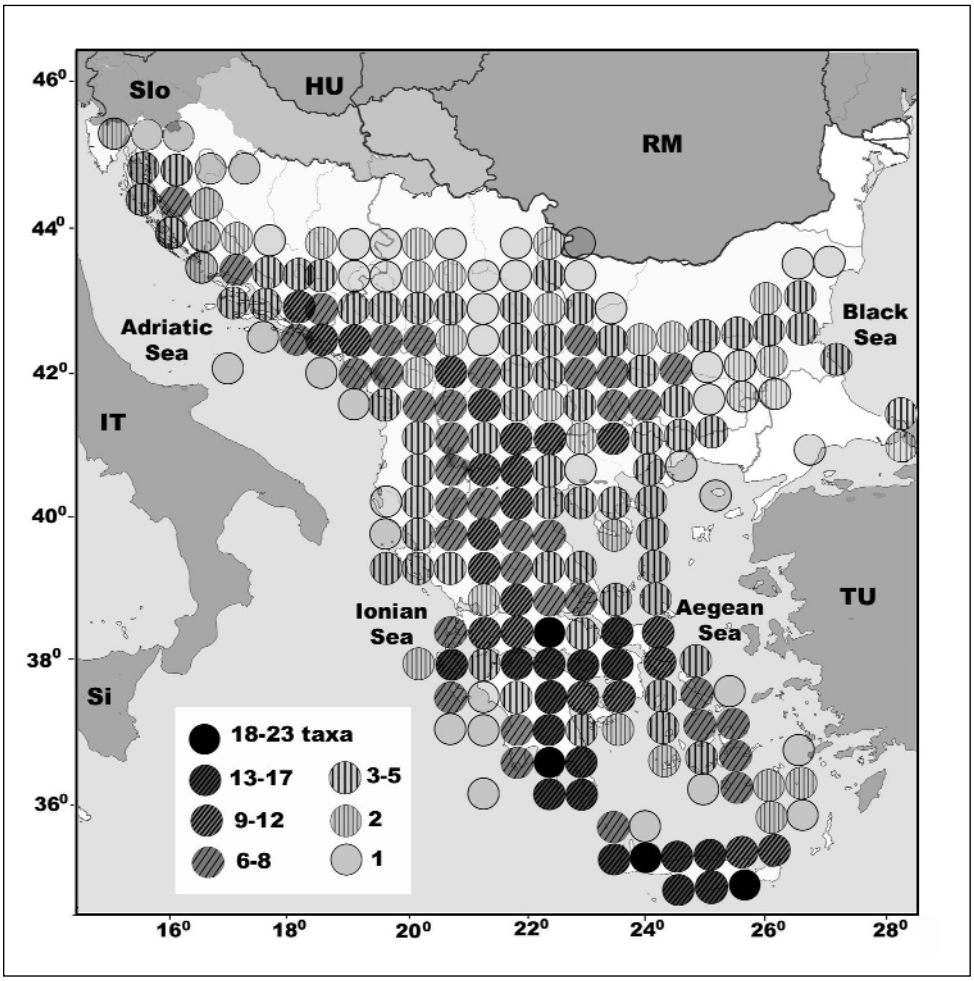

Fig. 1. Distribution of endemic geophytes based on 170 taxa (*Liliaceae*, *Iridaceae*, *Amaryllidaceae*, *Araceae*) on UTM (50x50 km) map.

As expected, the dominant life form in endemic geophytes is bulbous (or bulb-like). The entire *Liliaceae* family is a major contributor to the endemic geophyte flora, likewise the *Amaryllidaceae*. *Crocus* belongs to the transitional type of bulb to corm while the *Araceae* are entirely tuberous. Table 1 indicates the proportions of each particular geophyte life form in the analyzed Balkan flora.

If we bear in mind that the life form of a geophyte in Europe or W Asia is adapted for life in mainly arid and semi-arid habitats such as desert, steppe, Mediterranean grassland and rocky ground, as well as mountain regions of the submeridional and meridional zones, their abundance naturally decreases from the Mediterranean basin towards the north. The bulbous life form is almost absent from the flora of boreal coniferous and tundra zones and

Table 1. Geophyte life form in analyzed endemic flora.

Life form	Number of taxa	% of flora composition
bulb	130	74.3
corm-bulb	28	16.0
rhizome	9	5.1
tuber	8	4.6

replaced by the rhizomatous one. A similar distribution pattern is expressed within the Balkans, i.e., the number of endemic geophytes decreases towards the north, both in lowland and in hill regions or high alpine mountains. The obvious corollary would be that the number of endemic geophytes increases towards the Mediterranean region, reaching a maximum in the Peloponnesus and Crete; this is true for both the lowlands and mountains. The high number of endemic geophytes in the southern part of the Balkans can be partly explained by the existence of favorable habitats. Diverse topography and geological substrate as well as less dramatic changes in climate during the Ice Age have all contributed to speciation. Any significant climatic influence would presumably have supported speciation in isolated places such as mountains and islands.

Is the distribution of endemic geophytes correlated to altitude and if so, to what extent?

From the map of total distribution (Fig. 1) the centres of diversity in the Balkans are positioned in regions (as represented by squares) with wide altitudinal amplitude. Thus those regions are richer in geophytes than those regions with narrower altitudinal ranges. This conclusion is borne out by analysis of all squares in the S Balkans as occupied by islands, coastal and inland regions. We have prepared graphs presenting the relationship between the number of taxa and the average altitudinal range of each square. They are separately indicated (in terms of squares) for the island regions, coastal regions and inland areas. All clearly show the same correlation. The most important centres of diversity are situated in mountainous areas such as Parnassos and Giona (23 taxa), mountains of Peloponnesus, in particular Taygetos, Chelmos and Killini (15-19), mountains of Crete, viz., Levka Ori, Dikti and Psiloritis (15-20). The mountain regions of N and S Pindos, Thessaly, S Albania, Macedonia [FYR] and SW Bulgaria represent a second group with fewer taxa in comparison with the mountains of Crete, Peloponnesus and Sterea Ellas. Lowland and hill regions, i.e. represented by squares with narrow altitudinal ranges are generally poor in endemics as demonstrated by areas in the N and E Balkans (Vlaška plain, Black Sea coast, Peripannonian mountains). The Aegean islands, however, are an exception because they have a relatively rich endemic flora well developed at lower altitudes. In this case, it is island-isolation which is the presiding factor responsible for speciation.

How are the endemic geophytes distributed in relation to flowering time?

It is well known that the visible though ephemeral appearance of geophytes and their temporal use of ecological niches is a specific survival strategy to avoid unfavourable conditions such as drought and competition. In the Mediterranean favourable growth periods are generally in the spring and autumn while in mountainous regions it is usually late spring and summer.

Figute 2 and Table 2 show the flowering time of the four main groups of life form and as expressed in terms of the number of taxa flowering per month. Endemic geophytes flower throughout the year but the flowering peaks differ for the various life forms. The number of flowering bulbs gradually increases from January to May and gradually decrease to December. These endemic geophytes can be considered predominantly vernal. *Scilla*, *Androcymbium*, *Fritillaria*, *Tulipa*, *Muscari* and one-third of the Colchicums in the Balkans belong to this group of spring-flowering plants. Two-thirds of *Colchicum* species and a few *Allium* species are autumnal. The dominant bulbous geophytes in summer are *Allium* and *Lilium*.

Corm-bulb geophytes (*Crocus*) have two flowering peaks in early spring (February to March, reaching May to June in high mountain regions) and autumn. More taxa flower in the spring (18 taxa) than in autumn (12), thus the vernal state is predominant in this genus. The *Araceae* shows a similar flowering pattern with recognizable vernal and autumnal peaks; summer forms are completely absent. Rhizomatous geophytes as represented by *Iris* and *Narthecium* are exclusively spring-flowering plants which in the case of *N. scardicum* from the high mountains have finished anthesis by June or July.

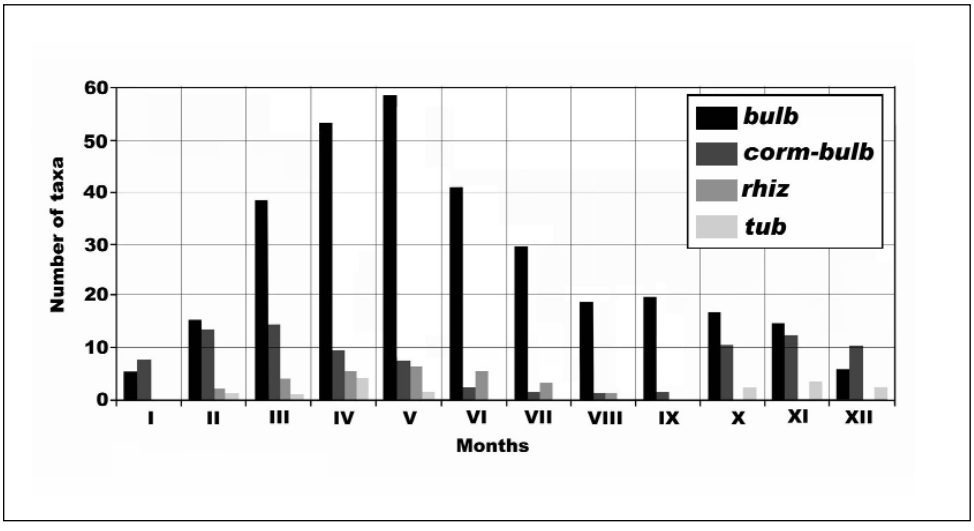

Fig. 2. Flowering time of geophyte life form (bulb, corm-bulb, rhizome = rhiz and tuber = tub) as expressed by the number of taxa per month.

Table 2. Months of flowering for the four main life forms.

Life form	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
bulb	5	15	38	53	**58**	41	29	19	20	16	14	5
corm-bulb	7	11	13	**14**	9	7	2	1	1	10	12	10
rhizome		2	4	5	**6**	5	3	1				
tuber		1	1	**4**	**4**	1			2	2	2	

Summation

Owing to space restrictions it is not possible to present here the numerous results of our mapping which clearly indicate the areas occupied by a rich and diverse endemic geophytic flora in the Balkans. Nevertheless, the results are an important contribution to aid any conservation measures aimed at protecting floristically rich sites. The paper outlines a first step in an analysis of endemic geophytes in the Balkans with respect to their distribution, centres of diversity, and their relationships with altitude and phenology. It is a basic but very necessary work in attempt to understand the phytogeographical position and evolution of the Balkan flora. Further and more detailed analysis will be presented in a second publication.

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Addresses of the authors:
Kit Tan, Institute of Biology, University of Copenhagen, Øster Farimagsgade 2D, 1353 Copenhagen K, Denmark. E-mail: kitt@bi.ku.dk.
Vladimir Stevanović, Botanical Institute and Garden, University of Belgrade, Takovska 43, 11000 Beograd, Serbia. E-mail: vstev@bfbot.bg.ac.yu.
Arne Strid, Botanical Garden, Carl Skottsbergs gata 22A, 41319 Göteborg, Sweden. E-mail: arne.strid@vgregion.se.