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Abstract

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Graveyards in Turkey are widely known among orchidologists as places where several orchid (*Orchidaceae*) taxa can be found, including some very rare and localized ones. Graveyards are less strongly affected by landscape-altering human activities than other habitats because of their special cultural roles and religious privileges. In this study we performed a comprehensive survey of Turkish graveyards as orchid habitats. In total, 300 graveyards were studied in 30 provinces of Turkey in 2014. Altogether, we found 86 orchid taxa (almost half of the known Turkish orchid flora) in 208 graveyards. Among the studied provinces, Muğla and Antalya, in the southwest, emerged as peaks of taxon richness. This finding is in accordance with the overall biogeographic pattern of orchid diversity in Turkey. Our survey also contributes new floristic data to the orchid flora of Turkey. Additionally we documented salep collection in ten graveyards from six provinces involving nine taxa. We conclude that the occurrence of orchids in Turkish graveyards is not a rare phenomenon, and thus graveyards can be important refuges for orchids in the changing economic and agricultural circumstances of Turkey.

Additional key words: Asia minor, cemetery, flora of Turkey, Near East, *Orchidaceae*, salep, SW Asia

Introduction

The flora of Turkey is probably one of the richest in the Mediterranean region, and due to its geographic location, as well as various climatological, geological and geomorphological circumstances, one-third of the c. 9000 vascular plants reported from Turkey is endemic (Çolak 2001). Unfortunately, this globally important biodiversity hotspot is in crisis (Şekercioğlu & al. 2011), mainly due to dramatic changes in human activities. Agricultural intensification has resulted in significant degradation of natural habitats in Turkey, e.g. the total forest cover has decreased by 44 % up to the end of the 20th century (Mayer & Aksoy 1986).

Nonetheless, the number of recently described plant taxa keeps growing, even in well-studied groups: 67 geophyte taxa belonging to 19 genera have been described since 2001 in Turkey (Koyuncu & Alp 2014). Since 2000 also numerous new *Apiaceae*, *Asteraceae*, *Brassicaceae*, *Dipsacaceae*, *Poaceae* and *Scrophulariaceae* taxa were described (e.g. Gottschlich & al. 2000; Parolly & Kilian 2003; Parolly & Scholz 2004; Wörz & Duman 2004; Parolly & Nordt 2005; Parolly & al. 2005; Wagenitz & al. 2006; Parolly & Tan 2006, 2007; Kandemir & Hedge 2007; Parolly & Eren 2008; Wagenitz & Kandemir 2008).

Turkey probably has the richest orchid flora in the Mediterranean region. This flora is well documented by Kreutz & Çolak (2009), who enumerated 170 orchid taxa

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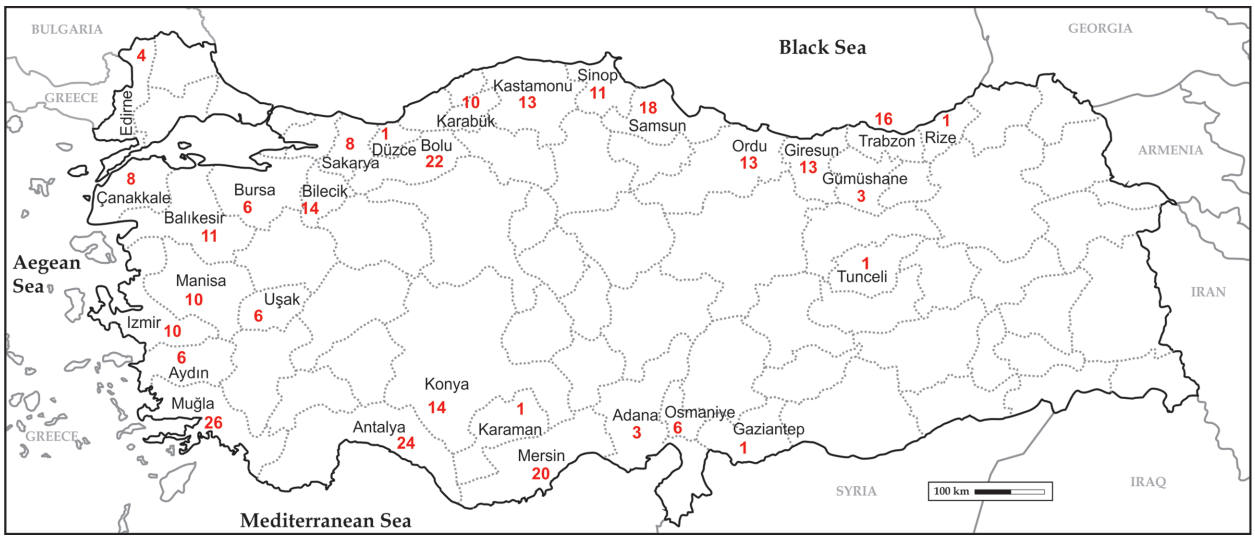

Fig. 1. Surveyed provinces in Turkey. The red numbers indicate the number of graveyards visited in each province.

(species and subspecies). Nevertheless, orchids are still greatly threatened by overgrazing and salep collection (Özhatay & al. 1997; Kasparek & Grimm 1999; Sezik 2002; Kreutz 2004). The value of the Turkish orchid flora is further underlined by the fact that 40 taxa (23.5 %) are endemic. The main threatening factors for this exceptionally rich and precious orchid flora are agricultural intensification, overgrazing, salep collecting and rapid urbanization (Kreutz 2004). Although the total area covered by trees increased by 5.9 % between 1973 and 2009 (Gross 2012), this was mainly the result of forestation with monodominant conifer plantations. The area of grassland and shrubland with high biodiversity is decreasing, mainly due to intensive overgrazing (Çetin & al. 2007).

Graveyards represent refuges for different kinds of plants worldwide. A study from Pakistan reports that because of their special cultural role, graveyards are able to preserve several (in total 41) plant taxa, which are extinct or nearly extinct in the surrounding areas (Hadi & al. 2014). As these places are usually fenced off, they keep grazing and trampling animals out; also the intensive use of graveyards for economic (e.g. agricultural or forestry) purpose is unusual. The refuge provided by graveyards can even host undiscovered taxa like *Iris masia* subsp. *dumaniana* Güner, which has recently been described from the graveyard of Kasabası, Antalya (Özhatay & al. 2013). Similarly, several orchid taxa were described from Turkish graveyards, e.g. *Ophrys konyana* (Kreutz & Peter 2007), *Ophrys mammosa* subsp. *ciliciana* Kreutz (Kreutz 2013) and *Epipactis helleborine* subsp. *levantina* Kreutz, Óvári & A. Shifman (Kreutz 2010). Several threatened, rare orchid taxa have been found in graveyards in Turkey, sometimes significantly extending their known distributions. For example, the distribution gap of the critically endangered *Ophrys isaura* Renz & Taubenheim was closed between Kuyuçak (Antalya) and Gülnar (Mersin) when this species was found in a graveyard in Taşkent (Konya) by Kreutz & Krüger (2014).

Based on the data of Kreutz (1998) and Kreutz & Çolak (2009), 73 orchid taxa are known from 54 different Turkish graveyards. Around a dozen famous graveyards are regularly visited mostly by orchid enthusiasts, especially localities of very localized and spectacular taxa. Nonetheless, Turkish graveyards in general are still unexplored as orchid habitats. We aimed to perform a comprehensive field study of orchids of Turkish graveyards in order to document and assess the conservation value of graveyards as habitats of rare Mediterranean plants.

Material and methods

We studied muslim burial grounds (Turkish: mezarlık, hereafter graveyards) regardless of their spatial dimension, position within settlements or presence of religious facilities. After preliminary studies in 2010 and 2013, we surveyed 300 graveyards in 30 provinces during two field trips in 2014 (2–19 April and 6–23 June). Most (296) graveyards were visited only once (April or June), but four graveyards (indicated by the symbol "#" in Table 5; see Supplementary Materials online) were visited on both occasions to identify orchids found in a vegetative state during the first trip.

We surveyed 1–26 (mean ±SD = 10.0 ±7.1) graveyards in the provinces studied (Fig. 1). We mostly visited those provinces that lie near to the coast (Sea of Marmara, Aegean Sea, Mediterranean Sea, Black Sea), where most orchid taxa are reported (Kreutz & Çolak 2009), thus we did not survey most of the (orchid-poor) continental regions of Anatolia. Of the 300 graveyards, 14 (4.7 %) were known previously as orchid habitats (indicated by an asterisk "*" in Table 5).

All orchid taxa and the number of individuals were counted or estimated in each graveyard. Taxa are defined as species, subspecies and varieties; a subspecies or variety is counted as one taxon, i.e. the species to which it be-

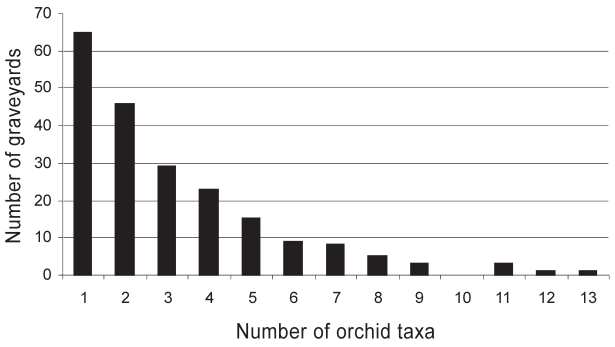

Fig. 2. Distribution of number of orchid taxa in the 208 graveyards with orchids.

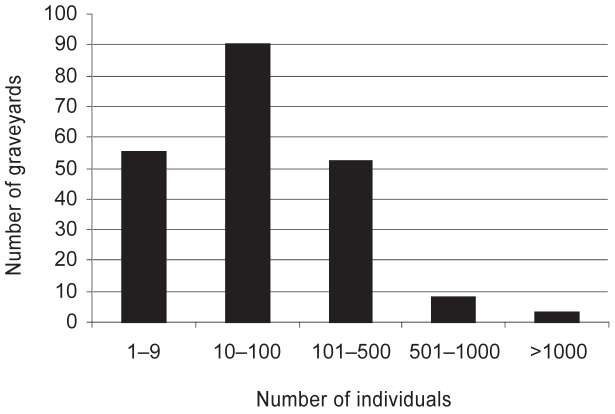

Fig. 3. Distribution of number of orchid individuals in the 208 graveyards with orchids.

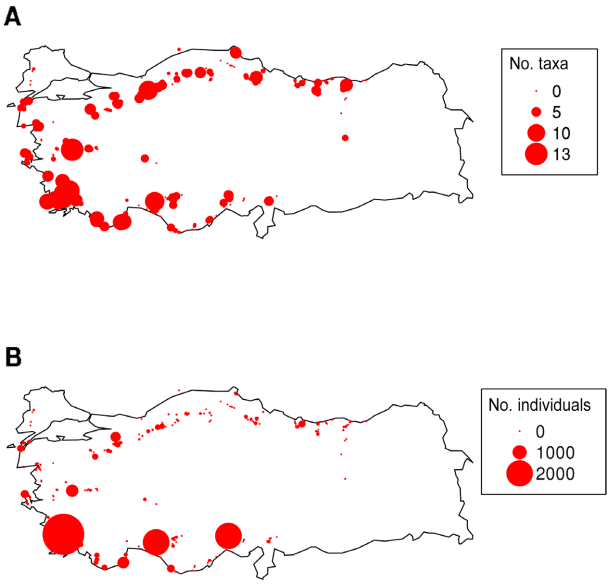

Fig. 4. Number of orchid taxa (A) and individuals (B) in the graveyards surveyed.

longs is not counted as well. Taxa were identified based on Kreutz & Çolak (2009) and Delforge (2006). In this paper we follow the nomenclature of Kreutz & Çolak (2009), except in the case of the genus *Himantoglossum* Spreng. s.l. (incl. *Barlia* Parl. and *Comperia* K. Koch), where we follow the nomenclature of Sramkó & al. (2014). Authors of plant names are listed in Table 1. Printed colour photographs as vouchers were deposited in the herbarium of the University of Debrecen (DE). During both field trips particular attention was paid to documenting salep collection activity in graveyards. The geocoordinates and the altitude of the visited graveyards were determined by a Garmin E-Trex Legend GPS handheld device recorded in WGS84 format. The area of the graveyards was measured using Google Earth Pro software.

To understand the role of geographic factors in determining variation in taxon richness and abundance of orchids across Turkey, we built statistical models with either of these variables as dependent variables, and latitude, longitude, their interaction and altitude as explanatory variables. We also controlled for the actual area of graveyards in these analyses. Both the number of individuals and the number of taxa were Poisson variables with overdispersion; therefore, we used Generalized Linear Model (GLMs) with quasipoisson distribution in the R statistical environment (R Core Team 2014). Finally, we tested if the obtained geographic distribution of graveyard orchid diversity reflects an actual biogeographic pattern by acquiring data on the total number of orchid taxa in Turkey from the literature (lower map of Kreutz & Çolak 2009: 53). These data, recorded in a 25 × 25 km UTM grid were georeferenced and taxon richness was analysed in the same way as our graveyard data using quasipoisson GLMs with latitude, longitude and their interaction as predictors. For each analysis, we report parameter estimates showing the direction of relationship (negative or positive), their standard errors (SE, a measure of how precise the estimates are), and results from the statistical analysis – t-values and significance levels (p-values) performed on the null hypothesis that the parameter estimates are zero. The estimates are derived from multivariate models, i.e. controlling for the effect of other variables.

Results

Numbering, geographic location, altitude and area of the graveyards visited, together with lists of the orchid taxa found in each one, are given in Table 5 (see Supplementary Materials online). In total, 86 orchid taxa were found; substantial differences can be observed in the number of individuals, range and frequency of each taxon. Each taxon was found in 1–18 provinces (mean±SD = 3.3±3.3), and in 1–68 graveyards (mean±SD = 7.5±10.4). The number of taxa detected in only one graveyard was 30, whereas the number found in more than ten graveyards was 21. A range of 1–4220 individuals was recorded in a given graveyard (mean±SD = 342±758). In the case of five taxa, only one individual was found; in the case of six taxa, more than 1000 individuals were found (Table 1).

Table 1. Statistics of orchid taxa recorded in graveyards in 2014.

Taxon	Number of graveyards	Number of provinces	Total number of observed individuals
Anacamptis pyramidalis (L.) Rich.	68	18	3509
Ophrys lutea subsp. *minor* (Tod.) O. Danesch & E. Danesch ex Gölz & H. R. Reinhard	36	8	4220
Epipactis helleborine (L.) Crantz s.l.	31	13	712
Himantoglossum jankae Somlyay & al.	29	9	1128
Serapias bergonii subsp. *politisii* (Renz) Kreutz	27	4	3447
Anacamptis sancta (L.) R. M. Bateman & al.	25	4	1063
Ophrys oestrifera M. Bieb. subsp. *oestrifera*	22	10	454
Ophrys mammosa Desf. subsp. *mammosa*	20	8	871
Limodorum abortivum (L.) Sw.	20	8	361
Anacamptis coriophora subsp. *fragrans* (Pollini) R. M. Bateman & al.	16	6	2470
Himantoglossum comperianum (Steven) P. Delforge	16	8	318
Neotinea tridentata (Scop.) R. M. Bateman & al.	16	9	255
Himantoglossum robertianum (Loisel.) P. Delforge	16	3	225
Spiranthes spiralis (L.) Chevall.	15	7	886
Platanthera chlorantha (Custer) Rchb. subsp. *chlorantha*	15	9	146
Orchis simia Lam.	14	9	271
Cephalanthera epipactoides Fisch. & C. A. Mey	13	8	190
Cephalanthera rubra (L.) Rich.	13	7	164
Himantoglossum caprinum (M. Bieb.) Spreng.	11	7	184
Cephalanthera damasonium (Mill.) Druce	11	7	83
Ophrys apifera Huds.	11	5	76
Serapias bergonii E. G. Camus subsp. *bergonii*	9	3	958
Ophrys speculum var. *orientalis* (Paulus) Kreutz	9	5	196
Cephalanthera kurdica Bornm. ex Kraenzl.	8	2	986
Dactylorhiza urvilleana (Steud.) H. Baumann & Künkele subsp. *urvilleana*	8	3	397
Epipactis microphylla (Ehrh.) Sw.	8	6	53
Ophrys minoa (C. Alibertis & A. Alibertis) P. Delforge	7	2	424
Orchis purpurea Huds. subsp. *purpurea*	7	5	51
Orchis anatolica Boiss.	6	4	400
Orchis provincialis Balb. ex Lam. & DC.	6	4	118
Ophrys reinholdii Spruner ex Fleischm.	6	2	86
Orchis italica Poir.	6	5	25
Anacamptis morio subsp. *caucasica* (K. Koch) H. Kretzschmar & al.	5	3	279
Ophrys argolica subsp. *lucis* (Kalteisen & H. R. Reinhard) H. A. Pedersen & Faurh.	5	2	39
Neotinea maculata (Desf.) Stearn	4	3	534
Ophrys holoserica subsp. *episcopalis* (Poir.) Kreutz	4	3	101
Ophrys phrygia H. Fleischm. & Bornm.	4	2	994
Ophrys bombyliflora Link	4	2	253
Ophrys straussii H. Fleischm. subsp. *straussii*	4	2	228
Serapias levantina subsp. *feldwegiana* (H. Baumann & Künkele) H. Baumann & R. Lorenz	4	3	168
Anacamptis morio subsp. *syriaca* (E. G. Camus) H. Kretzschmar & al.	3	1	182
Ophrys holoserica subsp. *heterochila* Renz & Taubenheim	3	1	91
Gymnadenia conopsea (L.) R. Br.	3	2	46
Orchis mascula subsp. *pinetorum* (Boiss. & Kotschy) E. G. Camus	3	2	33
Ophrys tenthredinifera subsp. *villosa* (Desf.) H. Baumann & Künkele	3	1	14

Taxon	Number of graveyards	Number of provinces	Total number of observed individuals
Epipactis persica (Soó) Hausskn. ex Nannf.	3	2	13
Ophrys umbilicata Desf. subsp. *umbilicata*	3	3	5
Ophrys sphegodes subsp. *herae* (M. Hirth & H. Spaeth) Kreutz	2	2	241
Anacamptis papilionacea (L.) R. M. Bateman & al. subsp. *papilionacea*	2	2	23
Ophrys fusca subsp. *leucadica* (Renz) H. Kretzschmar	2	1	22
Ophrys iricolor Desf.	2	1	13
Cephalanthera kotschyana Renz & Taubenheim	2	2	12
Ophrys lutea subsp. *phryganae* (Devillers-Tersch. & Devillers) Melki	2	2	7
Steveniella satyrioides (Spreng.) Schltr.	2	2	5
Cephalanthera longifolia (L.) Fritsch	2	1	4
Ophrys mammosa subsp. *leucophthalma* (Devillers-Tersch. & Devillers) Kreutz	2	1	4
Ophrys kreutzii W. Hahn & al.	1	1	80
Ophrys ulupinara W. Hahn & al.	1	1	80
Ophrys konyana Kreutz & Ruedi Peter	1	1	70
Dactylorhiza iberica (M. Bieb. ex Willd.) Soó	1	1	50
Orchis punctulata Steven ex Lindl.	1	1	48
Ophrys mammosa subsp. *posteria* B. Baumann & H. Baumann	1	1	45
Ophrys subfusca subsp. *blitopertha* (Paulus & Gack) Kreutz	1	1	35
Ophrys ferrum-equinum Desf. subsp. *ferrum-equinum*	1	1	30
Ophrys lycia Renz & Taubenheim	1	1	28
Dactylorhiza romana (Sebast.) Soó subsp. *romana*	1	1	25
Himantoglossum montis-tauri Kreutz & W. Lüders	1	1	25
Ophrys oestrifera subsp. *minutula* (Gölz & H. R. Reinhard) Kreutz	1	1	22
Anacamptis collina (Banks & Sol. ex Russell) R. M. Bateman & al.	1	1	20
Ophrys holoserica subsp. *homeri* (M. Hirth & H. Spaeth) Kreutz	1	1	20
Orchis sezikiana B. Baumann & H. Baumann	1	1	20
Ophrys umbilicata subsp. *bucephala* (Gölz & H. R. Reinhard) Biel	1	1	18
Anacamptis coriophora (L.) R. M. Bateman & al. subsp. *coriophora*	1	1	15
Ophrys caucasica Woronow	1	1	14
Ophrys candica subsp. *lyciensis* (Paulus & al.) Kreutz	1	1	10
Ophrys heldreichii subsp. *calypsus* (M. Hirth & H. Spaeth) Kreutz	1	1	10
Ophrys oblita Kreutz & al.	1	1	9
Epipogium aphyllum Sw.	1	1	7
Ophrys amanensis subsp. *antalyensis* (Kreutz & Seckel) Kreutz	1	1	6
Ophrys bornmuelleri M. Schulze subsp. *bornmuelleri*	1	1	5
Ophrys levantina Gölz & H. R. Reinhard subsp. *levantina*	1	1	5
Dactylorhiza saccifera (Brongn.) Soó subsp. *saccifera*	1	1	1
Epipactis condensata Boiss. ex D. P. Young	1	1	1
Listera ovata (L.) R. Br.	1	1	1
Neotinea lactea (Poir.) R. M. Bateman & al.	1	1	1
Ophrys transhyrcana subsp. *mouterdeana* (B. H. Baumann) Kreutz	1	1	1

Table 2. Effect of geographic location on number of orchid taxa and number of orchid individuals per graveyard. Parameter estimates, their standard errors (SE), associated t-values (t) and significance levels (p) are presented.

	Number of orchid taxa per graveyard				Number of orchid individuals per graveyard			
	Estimate	**SE**	**t**	**p**	**Estimate**	**SE**	**t**	**p**
Intercept	66.977	16.091	4.162	<0.001	84.407	35.271	2.393	0.0173
Area	0.009	0.038	0.247	0.805	0.088	0.064	1.394	0.164
Latitude	-1.628	0.408	-3.993	<0.001	-1.955	0.904	-2.164	0.031
Longitude	-1.953	0.507	-3.853	<0.001	-2.145	1.109	-1.935	0.054
Altitude	0.009	0.038	0.247	0.025	<0.001	<0.001	2.078	0.039
Latitude × longitude	0.048	0.013	3.730	<0.001	0.051	0.028	1.821	0.070

The mean number (±SD) of orchid taxa found in graveyards was 2.1±2.4. The highest number of taxa in a given graveyard was 14, but in most cases (66 graveyards; 22 %) only one taxon occurred. Those graveyards that are habitats for ten or more taxa are extremely rare (5–1.7 %) (Fig. 2). The most taxon-rich graveyards were found in the provinces Muğla (no. 210, 207), Antalya (no. 16), Bolu (no. 64) and Manisa (no. 169). Among these localities three were formerly unknown, including the last one, with 13 taxa, located in a floristically scarcely studied province.

The mean number of individuals per graveyard was 96±286. The vast majority (90 graveyards; 30 %) hosted individuals in an order of magnitude of tens. The top ten most individual-rich graveyards (with more than 800 orchid individuals) were located in the provinces Muğla (four graveyards), Antalya (three), and Manisa, Mersin and Sakarya (one each). We detected more than 1000 individuals at only three sites (1 %) (Fig. 3).

A southwestern concentration of both taxa and number of individuals can be observed (Table 2): geographic latitude, longitude and their interaction were significantly related to the number of taxa (Fig. 4A).

Table 3. Characteristics of graveyards in provinces represented by at least six graveyards.

Province	**Number of orchid taxa**	**Percentage of graveyards with orchids**	**Number of surveyed graveyards**	**Mean number of orchid taxa per graveyard ±SD**	**Mean number of orchid individuals per graveyard**
Muğla	33	96.2 %	26	4.8±3.3	342±651
Antalya	31	87.5 %	24	3.8±3.3	267±452
Bolu	18	81.8 %	22	2.5±2.5	59±91
Mersin	18	65.0 %	20	1.7±1.8	127±450
Manisa	17	50.0 %	10	2.2±4.0	96±267
Kastamonu	14	69.2 %	13	2.1±2.0	25±29
Balikesir	14	63.6 %	11	2.0±1.9	28±28
Sinop	13	54.5 %	11	2.3±2.5	19±33
Aydın	12	83.3 %	6	3.0±3.1	73±94
Konya	12	57.1 %	14	1.5±1.9	39±61
Trabzon	11	43.8 %	16	1.3±2.2	11±20
Samsun	10	72.2 %	18	1.7±1.7	41±57
Giresun	10	69.2 %	13	1.5±1.6	30±49
Sakarya	9	87.5 %	8	2.3±1.5	144±225
Bursa	9	83.3 %	6	2.3±2.3	76±144
Bilecik	9	71.4 %	14	1.4±1.6	88±106
İzmir	8	72.7 %	11	2.1±1.4	73±159
Çanakkale	7	87.5 %	8	2.4±1.2	107±144
Osmaniye	7	66.7 %	6	1.7±2.0	30±44
Ordu	6	69.2 %	13	0.9±0.9	60±120
Karabük	5	80.0 %	10	1.1±0.9	9±12
Uşak	4	33.3 %	6	0.7±1.2	14±25

Table 4. Detected salep-collecting activities in graveyards during our field trips in 2014.

Taxa collected for salep	**Provinces (location)**	**No. of graveyards**
Anacamptis coriophora subsp. *fragrans*	Muğla (Çukurincir)	1
Anacamptis pyramidalis	Antalya (Emiraşıklar); Ordu (Cevizlik)	2
Anacamptis morio subsp. *syriaca*	Antalya (Belen)	1
Himantoglossum jankae	Bolu (Afşar; Yayladınlar); Samsun (Alaçamderesi); Kastamonu (Damla)	4
Himantoglossum caprinum	Samsun (Alaçamderesi)	1
Himantoglossum comperianum	Samsun (Alaçamderesi)	1
Himantoglossum robertianum	Muğla (Meşelik; Kemer)	2
Ophrys minoa	Antalya (Belen)	1
Ophrys speculum var. *orientalis*	Muğla (Kemer)	1

Fig. 5. A: *Anacamptis coriophora* subsp. *fragrans*, showing habitat [Gülek (no. 183), Mersin]; B: *A. pyramidalis* growing on a grave [Yayladınlar (no. 77), Bolu]; C: *Cephalanthera epipactoides* [Behram (no. 88), Çanakkale]; D: *C. kotschyana* [Hacıbahattin (no. 184), Mersin]; E: *C. kurdica*, showing habitat [Gençler (no. 17), Antalya]; F: *Dactylorhiza iberica* [Taşkent (no. 160), Konya]; G: *D. romana* subsp. *romana* [Tahtakuşlar (no. 44), Balıkesir]; H: *D. urvilleana* subsp. *urvilleana* growing on a grave [Işıktepe (no. 227), Ordu]; I: *Epipactis condensata* [Mehmetali (no. 158), Konya]. – Photographs: A–I by A. Molnár V.

Fig. 6. A: *Epipogium aphyllum* [Haydarlar (no. 142), Kastamonu]; B: *Himantoglossum comperianum* growing on a grave [Ulupınar (no. 161), Konya]; C: *H. jankae* growing on a grave [Kandamış (no. 67), Bolu]; D: *H. montis-tauri* [Emiraşıklar (no. 16), Antalya]; E: *H. robertianum* [Ormandamı (no. 300), Uşak]; F: *Limodorum abortivum* [Kadıköy (no. 206), Muğla]; G: *Ophrys argolica* subsp. *lucis* [Emiraşıklar (no. 16), Antalya]; H: *O. caucasica* [Çatak (no. 278), Trabzon]; I: *O. holoserica* subsp. *heterochila* [Çiçekli (no. 204), Muğla]. – Photographs: A–I by A. Molnár V.

Fig. 7. A: *Ophrys holoserica* subsp. *homeri* [Kemer (no. 209), Muğla]; B: *O. lutea* subsp. *phryganae* [Kultak (no. 212), Muğla]; C: *O. mammosa* subsp. *mammosa* growing on a grave [Kayalar (no. 54), Bilecik]; D: *O. minoa,* hypochromic variant [Kultak (no. 212), Muğla]; E: *O. oblita* [Karataş (no. 237), Osmaniye]; F: *O. oestrifera* subsp. *oestrifera* [Alaçamderesi (no. 250), Samsun]; G: *O. sphegodes* subsp. *herae* [Hayrettin (no. 243), Sakarya]; H: *O. ulupinara* [Belen (no. 10), Antalya]; I: *O. umbilicata* subsp. *bucephala* [Burhanlı (no. 89), Çanakkale]. – Photographs: A–G, I by A. Molnár V.; H by Á. Lovas-Kiss.

Fig. 8. A: *Orchis anatolica* [Emiraşıklar (no. 16), Antalya]; B: *O. provincialis*, showing habitat [Soğukpınar (no. 86), Bursa]; C: *O. punctulata* [Gözne (no. 181), Mersin]; D: *Serapias bergonii* subsp. *bergonii* [Parlak (no. 123), İzmir]; E: *S. bergonii* subsp. *politisii* growing on a grave [Çobanlar (no. 198), Muğla]; F: *S. levantina* subsp. *feldwegiana* [Küçükköy (no. 110), Giresun]; G: *Spiranthes spiralis*, spring leaf rosette [Çamlıbel (no. 36), Balıkesir]; H: *Steveniella satyrioides*, leaf [Afşar (no. 59), Bolu]; I: *S. satyrioides*, infructescence [Samatlar (no. 145), Kastamonu]; J: *Epipactis microphylla* and *Ophrys phrygia* [Akseki (no. 7), Antalya]. – Photographs: A–J by A. Molnár V.

Fig. 9. Fresh traces of salep collecting in graveyards – A: *Himantoglossum robertianum* fruiting [Kemer (no. 209), Muğla]; B: *H. caprinum* flowering [Alaçamderesi (no. 250), Samsun]. – Photographs: A by V. Löki; B by A. Molnár V.

In addition, a positive relationship was found between altitude and the number of taxa in graveyards. These results did not change qualitatively when graveyard area (which had a non-significant effect) was removed from the model.

Our analysis of biogeographic determination of taxon richness revealed a basically identical pattern between the literature data and our 2014 data: latitude (estimate=-1.470, SE=0.256, t=-5.743, p<0.001) and longitude (longitude: estimate=-1.743, SE=0.300, t=-5.826, p<0.001) had significant negative effects, and there was a significant positive interaction between these negative effects (estimate=0.043, SE=0.008, t=-5.698, p<0.001), implying that the decline in taxa is greater in the north and east of the country than in the south and west (i.e. the taxon number is highest in the southwest).

The number of individuals found in graveyards was significantly negatively related to latitude and positively related to altitude (Table 2, Fig. 4B), whereas longitude and the interaction between latitude and longitude were marginally significant. However, when non-significant predictors were removed from the model in a stepwise manner (based on the largest p-values), all parameters, except for latitude and longitude, dropped out (i.e. altitude dropped out as well); both latitude and longitude had significant negative effects (latitude: estimate=-0.306, SE=0.084, t=-3.649, p<0.001; longitude: estimate=-0.099, SE=0.044, t=-2.251, p=0.025).

During our work, several notable floristic data were recorded. We found 20 individuals of *Anacamptis collina* at Parlak (no. 123), İzmir province. This is a rare species in Turkey, occurring mainly in the south; according to Kreutz & Çolak (2009) it was formerly unknown from the Çeşme peninsula. We found one individual of *Anacamptis coriophora* subsp. *fragrans* at Dizdaroğlu (no. 269) and three individuals at Taşmanlı (no. 275), both in Sinop province. This taxon was previously unknown from the Black Sea region. We unexpectedly found a new location for the rare *Epipogium aphyllum* at Haydarlar (no. 142), Kastamonu province (Fig. 6A). This species was reported recently from 11 flora mapping grids and there are six historical records from Turkey (Kreutz & Çolak 2009). A single individual of *Himantoglossum caprinum* was found at Haydarlar (no. 142) and two individuals at Yeşilova (no. 149), both in Kastamonu province. These records represent the westernmost known localities of this species in Turkey. Nine individuals of *H. comperianum* were found at Davutlar (no. 82), Bursa province, and also nine individuals at Ormandamı (no. 300), Uşak province. This species was hitherto unreported from these provinces. We found four

localities for *H. jankae* new to three provinces: Hisarköy (no. 39, 45 individuals), Balıkesir province; Başpınar (no. 128 and 129, two and six individuals, respectively), Karabük province; and İkizkuyu (no. 169, 30 individuals), Manisa province. Two individuals of *H. robertianum* were found at 820 m altitude at Ormandamı (no. 300), Uşak province (Fig. 6E). The record is new for this province and represents the northernmost and highest-altitude occurrence of *H. robertianum* reported in Turkey to date; Kreutz & Çolak (2009) reported 700 m as the highest known altitude.

Nowadays, salep collection is considered one of the most important threats to orchids in the Near East (Kasparek & Grimm 1999; Sezik 2002; Tamer & al. 2006; Ghorbani & al. 2014). Although we thought previously that graveyards might be safe against salep harvesting, we detected signs of digging orchid tubers of in ten graveyards in six provinces, with nine taxa involved (Table 4). Salep harvesting affected 11.5 % of visited graveyards in Muğla, 8.3 % in Antalya, 9.1 % in Bolu, 7.7 % in Kastamonu and Ordu and 5.6 % in Samsun. In these graveyards salep harvesting of 1.4±0.7 taxa (min. 1, max. 3) was documented. The most frequently collected orchids were in the genera *Himantoglossum* (Fig. 9) and *Anacamptis* Rich.

Discussion

In 208 (69 %) of the evaluated 300 graveyards we found at least one orchid taxon. The 86 orchid taxa recorded represent 49.4 % of the total Turkish orchid flora. Although the total area of Turkey is 780 580 km^2 and the total area of our studied graveyards is only c. 420 hectares, half of the Turkish orchid flora was found on a mere c. 0.0005 % of the total area of the country. This fact alone suggests that graveyards are worthy of conservation of plant diversity, and they merit further, more detailed researches in the future.

The conservation importance of graveyards in different regions of Turkey might be considerably different. From the studied provinces, two southwestern provinces, Muğla and Antalya, emerged as fortresses of taxon richness and number of individuals per graveyard (Table 3). This finding, which is in line with the overall biogeographic pattern of orchid diversity, can be explained by the importance of southwestern Anatolia as one of the several centres of plant diversity (CPDs) in the Mediterranean (Médail & Quézel 1999). This region harbours exceptionally high biodiversity, and the work of Kreutz & Çolak (2009), together with our observations, confirms this for orchids, suggesting that surveying graveyards could be a good strategy to obtain representative samples of the local flora.

We revealed that the occurrence of orchids in Turkish graveyards is not a rare phenomenon. Therefore, graveyards can play a significant role in conserving orchids in Turkey. This study provides a basis for further conservation research in the future, as it is still an open question as to what abiotic and biotic conditions of graveyards determine their conservation value. Whatever these factors are, our survey showed that the actual number of taxa was not related to graveyard area, suggesting that even small graveyards can have a large conservation value. Systematic research could reveal these small, hidden "conservational islands" in the changed landscape, and could help us to elaborate suitable plans to conserve these areas of biodiversity value for the future.

Such importance of graveyards in other regions with traditional burial traditions (e.g. eastern Europe, the Balkan peninsula, Caucasus and southwest Asia) can be presumed.

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