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Ornithogalum insulare (Hyacinthaceae): A new species from the Cretan area (S. Aegean, Greece)

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ABSTRACT: *Ornithogalum insulare* collected from three offshore islets of Crete is described as a species new to science. It is illustrated and compared with other related species of the genus. Information regarding its chromosome number ($2n = 44$) and karyotype is also provided.

Keywords: *Ornithogalum* subg. *Beryllis*, Aegean flora, chromosome number, conservation, new species

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INTRODUCTION

The Aegean archipelago is one of the largest archipelagos in the world, since it hosts more than 7000 islands and islets (Triantis & Mylonas 2009). Large islands and small islets form a labyrinthine mosaic strongly affecting plant distribution patterns in this area. The floristic composition of small islets is characterised, and sometimes even dominated, by the presence of islet specialists, i.e., plant species that are exclusively or mainly distributed on small islets, while they are absent or especially rare on large islands (Runemark 1971; Panitsa *et al.* 1994). As a result, the flora of islets is not a random subset of the coastal flora of neighbouring larger islands (Georgiou *et al.* 2006), while islets themselves are often considered as non-equilibrium island systems, characterised by increased species turnover rates (Panitsa *et al.* 2008).

Numerous offshore islets are distributed in the south Aegean region, and several of them are located in the Cretan area. Some Cretan endemic plants were first discovered and described from the offshore islets of Crete and subsequently found on the main island, e.g., *Carlina diae* (Rech. f.) Meusel & Kästner, *Androcymbium rechingeri* Greuter. Others are still known only from the offshore islets of Crete, e.g., *Anthemis glaberrima* (Rech. f.) Greuter, *Prospero talosii* (Tzanoud. & Kypr.) Speta, and *Allium platakisii* Tzanoud. & Kypriotakis.

The material of *Ornithogalum* described here as a species new to science was first collected from the small islet of Psira, off the north coast of eastern Crete. Based on its morphology, the collected material showed affinities with taxa of *Ornithogalum* subg. *Beryllis* (Salisb.) Baker, but it had significant differences from species of this subgenus occurring in the area. Later on, the species was found on Konidha islet in the same area and also on Megalo Paximadhi islet, which lies off the south coast of western Crete (Fig. 1). The results of morphological and karyological research done after collecting living bulbs suggest that the material concerned belongs to a species new to science. The main morphological characters of the new species were stable in all of the three populations studied and all three populations share the same (unusual for the genus) chromosome number ($2n = 44$).

Although the definition of genera and assignment of species to genera within the subfamily Ornithogaloidae of the family Hyacinthaceae are still under discussion, there is no doubt that the herein described new species shows affinities to species of *Ornithogalum* subg. *Beryllis* (Salisb.) Baker according to Zachariadi (1977b,

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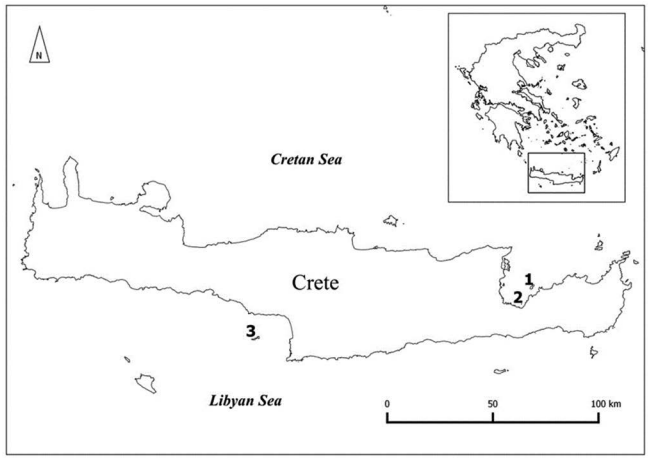

Fig. 1. Total distribution area of *Ornithogalum insulare* in the Cretan area: 1. Psira islet, 2. Konidha islet, 3. Megalo Paximadhi islet.

1980) and / or to the genus *Loncomelos* Raf. according to Speta (2006, 2010) and Martinez-Azorin *et al.* (2011). Moreover, Manning *et al.* (2009) conducted a molecular phylogenetic analysis in the subfamily *Ornithogaloideae*, from which they concluded that the genus *Loncomelos* should be considered as a synonym of the genus *Ornithogalum* L. in the section *Ornithogalum*.

According to Zahariadi (1977a, 1980), Wittman (1985), and Speta (2006), the subgenus *Beryllis* is represented in Greece by seven *Ornithogalum* species, namely: *O. pyrenaicum* L., *O. narbonense* L., *O. spetae* Wittman, *O. sphaerocarpum* A. Kern., *O. creticum* Zahar., *O. prasinantherum* Zahar., and *O. ulixis* Speta. However, only the first two of them, viz., *O. pyrenaicum* L. and *O. narbonense* L., are included in the molecular phylogenetic analyses of Martinez-Azorin *et al.* (2011). Taking into consideration that our material differs from both these species in a number of morphological and cytological features [long pedicels not appressed to the stem in fruit, different perigon segments, curved scape, leaf width, chromosome number ($2n$ = 44)], we prefer to use in this paper the generic name *Ornithogalum*, a name also accepted in the recently published checklist Vascular plants of Greece (Dimopoulos *et al.* 2013).

MATERIALS AND METHODS

Our study and description of the new species were based on living material collected from three different islets in the Cretan area (Fig. 1) and on material of wild origin cultivated in the experimental botanical gardens of the University of Patras and the Technological Education Institute of Heraklion. In view of the small size of the populations and peculiarities of the small islets' ecosystems, only a few bulbs (3-5) were collected from each islet. For taxonomical purposes, relevant bibliography sources were also taken into consideration (Fedorov 1974; Zahariadi 1980; Cullen 1984; Wittman 1985; Martines-Azorin *et al.* 2009; Öztürk 2014). The

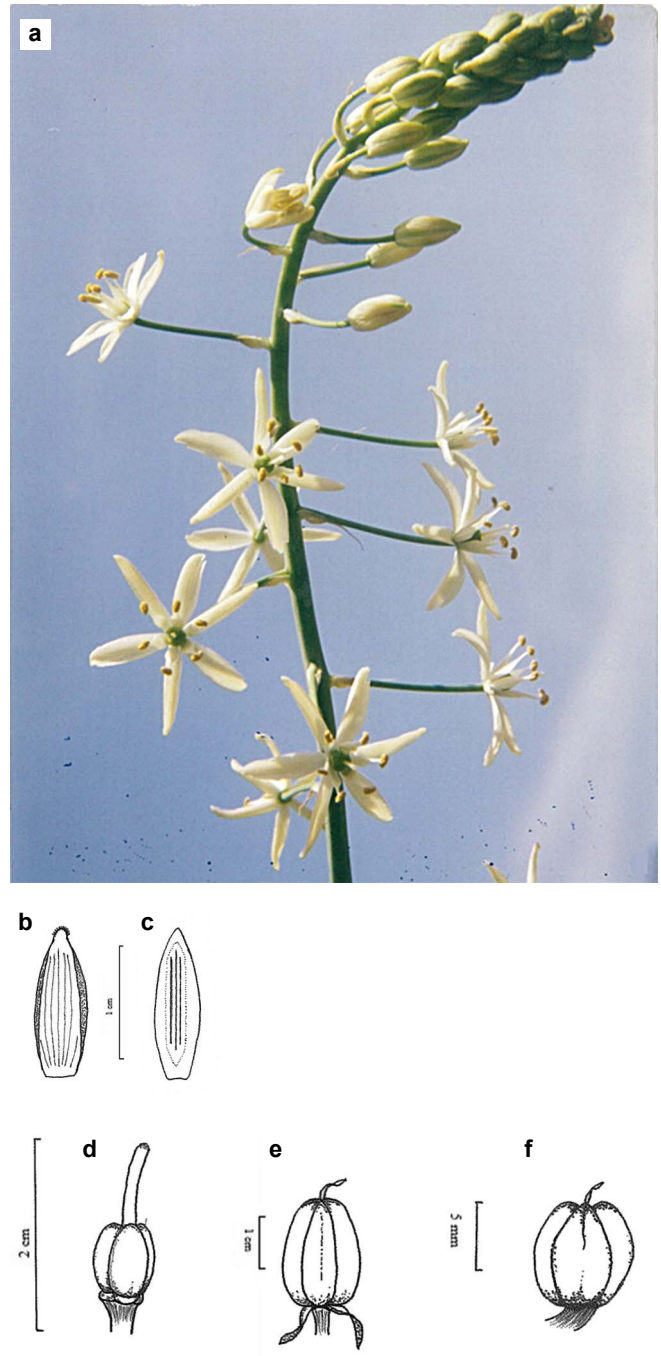

Fig. 2. *Ornithogalum insulare* (**a-e**): **a**. Photo of inflorescence, **b**. inner tepal, **c**. outer tepal (outer surface), **d**. ovary, **e**. capsule. **f.** Capsule of *O. creticum*.

comparison of the new species with its close relatives (Table 1) is mainly based on diagnostic characters and measurements provided in the corresponding original descriptions, but herbarium specimens kept in UPA, MAIC, and herbarium Kypriotakis were also taken into consideration. In the case of *O. creticum*, available living collections, among them plants gathered from the type locality of the species (Ierapetra, near Kalamafka), were

Table 1. Main morphological differences between *Ornithogalum insulare* and its allied species *O. creticum* and *O. pyrenaicum*.

Character	*O. insulare*	*O. creticum*	*O. pyrenaicum*
Bulbs (diameter)	4–6 cm	2.5–4 cm	2.3–3.8 cm
Scape	±curved, 60–90 (–120) cm	straight, (20-) 30–65 cm	straight, 30–80 (100) cm
Leaves (width)	1.5–2.5(–3.5) cm	0.7–1.3 cm	0.2–0.5 cm
Leaf margins	entire	entire	denticulate
Racemes (flowers)	35–47 (50)	16–23 (-30)	25–40
Tepal colour	dirty white or, sometimes, greenish–white	greenish	pale yellow inside, greenish outside
Tepal length	12–18 mm	8–10.5 mm	7–13 mm
Ovary	3–4 × 2.8–3.2 mm	2.5–3 × 2–3.3 mm	2.4–3 mm
Anther length	3.5–4.8 mm	1.8–3.5 mm	2–2.4 mm
Capsules	12–14 × 9–10 mm	9–11 × 6–7mm	10–14 × 7–9
Capsule shape	ovoid, truncate at apex, three rounded angles separated by shallow furrows	subsphaerical, three rounded angles separated by deep furrows, emarginated at apex	ovoid–obconical
Seeds	5–7 mm	3–4.5 mm	2.5–3.5 mm
Flowering period	Late spring (May)	Early summer (June)	May-June
Chromosome number	$2n = 44$	$2n = 28$	$2n = 16, 18, 24$

also considered. For karyological analysis, root tips from potted bulbs were pretreated in a-bromonaphthalene for ca. 8 h at 4°C. Fixation, staining, chromosome measurements, and construction of the karyogram follow Tzanoudakis (1983).

RESULTS & DISCUSSION

Description of the new species. *Ornithogalum insulare* Kypriotakis, Antaloudaki & Tzanoudakis, *sp. nov.* (Fig. 2)

It differs from the related *O. creticum* Zahar. and *O. pyrenaicum* L. in having a curved and more robust stem; larger bulbs, flowers, and seeds; a many-flowered inflorescence; and different shape of the capsule (Table 1).

Type: —GREECE. Southern Aegean area, Kriti (Crete), Nomos Lassithiou, Psira islet, W-NW of the archaeological site, 35°11'11.65"N, 25°51'33.56"E, 35 m a.s.l., rocky places among phrygana with *Thymbra capitata* (L.) Cav., 6 June 1998, Kypriotakis 15587 (Holotype: NHMC!, isotypes, herb. Kypriotakis!, UPA!).

Description: Bulbs ovoid to ovoid–globose, 4–6 cm in diameter and 4.5–7 cm long; tunics membranous, the outer pale brownish to dirty white, the inner whitish, scales free. Scape robust, terete, 60–90(–120) cm long, 5–7(–9) mm in diameter at base, more or less curved. Leaves 4–6(–7), shorter than scape, linear, 50–60(–75) cm long and 1.5–2.5(–3.5) cm wide, uniformly pale green, flat or slightly canaliculate, margins entire, glabrous, tapering to apex and almost withered at anthesis. Inflorescence a 35–47 (–50)-flowered, dense, bent, cylindrical raceme 22–40(–50) cm long, elongating up to 27–45 (–55) cm in fruit. Pedicels 45 mm long in the lower flowers, up to 20 mm in the upper ones, erecto–patent or patent at anthesis; suberect or patent in fruit, but never appressed to the axis of the inflorescence. Bracts lanceolate, shorter than pedicels, membranous, subulate, semi–cylindrical at base, whitish, with 5–12 faint greenish nerves, 2–5 mm wide at base, ranging in length from 20–28 mm in the lower pedicels to 8–11 mm in the upper ones. Flowers more or less stellate, 20–30 (35) mm in diameter. Perigon segments 12–18 × 4.5–5.5 mm, lanceolate–elliptical, with papillate-glandular apex and longitudinally inrolled margins, white to dirty white on the inner surface, dirty white, greenish white or sometimes with an inconspicuous yellowish-green median stripe on the outer surface with 3–5 faint nerves, 1.5–2 mm wide, not reaching the base and apex of the tepals. Perigon segments slightly deflexed, withered and persisted in fruit. Filaments white, 7–9 × 1.5–2 mm, more or less abruptly contracted in a short appendage; anthers 3.5–4.8 × 1.5–1.7 mm, dirty white. Ovary subglobose to cylindrical, 3–4 × 2.8–3.2 mm, green, glabrous, with three rounded obtuse angles and subtruncate at apex; style white, longer than ovary, 4–5.5 mm long; stigma subcapitate. Capsule ovoid, truncate at apex with three

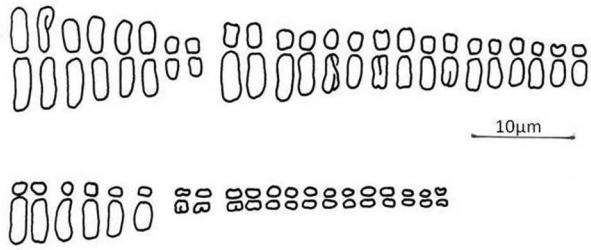

Fig. 3. Karyogram of *Ornithogalum insulare*, 2*n* = 44, from the population of Psira islet.

rounded angles separated by shallow furrows, 12–14 × 9–10 mm, pale brown, and obscurely reticulate. Seeds 5–7 mm long, angular with a short lingulate appendage. Testa black, rugulose, minutely papillose. Germination epigeal. Chromosome number 2*n* = 44.

Additional specimens seen (paratypes): Kriti, Nomos Lassithiou, Psira islet, TZ 99/40. May 20. 2006 and TZ 99/40 May 23.2006 (UPA).
Kriti, Nomos Lassithiou, Konidha islet (35° 7'33.24"N, 25°48'39.84"E , ca. 2 m. a.s.l., June 3. 1999, Kypriotakis 15588 (herb. Kypriotakis, UPA); TZ 04/14. May 23. 2006 (UPA).
Kriti, Nomos Rethymnis, Megalo Paximadhi islet, 35° 0'25.68"N, 24°35'25.92"E, ca. 22 m. a.s.l., June 10. 1999, Kypriotakis 15589 (herb. Kypriotakis, UPA)

Etymology:—The specific epithet refers to the known distribution of the species, which is restricted to only three small islets in the south Aegean area.

Karyotype. Material of *O. insulare* collected from all three islets was cytologically investigated and the chromosome number of all individuals was found to be *2n* = 44. This chromosome number (*2n* = 44) is uncommon in the genus *Ornithogalum* and is not related to the basic chromosome numbers x = 7, 8, and 9 reported from the related species of *Ornithogalum* subg. *Beryllis* (Salisb.) Baker (Cullen & Ratter 1967; Kamari & Georgiou 1981; Moret 1987) and/or of the genus *Loncomelos* Raf. (Martinez-Azorin *et al*. 2010). A preliminary karyotype analysis in the populations of Psira and Konidha islets suggests that *O. insulare*, in spite of its high chromosome number, behaves as a diploid species. In the mitotic metaphases of the material analysed from Psira islet, the chromosome complement consists of two easily distinguished groups of chromosomes (Fig. 3); the first one includes 30 more or less large (L) chromosomes (representing ca. 90% of the total length of the chromosome complement), the second 14 obviously shorter ones (S). Such an arrangement of the chromosomes does not permit any kind of speculation with regard to the level of polyploidy and the basic chromosome number, as the only common denominator of the numbers 30 and 14 is the number 2. The diploid feature, or the diploidisation of the karyotype concerned (*2n* = *2x* = 44), is further supported by the presence in the metaphase plates of a "marker" pair of metacentric chromosomes, which is the smallest of the L group, but at the same time is clearly (almost two times) larger than the average size of chromosomes of the S set (Fig. 3). The conducted karyotype analysis also revealed a remarkable differentiation with regard to the centromeric position (r-index) and the chromosome size (R-length), mainly within the set of large (L) chromosomes. This set consists of chromosomes of three different types (m, sm, and st), which also differ in size (Fig. 3). The S set of 14 short chromosomes consists mainly of metacentric chromosomes, and only one pair seems to be anisobrachial (sm). Consequently, based on the centromeric position and the chromosome size, the following tentative karyotype formula is suggested for *O. insulare*: *2n* = *2x* = 30L (8m + 16sm + 6st) + 14S (12m + 2sm) = 44 (Fig. 3). Although plants from the second population studied (that of Konidha islet) are also characterised by the karyotype formula mentioned above, two differences are worth noticing. The first one, which also supports the diploid behaviour of the species studied, concerns the appearance of a marker pair of sub-telocentric SAT-chromosomes characterised by the presence of a nucleolar organiser located in a more or less median position of the short arm (Fig. 4). The second concerns the presence of size differentiation within the group of 14 small (S) chromosomes, since four of them appear to have R-length values higher than those of the remaining 10. However, these four chromosomes are clearly shorter than the smaller metacentric chromosome of the L set.

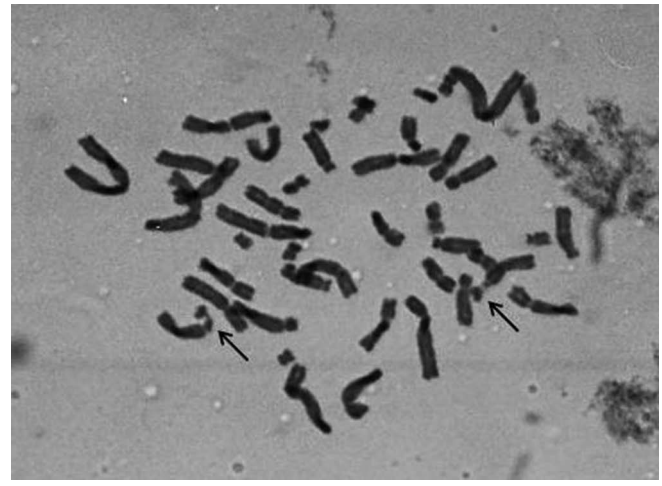

Fig. 4. Metaphase plate of *Ornithogalum. insulare*, 2*n* = 44, from the population of Konidha islet. Arrows indicate the pair of anisobrachial SAT-chromosomes.

Distribution and Ecology. Up to now the new species is known only from the Cretan area (S. Aegean) and,

more specifically, from the three offshore islets Psira, Konidha, and Megalo Paximadhi. The first two are located off the NNE coast of the island of Crete, while the third is located offshore from southern Crete (Fig. 1). Three subpopulations of the new species with approximately 150 individuals were found on Psira islet, ca. 30 individuals were found on Konidha islet, and a dozen plants were found on Megalo Paximadhi islet. On Psira islet, the plants occur on low rocky hill slopes as part of the phrygana community, dominated by *Thymbra capitata* (L.) Cav. and other plant species such as *Salvia fruticosa* Mill., *Cynara cornigera* Lindl., and *Muscari spreitzenhoferi* (Heldr.) H.R.Wehrh., together with therophytes like *Bromus madritensis* L. and *Urospermum picroides* (L.) F.W. Schmidt.

Taxonomic relationships. On the basis of its morphology, the new species seems to be related to *O. creticum* Zahar. and *O. pyrenaicum* L. within the *Ornithogalum* subgenus *Beryllis* (Federov 1974; Zahariadi 1980; Cullen 1984; Öztürk 2014). However, *O. insulare* is a taller and more robust plant with a more or less curved scape, numerous and larger flowers, long pedicels not appressed to the stem in fruit, larger seeds, and an ovoid capsule (Table 1). In addition, another species which shows some morphological similarities to the new taxon is *O. visianicum* Tomm., endemic to Palagruža islet (Croatia). However, this taxon differs from *O. insulare* in the shape of its perigon segments, which are oblanceolate-ellipsoid and shorter (Wittman 1985). Moreover, in *O. visianicum* the permanent green stripe extends over the entire surface of the perigon segments reaching their apex, the bracts are shorter, and the style length equals the ovary height. With regard to the inflorescence, and especially the position of the pedicels on the axis of the inflorescence, the new species resembles *O. arcuatum* Steven, an Irano-Turranian mountain element. The latter differs from *O. insulare* in the shape and colour of the perigon segments, the short style, and the cylindrical capsule. It also differs notably in its chromosome number ($2n = 32$) (Wittman 1985).

Conservation status. *Ornithogalum insulare* is currently known only from the three islets Psira, Konidha, and Megalo Paximadhi in the Cretan area. The total occupied area does not exceed 10 km^2 and the total number of individuals on all three islets is estimated to be less than 200. So in spite of the lack of monitoring data on fluctuation of size of the populations, *O. insulare* probably should be considered as a "critically endangered" taxon according to criteria B1 and C of IUCN (IUCN 2001).

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REZIME

Ornithogalum insulare (Hyacinthaceae): nova vrsta iz Kritske regije (južni Egej, Grčka)

Zacharias Kypriotakis, Eleftheria Antaloudaki i Dimitris Tzanoudakis

Ornithogalum insulare prikupljen sa obala tri kritska ostrva opisan je kao nova vrsta za nauku. Vrsta je opisana i upoređena sa ostalim srodnim vrstama roda. Dati su podaci o broju hromozoma ($2n = 44$) i određen je kariotip.

Ključne reči: *Ornithogalum* subg. *Beryllis*, egejska flora, broj hromozoma, zaštita, nova vrsta