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Origanum × symes Carlström is a newly formed hybrid of the Lamiaceae family's origanum genus.

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ABSTRACT

The Aegean Island of Symi in the Dodecanese, Greece, is where Carlström first identified Origanum × symes in 1984 as a new species. In this study, fresh evidence is presented to support a taxonomic reassessment of O. symes.

The first author gathered new Origanum symes specimens in 2017 while visiting the island of Symi.

The specimens were analyzed and contrasted with the O. symes type specimen with great care. In addition, the calyces of the new Origanum symes species were drawn and compared morphologically with those of O. calcaratum and O. onites, two potential parents.

Findings: Morphological comparisons were made between the novel hybrid and its presumed progenitors, Origanum calcaratum and O. onites. Details, images, and a map of its distribution were included, in addition to its diagnostic characteristics.

O. symes, as a result of comparing its leaves, calyx, and corolla to those of its two parents, exhibits a hybrid trait. Based on these findings, we propose that O. symes is a hybrid. The outcome was that Origanum × symes Carlström was rearranged as a hybrid of O. calcaratum and O. onites.

Topics covered: hybrid, Origanum symes, Symi, Dodecanese

INTRODUCTION

The novel hybrid reported here is one of around 42 species (49 taxa) and 22 hybrids within the Origanum L. (Dirmenci et al., 2021). The family Origanaceae is subfamily Nepetoideae and the tribe Mentheae is subtribe Menthinae. Turkiye is a hotspot of Origanum diversity, with 21 species (24 taxa, 13 endemic) and 13 hybrids (12 endemics) (Ietswaart, 1980, 1982; Harley, 2004; Dirmenci, Yazıcı, Özcan, Çelenk, & Martin, 2018; Dirmenci, Özcan, Yazıcı, Arabacı, & Martin, 2018; Dirmenci et al., 2019; Arabaci, Dirmenci, & Yildiz, 2020; Dirmenci, Özcan, Arabacı, Çelenk, & Martin, 2020; Arabaci et al., 2021; Dirmenci et al., 2021). Three hybrids, O. × intercedens Rech.f. (1961: 395), O. × minoanum P.H. Davis (1953: 137) (endemic), and the newly-discovered endemic O. × symes, are among the nine species of Origanum found in Greece. Six of these species are endemic.

Rechinger (1944, 1961), Davis (1953), Ietswaart (1980), Carlström (1984: 19), Kokkini & Vokou (1993), and Dimopoulos, Raus, & Strid (2018) are also cited. Many members of the Lamiaceae family engage in hybridization, both in nature and in culture. This is particularly true among the Origanum, Phlomis, Thymus, Salvia, and Sideritis genera (Celep, Rader & Drew, 2020; Dirmenci et al., 2021; Dadandi & Duman, 2003). According to many studies (Ietswaart, 1980; Dirmenci et al., 2019, 2020, 2021). Origanum hybridization may occur even across species from different segments.

Greek researchers doing a reevaluation of the Origanum genus found that O. symes has characteristics with both O. calcaratum Juss. (1789: 115) and O. onites L. (1753: 590). Two chromosomes, or 2n=30, are shared by both taxa.

According to Arabaci et al. (2021) and Martin, Dirmenci, Arabaci, Yazıcı, and Özcan (2020), the majority of Origanum species exhibit this form of diploidy. However, there are a few situations where the chromosomal number

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is 2n = 28 and/or 32. Since Orphanides' work in 1856, numerous botanical studies have been conducted on Symi. These studies include Desio (1924), Rechinger (1944), Davis (1965–1985), Carlström (1987), Keitel & Remm (1991), Jahn (Strid 2016), Chilton (2010), Galanos (2016), Galanos & Tzanoudakis (2017, 2019), Burton & Tan (2017), Cattaneo & Grano (2017, 2018, 2019, 2019), and Cattaneo (2020). However, only O. onites and O. symes have been detected on the island. Although it has not been discovered on Symi, O. calcaratum is the only species in this region that overlaps with O. onites. Keros, Anidros, Amorgos, Astypalea, Ofidoussa, Kounoupi, Safora, Sirina, Chalki, and eastern Crete (Sitia) are some of the Cyclades and Dodecanese islands and islets where O. calcaratum may be found. Chalki is the island that is 43 kilometers away from Symi and the closest place where O. calcaratum grows, whereas Crete is the farthest away at 222 kilometers.

Its preferred growing conditions are 50–500 m in the cracks of steep limestone cliffs (Strid, 2016). While O. onites is more widely distributed, it is most often seen in southern Greece and western and southern Turkey. A phryganic element, it flourishes between 0 and 800 meters on dry, rocky hillsides. A proposal has been made to reevaluate the taxonomy of O. × symes.

MATERIAL AND METHODS

The first author collected the Origanum × symes specimens in 2017 from Aghios Dhysalonas Bay on Symi Island, which is situated between two shady vertical limestone cliffs along the coast (Figure 1). This taxon was originally discovered by Carlström at the same location (Carlström, 1984). Considering the steep, vertical limestone cliffs that make study at this location difficult, the occurrence of a broader population of O. × symes is not ruled out, even if it has not been detected anywhere else. By comparing the obtained specimens with Carlström's

Figure 1. Distribution map of *Origanum × symes* on Symi Island.

LD Herbarium has conserved samples from Carlström (Figure 2). In Cattaneo's own herbarium, voucher specimens were placed (Figure 3). You may find the calyx drawings in Figure 4. Table 1 also shows morphological comparisons between the novel hybrid and its presumed parents, Onites and O. calcaratum.

RESULTS

An analysis of morphology

Figures 2-4 show the hybrid Origanum × symes Carlström, as described in Willdenowia 14: 19-21 (1984).

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The species Origanum calcaratum Jussieu, which is a member of the Origanum family, is crossed with Origanum onites L., a member of the Origanum family, by Bentham.

Category: Greek Hylo LD shot from Symi, Georgiou Disalona Bay, close to s.l., Carlström 8363.

Description: Medicinal plant. Plants with rising stems that reach a height of 35 cm and are either light yellow or yellow-brown in color. They have pubescence at the base and hairs that are around 1 mm long. On top of that, they are hairy. The first-order branches often occur in the top portion of the stems, in pairs of up to six, and are three to five centimeters long; they are not rami-

Figure 2. *Origanum* × *symes* holotype (reproduced with permission of the Director of the Biological Museum of Lund).

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Figure 3. Specimen of Cattaneo's personal herbarium.

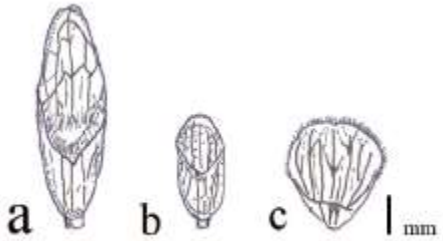

Figure 4. Calyx of *Origanum calcaratum* (a), *O. ×symes* (b), and *O. onites* (c).

glands that are stalked and fied. The stems can support up to 15 pairs of leaves, which are 13–28 mm long and 9–17 mm wide. At the tip, they are obtuse to acute, and there are numerous sessile glands (up to 1000 per cm2) on the undersides of the leaves. The lower leaves are lanate and have a distinct petiole, measuring approximately 1.5 cm in length. The upper leaves are ciliate and subsessile. The typical spikes are upright, broad (10–20 mm), oblong–ovoid, and 20–30 mm in length. Each spike has 8 to 12 pairs of green, imbricate, broadly ovate to suborbicular, slightly rounded at the tip, 7 to 10 mm in length, 7 to 9 mm in width, and covered with sessile glandular hairs. Subsessile flowers, 2 per verticillaster. A calyx that is about 3.3 to 3.8 mm in length and 1.3 mm in width, adorned with colorful sessile and colorless stalked glands; a complete upper lip; a missing lower lip; and a glabrous neck. Corolla with two lips, about 13 mm in length, pink, plainly saccate, with glands dispersed throughout; top lip either subentire or split into two lobes, 0.3–0.5 mm long; lower lip divided into three subequal lobes, 1.5–2 mm long. This flower has four stamens, all of which stick out from the top of the corolla. The filaments are around 1.5 to 11 mm long, and the anthers are about the same length.

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Table 1. Comparison of diagnostic characters in *O. calcaratum*, *O. × symes*, and *O. onites*.

	O. calcaratum	*O. × symes*	*O. onites*
Stems	erect, up to 35 cm, hirsute or slightly lanate, branches up to 6 pairs per stem and up to 2.5 cm	ascending, up to 35 cm, pubescent at base, branches 6 pairs per stem and up to 5 cm	erect or ascending, up to 100 cm, hirsute and glandular, branches up to 8 pairs per stem and up to 7.5 cm
Leaves	(sub)sessile, roundish to ovate, 6-28 × 5-25 mm, hirsute or slightly lanate, with sessile glands up to 600 per cm²	subsessile to petiolate, cordate-ovate, 13-28 × 9-17 mm, ciliate, lanate with numerous sessile glands up to 1.000 per cm²	shortly petiolate, cordate, ovate or oval with an acute apex, 3-22 × 2-19 mm, hirsute and glandular-pilose with sessile glands up to 1700 cm²
Inflorescence	spikes cylindrical or pyramidal, 10-40 × 9-17 mm	spikes oblong-ovoid, 20-30 × 10-20 mm	spikes subglobose, ovoid, or quadrigonus-cylindrical, 3-17 × 3- 5 mm
Bracts	roundish to oval, acute at apex, 5-13 × 4-10 mm, glabrous, partly slightly purple	ovate-suborbicular, rounded at apex, 7-10 × 7-9 mm, glabrous, glandular, green	oval or obovate, acute at apex, 2-5 × 1.5-4 mm, hairy, light green
Calyx	5-8 mm, 1-lipped, upper lip (sub)entire, with a pilose throat	3.3-3.8 mm, 1-lipped, upper lip entire, with a glabrous throat	2-3 mm 1-lipped, upper lip entire or denticulate
Corolla	10-17 mm, pink, saccate, more or less glabrous	13 mm long, pink, saccate	3-7 mm, white, pilosellous
Stamens	4, exserted from corolla	4, exserted from corolla	4, or absent, if present, slightly exserted from corolla

on a length of 0.4 mm. The style may be up to 18 mm in length and protrudes between the filaments. Round, light-brown, somewhat tuberculate nuts with two depressions on one side, measuring about 1 × 0.5 mm. Found on limestone coastal cliffs in shady areas. Blooming season: June Evaluation of the hybrid by contrasting it with its parent species Carlström included Origanum × symes in the section Amaracus (Gled.) Benth, describing it as a new species (Carlström, 1984). She emphasized how closely O. × symes is related to O. calcaratum. But it did note a few distinctions, such as the fact that its inflorescences are less dense and consistently green in shape (ranging from ovate to suborbicular). The bracts of O. × symes are typically more elliptical and have an acute tip, in contrast to the typically hairy calyx of O. calcaratum, which is 5–8 mm long (Figure 4). Additionally, the spikes of O. × symes are not pyramidal like those of O. calcaratum, but they are smaller and have a glabrous throat.

Moreover, Origanum × symes differs from O. calcaratum in several other features (Table. 1); its stems are glabrous to puberulent (not hirsute or lanate); leaves rounded to ovate, ciliate (not hirsute), up to 15 pairs per stem (not 35 pairs per stem); lower leaves with a distinct petiole ca. 1.5 cm (not (sub)sessile); sessile glands up to 1000 per cm² (not 600 per cm²); bracts with rounded, very glandular apex, 7–10 × 7–9 mm (not acute apex, slightly glandular,

5–13 × 4–10 mm); calyx with glabrous throat, 3.3–3.8 mm long (not pilose throat, 5–8 mm long); and corolla 13 mm long (not 10–17 mm long). O. × symes resembles O. calcaratum more closely, although it also has certain intermediate traits with O. onites. These include the calyx's shape and size, as well as the leaves' look with distinct veins on the undersides. The puberulent-ciliate leaves of O. symes differ from those of O. onites in that they can have up to 15 pairs per stem, measuring 13–28 × 9–17 mm and having sessile glands up to 1000 per cm². On the other hand, hirsute leaves can have up to 28 pairs per stem, measuring 3–22 × 2–19 mm and having sessile glands up to 1700 cm². The bracts can be up to 12 pairs per spike, measuring 7–10 × 7–9 mm, and there are up to 34 pairs per spike, measuring 2–5 × 1.5–4 mm.

DISCUSSION

The genus Origanum is known for its frequent hybridization.

When two or more species from different sections mate, the resulting hybrid may take on characteristics of either parent or be a mix of the two. According to many studies (Rechinger, 1961; Duman, Başer, & Aytaç, 1996; Bakha et al., 2017; Dirmenci et al., 2018a, 2018b, 2020), the size and form of the calyx, bract, leaves, and corollas are often intermediate between the parents. Indeed, this is clearly recognizable in examples such as O. × aytacii Dirmenci, T. Yazıcı & Arabacı (2020: 4) (Arabaci et al., 2021) and O. × intermedium P.H. Davis (1949: 410), which is more similar to O. sipyleum L. (1753: 589), O. × intercedens, which is closer to O. vulgare subsp. hirtum (Link) Ietsw. (1980: 112), and O. haradjanii Rech.f. (1952: 64), which is closer to O. syriacum subsp. bevanii (Holmes) Greuter & Burdet (1985: 301) (Dirmenci et al., 2020; Arabaci et al., 2021).

While it's true that many hybrids of the genus Origanum live in close proximity to both of their parents, this is not always the case. O. × munzurense Kit, O. × malatyanum Yıldız, Arabaci & Dirmenci, and O. × intercedens have all been studied in this way (Tan & Sorger, 1984; Kokkini & Vokou, 1993; Dirmenci et al., 2019; Arabaci et al., 2020). Nonetheless, study errors might also be associated with the purported absence of a parent or parents. One possible parent, O. onites, has been identified near O. × symes, while the other, O. calcaratum, may have remained undiscovered due to the difficulty of conducting investigations in the region. Because of this, Carlström recognized O. × symes as an entirely distinct species.

In terms of overall appearance and ecological perspective, O. × symes is much more akin to O. calcaratum, although displaying intermediate traits between both parents. According to Cattaneo and Grano (2019), two chasmophilous species, O. calcaratum and O. × symes, may be found growing in the cracks of steep limestone cliffs. The fact that O. × symes was discovered in a deep, shady crevice in a cliff suggests that it tries to stay away from direct radiation. O. calcaratum is a member of the Amaracus section. The first-order branches are prevalent in this section and the second-order branches are rare. The leaves are typically leathery and the spikes are large and nodding. The bracts are imbricate, membraneous, partially purple, and more or less glabrous. There are usually two flowers per verticillaster, and they are hermaphrodite and subsessile. The calyx can be 1- or 2-lipped, and the corolla is saccate, with all the stamens long and extended from the corolla (Ietswaart, 1982). As a member of the Majorana sect, O. onites is easily identifiable by its abundance of first-order branches, as well as the occasional appearance of second- or third-order ones; The plants have herbaceous leaves and spikes that are small, upright, and often quadrigonus-cylindrical. The bracts are distinct from the leaves and are densely imbricate, ± as long as the calyces, and enclose the plant at the margins. The flowers can be either hermaphrodite or female, and they are small with a 1-lipped or 2-lipped flattened corolla. Inequal stamens that stick out just a little from the flower (Ietswaart, 1982).

CONCLUSION

The taxonomy of Origanum × symes has been reevaluated in this work.

Morphological analysis revealed that the species was a hybrid, drawing attention to shared characteristics with both its parents, O. calcaratum and O. onites, as well as distinguishing characteristics that were unique to it.

The authors believe that O. calcaratum, which occurs on the neighboring island of Chalki (southwest of Rhodes), is one of the putative parents due to its morphological similarity and geographical proximity to Symi. While the presence of Origanum onites has been confirmed, the presence of O. calcaratum has not.

The identification of possible parents in hybrids relies heavily on floral traits. In O. × symes, the corolla closely resembles O. calcaratum in terms of form (obviously saccate), size, and color (pink), while the calyx is more similar to O. onites in terms of shape and size. Like in O. calcaratum, all stamens of O. × symes are lengthy and extended from the corolla. In addition, O. × symes is more similar to O. calcaratum in terms of stem size and branch count, but it resembles O. onites in terms of its cordate-ovate leaves, which are abundant in sessile glands.

Based on its overall look, O. dictamnus L. (1753: 589) might be seen as another possible parent of O. × symes within the Amaracus sect., with Origanum calcaratum.

While both species have a similar calyx, the one in O. × symes is smaller and has a more or less saccate corolla, whilst the one in O. × symes is obviously saccate, much like O. calcaratum. Additionally, O. dictamnus is unique in that its stem and leaves are lanate and covered with branching hairs, but O. symes is more typical in that its stem is pubescent only around the base, its top leaves are ciliate, and its lower leaves are lanate.

From a geographical standpoint, O. calcaratum is found on Chalki, whereas O. dictamnus is exclusive to Crete, which is fairly far away from Symi. O. × symes is thought to have originated from O. calcaratum and O. onites, based on morphological and geographical evidence.

The Eastern Mediterranean area is home to the vast majority of Origanum species (Ietswaart, 1980), and the genus Origanum is mostly distributed across the Mediterranean (Zohary, 1973). One of the most significant mechanisms of speciation in the genus Origanum is hybridization, which occurs often within the species. O. × lirium, a kind of onion, was created by a hybridization process involving O. scabrum and O. vulgare subsp. hirtum, as shown by O. × lirium Heldr. ex Halácsy (1899: 192). For many plant species, hybrids and hybrid zones are commonplace. Closely related and genetically comparable taxa are the only ones likely to produce hybrids. Extensive prezygotic isolating mechanisms, including geographical barriers, divergent phenology, diverse pollinators, and differences in mating systems, and postzygotic mechanisms, including hybrid and immigrant inviability, keep many of these taxa reproductively isolated from one another. Unless these barriers are disturbed by either natural or human-caused disturbances, it is probable that these species will not hybridize and create hybrid zones in sympatric and parapatric settings. In addition, hybrid zones may form as a consequence of secondary contact after allopatric divergence, changes in the climate or the earth's crust, or both (Abbott, 2017). There may be many more hybrids in the overlapping regions of various species in Greece, however only three have been found so far: O. × intercedens, O. × minoanum P.H. Davis, and O. × symes.

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