A new yellow-flowered species of *Centaurea* (*Asteraceae*) from Mt Imittos, Attica, Greece

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Abstract. *Centaurea hymettia* (*Asteraceae*, *Centaurea* sect. *Acrolophus*) is described as a new species from Mt Imittos (Hymettus) near Athens, south-central Greece. It is the only steno-endemic of the mountain. Within the section the closest affinities are with *C. laureotica*, which occurs in an area *ca*. 30 km to the southeast. Both *C. hymettia* and *C. laureotica* are tetraploids with $2n$ = 36+2B and $2n$ = 36 chromosomes respectively.

Key words: *Centaurea* sect. *Acrolophus*, chromosome numbers, Greece, new species, steno-endemic.

Introduction

Attica is the triangular peninsula at the westernmost part of Sterea Ellas which is both an administrative region and a floristic region (Strid & Tan 1997). Excluding the central plain on which the city of Athens now stands, the terrain has six mountains over 1000 m in height and complex geological substrata with limestone, marble, schist and ultramafic rock. In recent years, detailed floristic studies have been carried out on all of Attica's mountains (Gerania, Pateras, Kitheronas, Parnitha, Pendeli) with the exception of Imittos (the Mt Hymettus of antiquity).

According to the recent checklist of vascular plants of Greece (Dimopoulos & al. 2013), the *Centaurea* group (Hilpold 2012) [= *Acrolophus* subgroup (Wagenitz & Hellwig 1996)] is represented in Greece by 53 species (36 endemic) and 17 subspecies (12 endemic). Karyologically, the group is characterized by a basic chromosome number of x = 9 and with only few exceptions, the species are either diploids (the majority) or tetraploids, the latter thought to be derived from diploid parents by the process of polyploidization (Španiel 2008; Hilpold 2012). Although not supported by recent molecular studies (Hilpold 2012), the *Centaurea* group is traditionally further divided into the sections *Acrolophus* (Cass.) DC. and *Phalolepis* (Cass.) DC., distinguished by the shape of the appendage, either fimbriate or membranous. Georgiadis (1980) studied *Centaurea* sect. *Acrolophus* in Greece and defined 10 lineages within the section. He found that in general, white- and yellow-flowered species of low and moderate altitudes show characters which are traditionally regarded as primitive and the evolutionary direction of the section appears to be from lowland plains to the mountains. The yellow-flowered *C. pelia* DC., a diploid and lineage-founder species endemic to the East Central mainland (just reaching northwestern Attica), is replaced in Attica and Evvia by the robust tetraploid taxa *C. laureotica* Halácsy and *C. mantoudii* T. Georgiadis respectively. *Centaurea carystea* Trigas & Constantin. from Mt Ochi in south Evvia is another closely related species in the same section. We found a yellow-flowered, tetraploid species from Mt

Imittos which is rather similar to *C. laureotica* but distinct by a combination of morphological, karyological and ecological features. It may seem amazing and unlikely that a new species could be found on the southern slopes of Mt Imittos so near the concrete of modern day Athens, but so it is. It has not been observed on any of the other five Attica mountains, and is therefore recorded as the only steno-endemic of Mt Imittos.

Materials and methods

For the measurements of involucres and phyllaries, five capitula were sampled from each of 20 randomly selected individual plants of *C. hymettia* and *C. laureotica*, a total sampling of 40 plants and 200 capitula.

For the chromosome counts, 30 mitotic metaphase plates of *C. hymettia* obtained from root tips of 25 seeds collected from 5 plants from the type locality and 39 mitotic metaphase plates of *C. laureotica* (30 seeds from 5 plants collected from the *locus classicus*, hills around Kamariza near Lavrio) were studied. Root tips were pretreated with 8-oxychinoline for 30 min, then fixed in acetic alcohol (1:3) for 24 h at 4 °C, hydrolysed in 1 M HCl for 15 min at 60 °C, stained with haematoxylin after Gomori (Melander & Wingstrand 1953) for 30 min at 60 °C, then squashed in 45 % acetic acid. The karyotype has been determined according to Levan & al. (1964).

Taxonomic treatment

Centaurea hymettia Kit Tan, Zografidis & Bancheva, **sp. nov.** (Figs. 1–4)**.**

Resembling *C. laureotica* but plants lanate, with procumbent to decumbent stems, broader involucres and broader, erecto-patent to recurved phyllary appendages with usually 1–3 additional cilia on either side.

Robust, lanate perennial herb, woody at base, producing each season one to many leaf rosettes and one to many (20 or even more) procumbent to decumbent flowering stems (5)10–45 cm in length. Stems branched from below middle, paniculate-subcorymbose; each stem bearing (1)3–30 solitary (rarely paired) capitula. Rosette leaves (excl. lowermost) petiolate, oblanceolate to oblong-linear in outline, 3–13 × 1–3 cm, pinnatisect to 3-pinnatisect; each side of the midrib with 4–9, obovate to oblanceolate-linear, opposite to subopposite primary segments 2–16 × 1–5 mm; upper segments often with basal lobes and/or interrupted by smaller lobes. Lowermost cauline leaves similar to rosette leaves; middle cauline leaves reduced, subsessile, pinnatisect, oblanceolate to lanceolate-ovate in outline, 1.2–5 × 0.8–2.5 cm with linear-oblanceolate, 5–16 × 1–4 mm lobes; uppermost cauline leaves sessile, lanceolate, 5–7 × 1–4 mm, entire or with 1–2 basal laciniae. Involucre ovoid to broadly ovoid (open at

Fig. 1. *Centaurea hymettia* in natural habitat.

maturity), 10.5–14 × 8–14.8 mm, 5.2–6.7 mm wide excl. appendages. Receptacle 1.8–2.8 mm diam. Phyllaries 35–50, imbricate, *ca*. 6-seriate, coriaceous, lanate to glabrous; body of phyllary green, 3–5-veined; appendage yellowish- to dark brown with brown to whitish cilia ± overlapping adjacent phyllaries; middle phyllaries lanceolate, auriculate, rarely exauriculate, with thin hyaline margin; body of middle phyllary (excl. appendage) ovate, 3–6 × 2–2.5 mm; appendage of middle phyllary decurrent, erecto-patent to recurved, 3–5(6.5) × 3.5–4.5 mm; base of appendage (excl. cilia) *ca*. 1mm; cilia on each side of appendage (5)6–8(13) in number, up to 2.5 mm long; spine (1.8)2.5–4(4.5) mm, distinctly ciliate at base; outer phyllaries similar to middle phyllaries but smaller, 2–6 × 0.5–3.5 mm and with fewer cilia; innermost phyllaries decurrent, lanceolate to linear, 8–13 × 0.4–2 mm, with hyaline margin and slender appendage either ciliate-lacerate or entire, with or without a weak, up to 2 mm long spinule. Florets with glandular yellow corolla; marginal sterile florets 6–11, with 4–5 lobed corolla 12–17 mm long (incl. 2–6 mm lobes); central florets 17–29, hermaphrodite, tubular, expanded into 5-lobed corolla 11–16 mm long (excl. 3–5 mm lobes); anthers connate into tube, with glabrous, *ca*. 0.5 mm long appendage. Achenes 2.8–4 × 0.8–1.3 mm, brown to dark brown; longest pappus hairs 1–2.5 mm.

Type. Greece: Nomos & Eparchia Attikis, southern slopes of Mt Imittos, along dirt road overlying marble, 650 m, 37°53'N, 23°47'E, 06.06.2013, *Zografidis* s.n. (**holotype** C; **isotypes** ATH, SOM).

Karyology

Centaurea hymettia is a tetraploid species with karyotype comprising 36 small chromosomes (*ca*. 1–2 μm) and 2 B chromosomes: $2n = 4x = 4m + 28sm + 2sm$-SAT + $2st$-SAT+ 2B = 36+2B (Fig. 4, B chromosomes indicated by white arrows), in contrast to the karyotype of *C. laureotica* which does not include any B chromosomes (Fig. 5). In the *Centaurea* group B chromosomes are generally very rare and regarding the Greek members of sect. *Acrolophus* (Georgiadis 1980) they have only been observed in *C. pannosa* DC. ($2n$ = 18 + 0–1B), *C. lacerata* (Hausskn.) Halácsy ($2n$ = 36 + 0–2B) and *C. peucedanifolia* Boiss. & Orph. ($2n$ = 18 + 0–2B). The origins of B chromosomes are not fully understood but they may be polyploidization byproducts coupled with genome rearrangements (Jones & Houben 2003, 2008).

Ecology and taxonomic affinities

The species was discovered along the dirt road leading to the peak Stroma (725 m) in the southern part of Mt Imittos, starting from elevations of 560 m up to the now-abandoned air base. The vegetation of southern Imittos is characterized by phrygana, *Quercus coccifera* scrub and a few, open stands of *Pinus halepensis* less than 5 m tall owing to the xeric conditions and steep eroded slopes. Evidence exists that even in antiquity, Imittos was more or less a bare mountain, exploited for marble and for whatever timber it could provide. Centuries of grazing and frequent devastation by fire have caused severe degradation of the flora (Gouvas 2001). The particular slopes around the biotope of *C. hymettia* are of exposed marble with sparse vegetation cover of *Quercus coccifera*, *Phlomis fruticosa*, *Euphorbia acanthothamnos* and a few pine trees. Not more than five plants of the new species, *C. hymettia*, were found in the phrygana along the dirt road and the entire known population consisting of *ca*. 600 plants, is restricted to the roadsides and the abandoned air base. The plants were accompanied by a few other species with the same stark ecological preferences, most notably the Greek endemics *Onosma kaheirei* and *Scabiosa hymettia*.

The presumed absence or rarity of *C. hymettia* from the southern slopes of Mt Imittos together with the large populations observed along a dirt road is not unexpected. One explanation for the delayed discovery of the species is the restriction of easy access to the area by the *ca*. 6 km long road leading to the air base; this is prohibited for vehicular traffic. Population duplication along roadsides has been noted within three years in the *Acrolophus* subgroup (Constantinids 2009). *Centaurea corensis* Vals. & Filigh. from Sardinia and Procida, a recently described tetraploid member of the same group, is also restricted to disturbed, anthropogenic sites and its recent origin has been postulated (Hilpold 2012). Plants with tetraploid cytotypes in this group have been shown to preferentially colonize drier and more open man-made microhabitats (Mráz & al. 2012). It is therefore possible that *C. hymettia* is either a species of recent origin or that it was originally a rare species and the closure of the dirt road and cessation of grazing in the area have protected the plants, giving them an advantage to increase their numbers.

Among the yellow-flowered relatives of *C. hymettia*, the species most similar to it in morphology and closest to it in location is *C. laureotica* which occurs

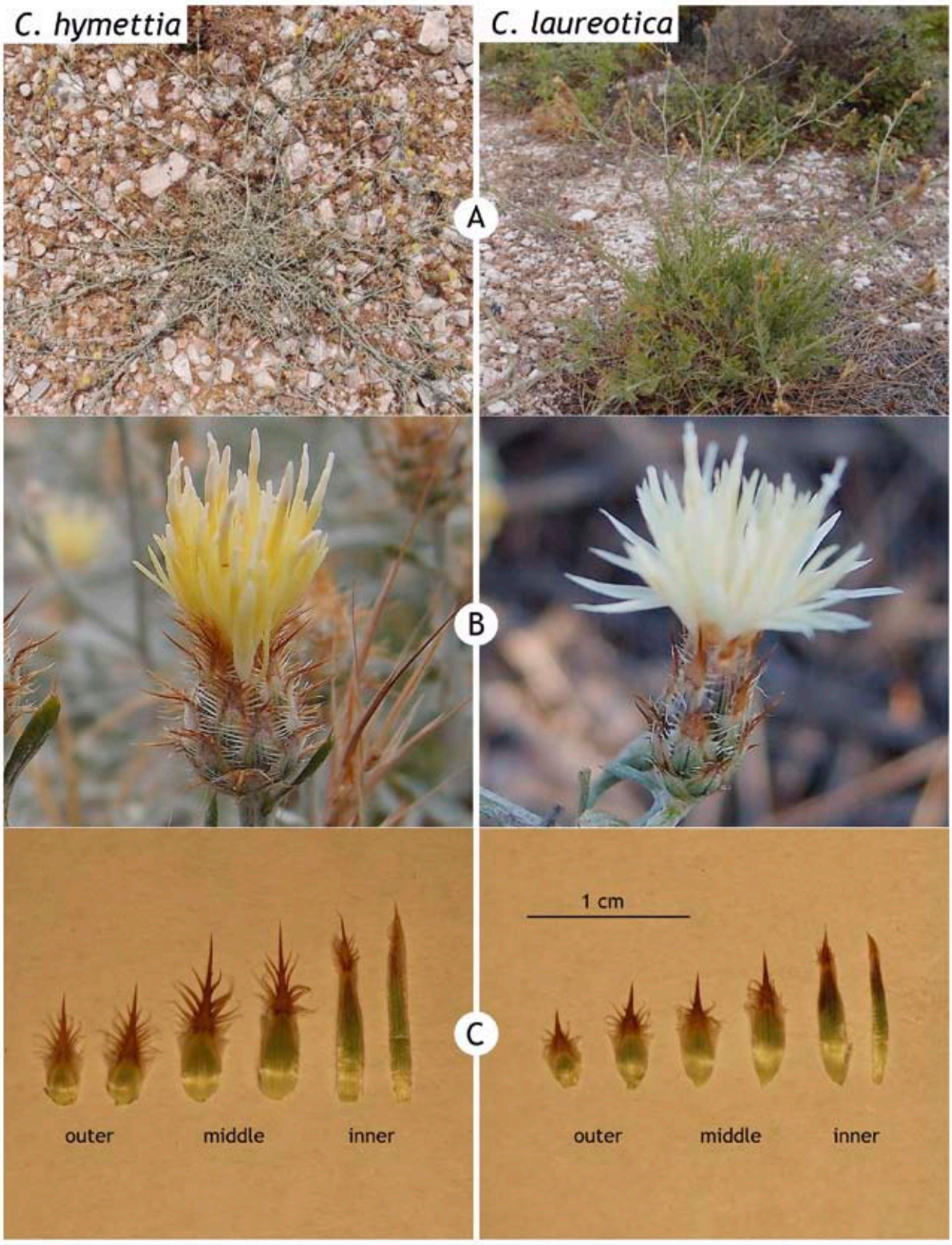

Fig. 2. *Centaurea hymettia* and *C. laureotica*: habit (A), capitula (B) and phyllaries (C).

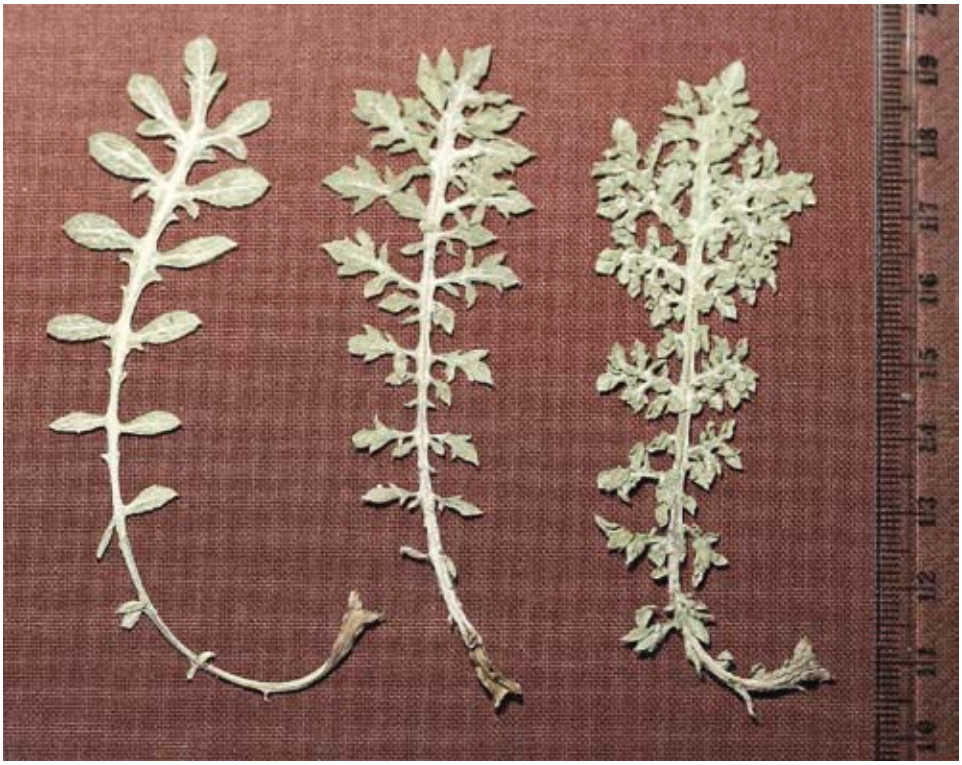

Fig. 3. *Centaurea hymettia*: 1- to 3-pinnatisect winter-rosette leaves. The 2-pinnatisect state is the most frequent. The leaf segments are broader than in late spring/summer-rosette leaves and the lanate indumentum less developed.

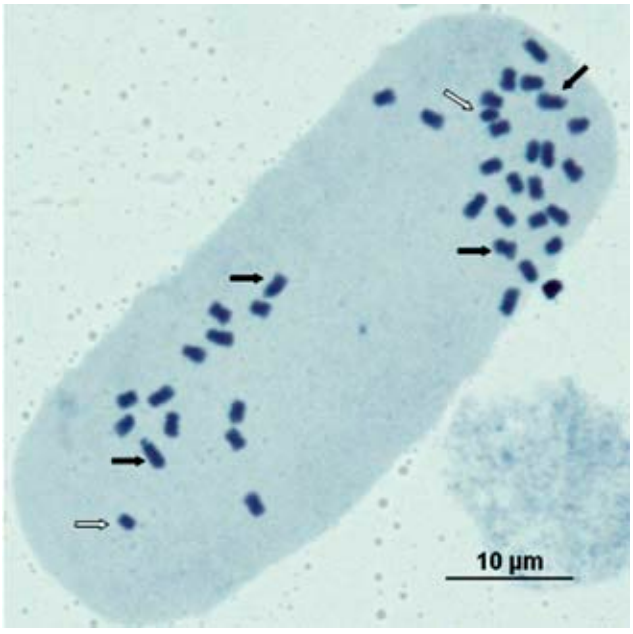

Fig. 4. *Centaurea hymettia* karyotype (B chromosomes white-arrowed, SAT black-arrowed).

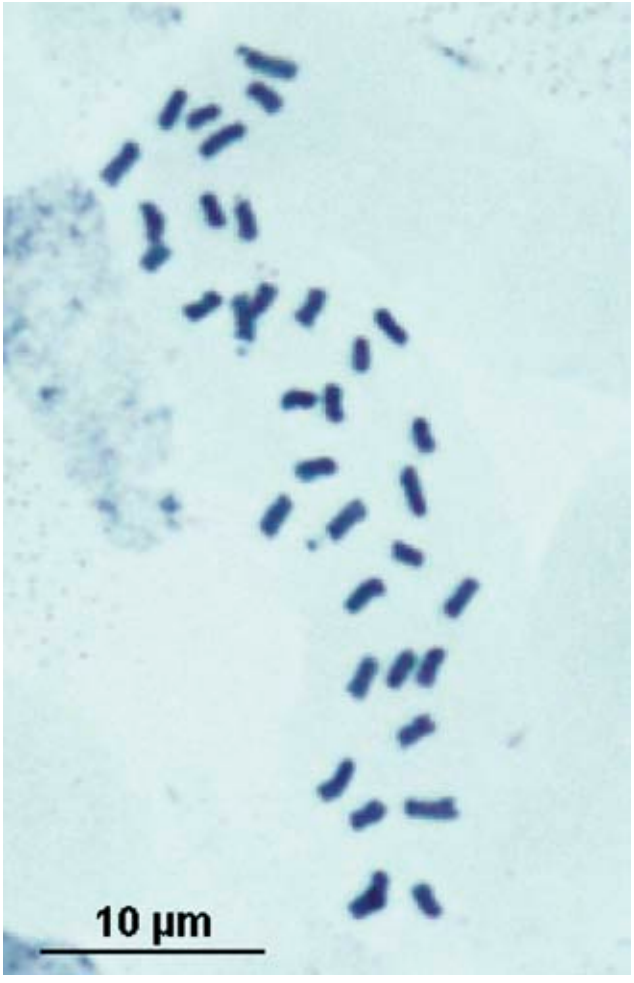

Fig. 5. *Centaurea laureotica* karyotype (absence of B chromosomes).

on the slopes surrounding the city of Lavrio (Lavreotiki) at the southeastern edge of Attica, *ca*. 30 km as the proverbial crow flies, i.e., in a straight line to the site of *C. hymettia* on Imittos. The two species are readily distinguished in their habitats since *C. hymettia* is a prostrate-decumbent, white-lanate plant (Figs. 1 & 2A) in contrast to the erect-ascending, greenish-scabrid *C. laureotica* (Fig. 2A). A closer look further reveals the distinct nature of *C. hymettia* as it has recurved appendages in late development. Leaf blade dissection and leaf segment size are other characters. *Centaurea hymettia* is almost consistently 2-pinnatisect to 1-pinnatisect with 6–9 primary segments on either side of the midrib whereas *C. laureotica* is often pinnatifid to 2-pinnatisect and rarely with more than 6 primary segments. The existence of *C. hymettia* plants with 3-pinnatisect leaves (Fig. 3) is noteworthy as 3-pinnatisect leaves have, to our knowledge, been seen only in *C. kalambakensis* Freyn & Sint. and *C. peucedanifolia* Boiss. & Orph. among the Greek taxa of this section. The differential characters of *C. hymettia* and *C. laureotica* are presented in Table 1.

Inflorescence and robustness are in general comparable between the two species but we should note a tendency for dichotomous branching in *C. laureotica*, a feature shared with the purple-flowered *C. attica* Nyman, a common species on the mountains of Attica. There is also a frequency of more stems with less capitula in *C. hymettia* versus fewer stems with more capitula in *C. laureotica*, which is most noticeable in robust individuals. *Centaurea hymettia* plants are characterized by procumbent to decumbent, prostrate stems which overlie each other in layers (Fig. 1). Moreover, habitat preferences are also different since *C. hymettia* is restricted to altitudes above 500 m, accompanied by the endemic *Onosma kaheirei* which is perhaps a good indicator species regarding the biotope's affinities. The hills of Lavrio where *C. laureotica* occurs do not exceed an elevation of 300 m. Within the populations of *C. laureotica*, plants with white or pink florets have been noted and named as *C. asperula* Halácsy. Georgiadis (1980) thus inferred that *C. laureotica* has been subjected to gene flow from tetraploid *C. attica* which is common above 300 m on Mts Imittos, Parnitha and Pendeli. Contrary to the situation in Lavrio, *C. hymettia* on Mt Imittos is always yellow-flowered. Given that neither B chromosomes have ever been found in either *C. attica* or *C. laureotica*, and no bicoloured florets, recurved appendages and spines more than 2.5 mm have ever been reported for the population of *C. attica* on Imittos we can conclude that *C. hymettia* appears genetically separate from both *C. attica* and *C. laureotica*.

Other related species to *C. hymettia* but with fewer morphological similarities are the hexaploid *C. carystea* from south Evvia, the tetraploid *C. mantoudii* from north Evvia and the diploid *C. pelia* from the central mainland. The two Evvian species are restricted to ser-

Table 1. Comparison of *Centaurea hymettia* and *C. laureotica*. Mean values and standard deviations in parentheses.

	Centaurea hymettia	***Centaurea laureotica***
Stems	procumbent to decumbent	erect to ascending
Number of capitula per stem	up to 30	up to 100
Indumentum	white-lanate	greenish-scabrid or weakly tomentose
Rosette leaves	pinnatisect to 3-pinnatisect	pinnatifid to 2-pinnatisect
Number of primary leaf segments	usually up to 9	4–6, rarely up to 9
Primary segments (mm)	2–16 × 1–5	2–20 × 1.5–9
Involucre shape	ovoid to broadly ovoid	ovoid or ellipsoid
Involucre size (mm)	10.5–14 × 8–14.8 [12.8 ± 1.3 × 10.6 ± 2.2]	10–14 × 5–8 [12.2 ± 1.4 × 6.1 ± 0.9]
Involucre width excl. appendages (mm)	5.2–6.7 [5.8 ± 0.5]	4–4.9 [4.4 ± 0.4]
Number of phyllaries	38–48 [43.4 ± 3.4]	35–44 [38.4 ± 3.4]
Middle phyllary (excl. appendage)	ovate	elliptic or ovate
Appendage of middle phyllary	erecto-patent to recurved	erect to erecto-patent
Size (mm)	3–6.5 × 3.5–4.5 [4.9 ± 0.8 × 4 ± 0.3]	2–4.9 × 2.8-3.5 [3.5 ± 0.8 × 2.9 ± 0.4]
Number of cilia on each side	5–8(13)	4–6
Spine length (mm)	1.8–4.5 [3.2 ± 0.7]	0.8–3.5 [2 ± 0.8]
Number of fertile florets	17–29 [21.5 ± 3.7]	12–20 [14.9 ± 2.5]
Corolla	yellow	yellow, pale yellow, white or pink
Habitat	limestone and marble slopes, above 500 m	various substrates, below 300 m
Chromosome number	36 + 2B	36

pentine and molecular studies place them apart from *C. laureotica* (Trigas & al. 2008), thus highlighting their insular isolation and giving some credit to recent findings suggesting that geography is a better predictor for affinities than morphology (Hilpold & al. 2012). *Centaurea mantoudii* is treated as a synonym of *C. laureotica* in the Euro+Med checklist (Greuter 2006) but we prefer to keep it as a separate taxon as also suggested by Trigas & al. (2008). Dimopoulos & al. (2013) dismisses *C. laureotica* as "doubtfully distinct from *C. pelia*" which, however, is not correct. *C. pelia* is a less robust plant with fewer stems, fewer capitula per stem and smaller involucres than *C. laureotica* and *C. hymettia*. Its wider distribution in Greece and its ploidy number (diploid) permits us to assume that this, or an ancient form of this species, has been the progenitor of both *C. hymettia* and *C. laureotica* through the process of polyploidization. An interesting question is whether the polyploidization event involved an additional diploid species (allopolyploidization) or not (autopolyploidization) and whether *C. hymettia* and *C. laureotica* have arisen from the same primary polyploidization event or not. Detailed molecular examinations (i.e., assaying ribotypes and cpDNA) may throw some light on these intriguing questions.

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