Botanical Journal of the Linnean Society, 2004, **146**, 375–383. With 6 figures

A new species of *Centaurea* (sect. *Phalolepis*, Compositae: Cardueae) from eastern Peloponnisos, Greece

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Received April 2004; accepted for publication June 2004

A new species of *Centaurea* L., ***Centaurea leonidia*** Kalpoutz. & Constantin., from two localities west and south-west of the town of Leonidio in eastern Peloponnisos, Greece, is described and illustrated. It belongs to *C*. sect. *Phalolepis*, and taxonomically its closest relatives are *C. heldreichii* Halácsy, a very localized species from south-west Sterea Ellas (Greece) and, surprisingly, *C. niederi* Heldr., which belongs to sect. *Acrolophus*. The new species is currently known from two populations of less than 100 individuals each, growing on almost inaccessible cliffs close to the convent of Agios Nikolaos Sintzas (St. Nicolas of Sintza) and the slopes of Poundes summit. Several other Greek endemic species are found in the same areas. *Centaurea leonidia* is scientifically important as it belongs to a small group of taxa, which, although they are members of sect. *Phalolepis*, have close allies in sect. *Acrolophus*. The chromosome number of *C. leonidia*, $2n = 18$, counted in root tips, is also reported and illustrated. *Botanical Journal of the Linnean Society*, 2004, **146**, 375–383.

ADDITIONAL KEYWORDS: Asteraceae – chromosome number – conservation – endemic species – *Flora Hellenica* – morphology – taxonomy.

INTRODUCTION

Centaurea L. (Compositae) is one of the richest genera in the flora of Greece. The total number of species and subspecies that grow in the country and are currently accepted by modern botanists is *c*. 140. A considerable portion of these taxa is endemic to the country or localized to a limited area, even a single mountain. The taxonomy of the genus is quite complicated, mostly because of the plasticity of morphological characters and the existing hybridization that has been observed even between species belonging to different groups (Georgiadis, 1981). Two sections of the Greek *Centaurea* species have been subjected to a critical revision, namely *C.* sect. *Acrolophus* (Georgiadis, 1980) and *C.* sect. *Acrocentron* (Wagenitz & Gamal-Eldin, 1985; Routsi, 1993). These sections include several local taxa. A third section, *C.* sect. *Phalolepis*, has not been revised recently but currently comprises *c*. 20 taxa in Greece, some of which have been described recently (Phitos & Constantinidis, 1993; Georgiadis, Dimitrellos & Routsi, 1996). About 15 species of these taxa are local endemics distributed in small areas.

The first observation that an interesting species of *Centaurea* grows on the rocks of eastern Peloponnisos was made by the first author, who brought rosette leaves and remnants of involucre bracts to the second author in autumn 2002. The species was subsequently monitored until the following May, when it flowered and a few complete herbarium specimens were collected. After careful examination it was realized that it constitutes a new, undescribed species that belongs to *C.* sect. *Phalolepis*. This species is described and illustrated here. It is the third in a series of endemic species (see Vassiliades & Persson, 2002; Constantinidis & Kalpoutzakis, in press) that has been found in

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Peloponnisos after the recent inventory of the endemic plant taxa of the area (Tan & Iatrou, 2001).

The new species of *Centaurea* was found during our current botanical work in Peloponnisos, which aims at a thorough floristic investigation of several important areas, mostly situated in the south and east parts of the region. Much of the resulting new floristic evidence that expands and enriches the plant life of Peloponnisos still remains unpublished.

MATERIAL AND METHODS

Living plants of *Centaurea leonidia* were examined in the field. Herbarium specimens of *C. leonidia* and its related species were studied and compared in the laboratory. Plant material consulted comes from the ACA, ATHU, B, C and UPA herbaria (herbarium acronyms according to Holmgren, Holmgren & Barnet, 1990). Owing to the inaccessibility of *C. leonidia*, collecting of ripe achenes of the species was difficult. Therefore, for karyological studies two young plants were transplanted from their rocky habitat and cultivated in pots with normal garden soil. The plants adapted well and provided fresh root tips, which were used for chromosomal examinations. To check chromosome number and morphology, root tips were pretreated with an aqueous solution of 8-hydroxyquinoline (0.3 g L^{-1}) for 3–3.5 h at room temperature. For further details of this procedure, see Constantinidis, Kamari & Phitos (1997). Photographs of metaphase plates were taken using a Sony CyberShot DSC-S75 digital camera.

RESULTS

CENTAUREA LEONIDIA KALPOUTZ. & CONSTANTIN. SP. NOV. (FIG. 1)

Type: GREECE: Peloponnisos: Nomos Arkadias, Eparchia Kinourias, Mt. Parnonas. The convent of Agios Nikolaos Sintzas, *c*. 6.4 km south-west of the town of Leonidion. Steep, calcareous rocks mostly to the north and north-east of the convent, 37°08′N, 22°49′E. *c*. 550–600 m a.s.l., 30.v.2003, leg. *Th. Constantinidis & E. Kalpoutzakis 10674*. (Holotype: ACA; isotype: UPA.)

Diagnosis: Affinis *Centaureae heldreichii* Halácsy, ab ea segmentis foliorum 4–6, latioribus (5–13 mm), appendicibus phyllorum mediorum involucri majoribus (5–7 mm longis), spinulis terminalibus longioribus (0.6–2.1 mm) specifice manifeste differt.

Description: Perennial herbs growing on rocks. CAUDEX suffruticose, greyish-brown, usually clothed with remnants of previous-years' leaves. Non-flowering plants with leaves in rosettes; rosettes one or usually more per individual, giving rise to 2–5 flowering stems 10–22 cm long growing lateral from the axils of the basal leaves of the rosette, each of them bearing 1–5 flowering heads. BASAL LEAVES white floccose, especially when young, latter sometimes pale green-whitish, tomentose; lamina broadly elliptic to obovate in outline, one-pinnatisect, 5.0–6.5 × 2.5–3.5 cm; petiole as long as or shorter than lamina, somewhat widening at base; leaf-lobes elliptic, 4–6 on each side, 1.3–3.2 × 0.5–1.3 cm, lower ones narrower, terminal one sometimes wider, all entire or more commonly remotely and shallowly denticulate-serrate; well-developed lobes bearing occasionally a small lobule at their base; CAULINE LEAVES like basal ones but gradually decreasing in size and number of lobes; uppermost entire, 1.2–2.8 × 0.3–0.7 cm. INVOLUCRE semiglobose to broadly ovoid, 1.2–1.6 × 1.2–1.8 cm. Involucral bracts green, striated, sparsely pubescent on their upper parts, the middle ones 7–13 × 6–7 mm; appendages of middle bracts 5–7 mm long, obovate to triangular, flat, slightly decurrent, comprising *c*. two-thirds of the bracts and usually completely covering them, with a wide, trigonous to ovate, brown to blackish-brown middle part and a membraneous, white to silvery, transparent marginal part, edges usually lacerate, upper part ending in a weak spinule or mucro 0.6–2.1 mm long, itself bearing 1–2 minute cilia; upper parts of the appendages occasionally with 1–4 cilia, otherwise cilia absent. COROLLA pink-purplish, glabrous but glandular; inner florets cylindrical, 16–17 mm long, with 5 lobes less than half as long as tube; outer florets cylindrical and expanded at limb, sterile, 20–23 mm, radiant, without staminodes, with 5 lobes c. half as long as tube and 0.4–0.7 mm wide. Stigma *c*. 3 mm. ACHENES (immature) sparsely hairy to glabrescent, 3.5–4.0 mm; pappus of several series of white, unequal, scabrid hairs; outer row up to 5.5 mm, longer than achene; inner much shorter, *c*. 1 mm long.

Etymology: The new species commemorates the small town of Leonidio. The area of Leonidio, together with the rocky slopes and the ravines to the south and south-west constitute a floristically important 'hot spot' in Peloponnisos, which has afforded a significant number of new plant taxa the last 20 years.

Habitat and ecology: Centaurea leonidia is an obligate chasmophyte and has been found growing only on steep, almost inaccessible cliffs. The plants form tufts of rosette leaves that grow on vertical or almost vertical rock faces. They bear a short or sometimes more elongate (in older plants) suffruticose caudex that emits new rosette leaves, especially where parts of the plant were destroyed or cut off. Its flowering stems are mostly ascending. Almost all the plants grow beyond the collecting ability of any botanist who is not trained

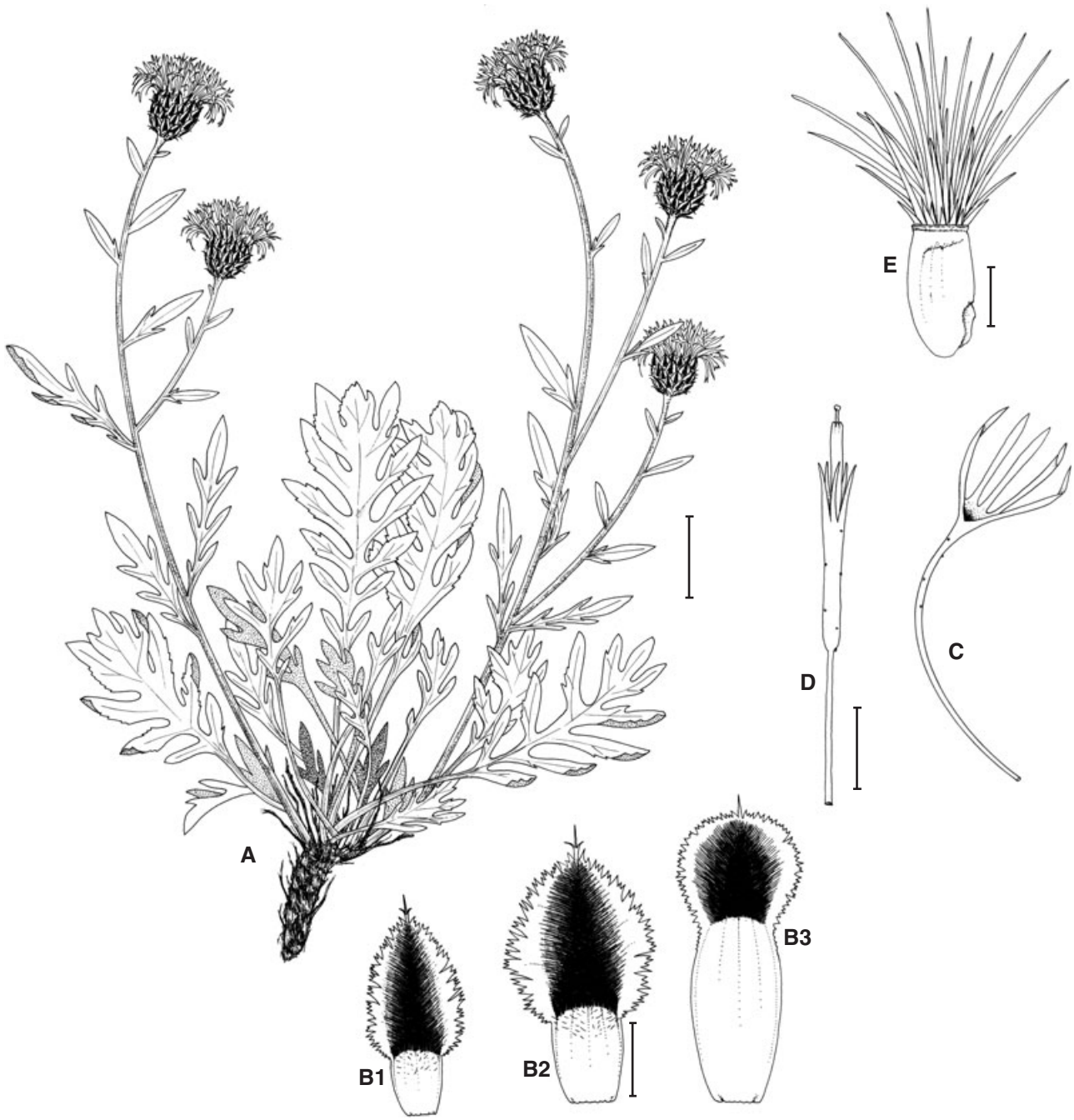

Figure 1. ***Centaurea leonidia*** Kalpoutz. & Constantin. **sp. nov.**: A, habit, scale bar = 2 cm; B, involucral bracts (B1 outer, B2 middle, B3 inner), scale bar = 2.5 mm; C, outer sterile floret, scale bar = 3.4 mm; D, disk floret, scale bar = 3.4 mm; E, achene, scale bar = 1.8 mm. Drawn from *Th. Constantinidis & E. Kalpoutzakis 10674*.

in climbing techniques. Likewise, the plants cannot be reached by domestic herbivorous animals (goats and sheep) that often frequent the cliff bases.

The two hard limestone cliff systems that harbour *C. leonidia* extend from *c*. 400–450 to 700–750 m a.s.l. and face east to south-east or south. A considerable area of their surface offers very few protuberances and clefts, especially where *C. leonidia* is found, and is therefore sparsely colonized by plant species. Several endemic and noteworthy taxa grow together with *C. leonidia.* These include (Greek endemic taxa marked with an asterisk) **Asperula taygetea* Boiss. &

Heldr., *Aurinia saxatilis* (L.) Desv. ssp. *orientalis* (Ard.) T.R. Dudley, **Brassica cretica* Lam. ssp. *laconica* M.A. Gust. & Snogerup, *Capparis spinosa* L. *s.l.*, **Centaurea laconica* Boiss. ssp. *laconica*, **Erysimum corinthium* (Boiss.) Wettst., **Inula verbascifolia* (Willd.) Hausskn. ssp. *methanea* (Hausskn.) Tutin, **Petrorhagia grandiflora* Iatrou, *Ptilostemon chamaepeuce* (L.) Less., **Stachys chrysantha* Boiss. & Heldr., **Teucrium francisci-werneri* Rech. f., etc. The bottom and certain less inclined parts of the cliffs harbour some woody vegetation consisting of *Acer sempervirens* L., *Ceratonia siliqua* L., *Fraxinus ornus* L., *Globularia alypum* L., *Phillyrea latifolia* L., *Phlomis fruticosa* L., *Pistacia lentiscus* L., *Quercus coccifera* L., *Q. ilex* L., etc.

Centaurea leonidia has been collected at *c*. 450–550 m and its populations reach 600–650 m a.s.l. It flowers in late May to June and ripe achenes are found from late June to early July.

Distribution: The new species is currently known from only two localities of eastern Peloponnisos (Fig. 2). The type locality is *c*. 6.4 km south-west of Leonidio. The second locality, discovered by the first author, lies *c*. 2–3 km west-north-west of Leonidio, on the slopes of Poundes summit (37°10′N, 22°50′E, corresponding voucher: *Constantinidis & Kalpoutzakis 11000*, ACA). Following an intense investigation of the second locality *C. leonidia* was found growing rather rarely, on a few rocks along a cliff system *c*. 1 km long. In its *locus classicus* the species inhabits only a small part of the cliff and is not further spread. Although, as currently known, the species seems to be extremely localized to parts of two cliffs only, further populations in the area cannot be ruled out.

Conservation: Centaurea leonidia is a rare and extremely localized species that should be classified as Endangered (EN), according to the IUCN (2001) categories. It has an area of occupancy of less than 500 km^2 and is known to exist at no more than five locations (criterion B1). Its total population is estimated at < 2500 mature individuals and the subpopulations are severely fragmented (criterion C2a).

According to our field observations we estimate that the total number of mature individuals of *C. leonidia*

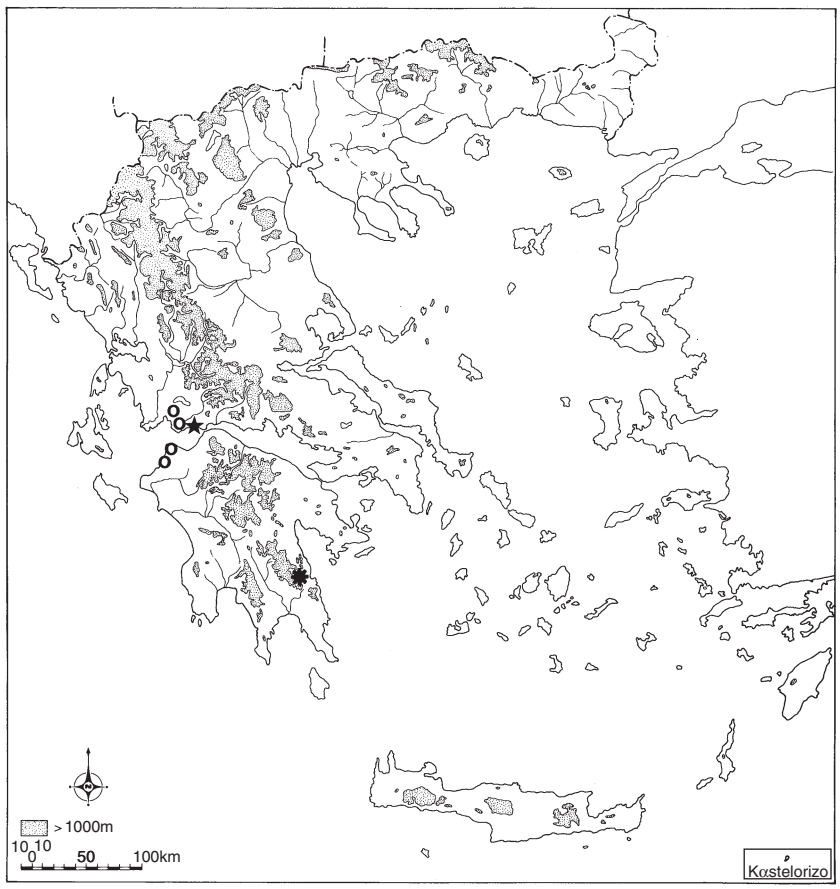

Figure 2. Total known distribution of ***Centaurea leonidia*** (hexagram) and the related species *C. heldreichii* (star) and *C. niederi* (open circles). The three species are local Greek endemics.

does not exceed 100 in each locality. This very small number does not secure the unhindered survival of the species in the long term. Genetic erosion or any stochastic phenomena are two possible threats that may affect population size and the overall survival of *C. leonidia* in the future.

The inaccessible area that *C. leonidia* occupies offers some protection from any human interference and constitutes a safe refuge for the species. However, the first author observed climbing activity on the cliffs where the species grows, which was intended at investigating certain caves mentioned in ancient Greek literature. Any such activity, especially if intensified, may cause a serious and unexpected threat for the species.

The expansion of the known populations of *C. leonidia* necessitates the establishment of new individuals on the steep rock. This is a highly tricky procedure because the achenes of the species are rather heavy and the availability of suitable fissures or rock cracks on the cliff is very limited. Furthermore, other chasmophytic plant species (see habitat and ecology) compete with *C. leonidia* for the same ecological niche. We observed very few juvenile plants in the two localities and estimated that the regeneration rate for the two known populations should be quite low. Indeed, most of the plants observed appear to be quite old and any new individuals attempting to establish at the cliff bases are unlike to survive intense grazing by domestic herbivores that visit the areas at regular intervals. The two known populations would certainly shrivel further should any intentional or unintentional activity affect the extant *C. leonidia* plants.

The ravine close to the convent of Agios Nikolaos Sintzas is a bifurcation of the ravine of Leonidio, which has its upper part near the village of Kosmas and ends close to the town of Leonidio. The cliffs of Poundes summit are also part of the same ravine. This area has been identified for legal protection and is included in the Natura 2000 net of ecologically important areas of Greece. The protection of its habitats would certainly have a beneficial effect on the populations of *C. leonidia,* and this is equally true for either the two known populations or any other population that may exist on neighbouring cliff systems.

TAXONOMIC DISCUSSION

THE POSITION OF *CENTAUREA LEONIDIA* IN SECTION *PHALOLEPIS*

A significant number of species in *Centaurea* sect. *Phalolepis* are found in the Balkan Peninsula and Turkey. These can be divided into two informal groups, differing in several aspects of their morphological and biological traits (Matthäs, 1981). *Centaurea leonidia* clearly belongs to the group that comprises low-growing, perennial taxa of natural habitats, with large involucres, whose bracts are spreading in fruit, and with achenes having a long pappus. This group includes several endemic species occurring in distinct, isolated populations that are distinguished by small but constant morphological features. In most cases, the differentiation exhibited is sufficient to warrant recognition at specific level. We do not accept the opinion expressed by Dostál (1976), who treated many quite different species of this group as geographical variants of one species, *C. alba* L. In his taxonomic proposal (Dostál, 1976), *C. alba* with its 20 subspecies consists a highly heterogeneous and unnatural unit. A second group in section *Phalolepis* consists of taller, more widespread, occasionally weedy biennials with ovoid to cylindrical capitula, which remain closed even in fruit and with smaller achenes having a short pappus or being epappose.

Many representatives of *Centaurea* sect. *Phalolepis* in Greece belong to the first group. Among these are several very rare species, even species considered extinct for almost one and a half centuries and recently rediscovered (Constantinidis & Vassiliades, 1996). *Centaurea leonidia* forms a small group together with *C. heldreichii* Halácsy, sharing with it common features but differing in distinct morphological characters and a separate geographical distribution.

TAXONOMIC COMPARISONS WITH RELATED SPECIES

Based on morphological characters, the closest ally of *Centaurea leonidia* is *C. heldreichii*, an equally rare species of very local distribution. The main differences between *C. leonidia* and *C. heldreichii* are found in the form of the leaves (Table 1, Fig. 3) and in the shape of the involucral bracts (Table 1, Fig. 4). In *C. heldreichii* the basal leaves, especially the inner ones, are clearly two-pinnatisect, with many narrow and rather remote segments. Well-developed leaves may have 7–12 or more primary lobes on each side. In *C. leonidia* all the basal leaves are mostly one-pinnatisect, with broader, more densely arranged lobes. Leaf rachis is wider, and there are 4–6 lobes on each leaf side. The median involucral bracts of *C. heldreichii* bear an almost orbicular, convex appendage that covers around half of the bract. The hyaline margins are wide, start rather abruptly from the middle of the bract and the central, almost triangular dark brown to blackish part is narrow. The appendage ends in a small or indistinct mucro. The median bracts of *C. leonidia* are larger, with an ovate to triangular, flat appendage that covers nearly two-thirds of the bract. The hyaline margins are narrower, shortly decurrent and start more

Table 1. Most important morphological differences between ***Centaurea leonidia*** and its relatives, C. heldreichii and C. niederi

Characters	***C. leonidia***	*C. heldreichii*	*C. niederi*
Inner rosette leaves	Mostly 1-pinnatisect, lobes sometimes with a basal lobule	2-pinnate	1–2-pinnate
Rachis	3–6 mm wide	1.5–3 mm wide	1.5–5 mm wide
Number of lobes per side	4–6	6–13	4–10
Primary lobes of basal leaves	Obovate to elliptic	Elliptic to narrowly elliptic	Ovate to elliptic
Size (mm)	13–32 × 5–13	10–40 × 1.5–4.5	11–35 × 4–12
Capitula per stem	1–4	1–17	2–20
Middle involucral bracts	Phalolepis type	Phalolepis type	Acrolophus type
Appendages	covering *c*. 2/3 of bract, slightly decurrent	covering *c*. 1/2 of bract, usually not decurrent	covering *c*. 1/2 of bract, decurrent
Cilia	Absent or 1–2 pairs on upper part	Absent	Well-developed
Mucro (mm)	0.6–2.1	0.3–0.6	2.0–4.3
Outer surface	With sparse hairs	With sessile glands	With sparse hairs

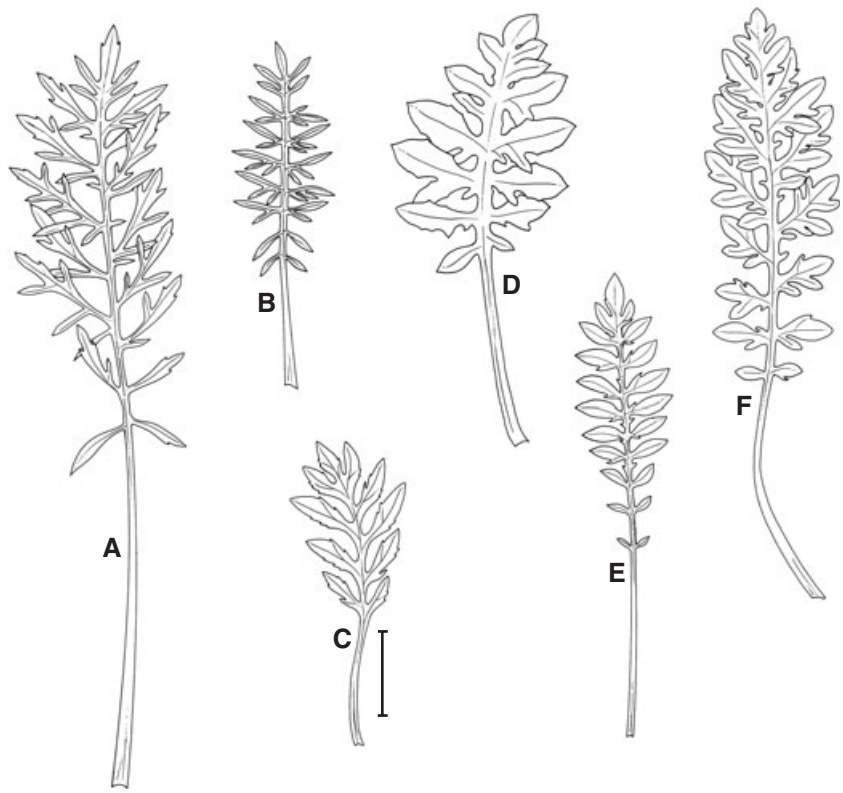

Figure 3. Inner rosette leaves of *Centaurea heldreichii* (A, B), ***C. leonidia*** (C, D) and *C. niederi* (E, F). Scale bar = 2 cm.

evenly from the lower third of the bract. The central, dark brown to blackish part may either be similar to *C. heldreichii* or more expanded, covering the largest part of the appendage. The mucro or spinule is generally well developed, longer than in *C. heldreichii* and bears a couple of short cilia near its base. Rarely, there may be 1–4 additional cilia below the mucro.

Centaurea leonidia shows rather superficial similarities with *C. deustiformis* Adamović, a species which

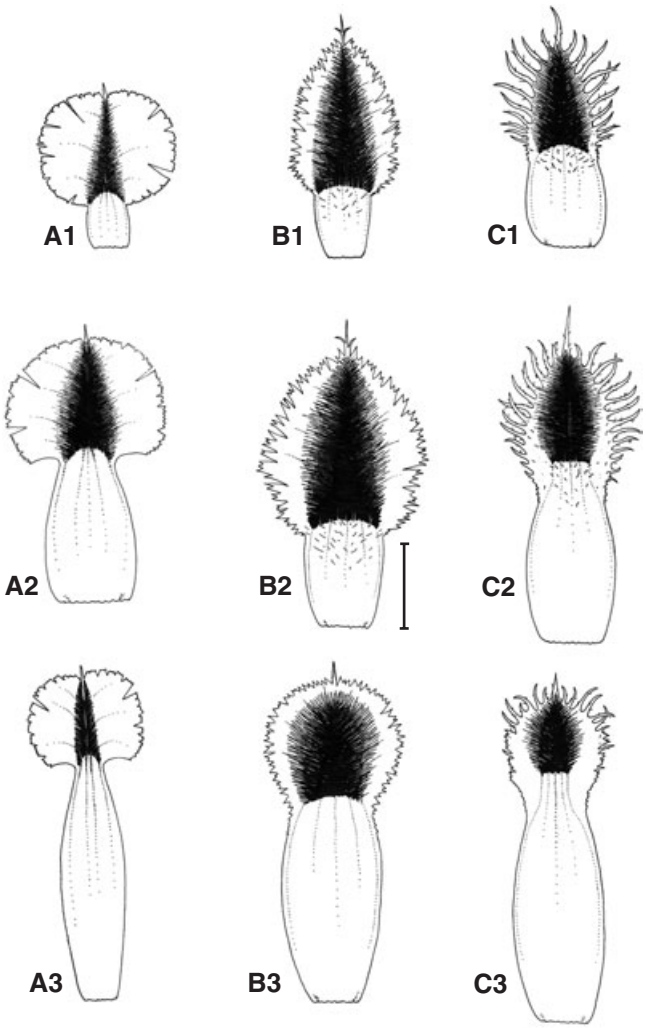

Figure 4. Involucral bracts (1 = outer, 2 = middle, 3 = inner) of *Centaurea heldreichii* (A), ***C. leonidia*** (B) and *C. niederi* (C). Scale bar = 2.5 mm.

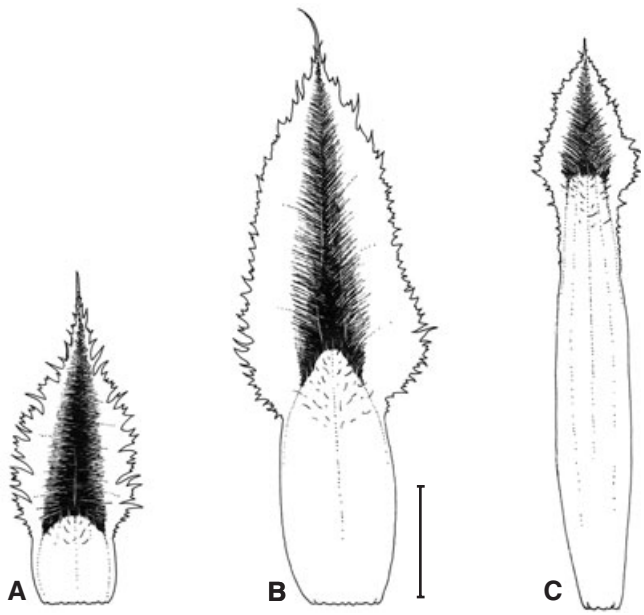

Figure 5. Involucral bracts (A = outer, B = middle, C = inner) of *Centaurea leonidia* drawn from *Th. Constantinidis & E. Kalpoutzakis 11000* (slopes of Poundes summit). Scale bar = 3.0 mm.

also has long appendages of middle involucral bracts. The latter species differs among others in having a different indumentum (sparsely arachnoid with short, stiff hairs), narrow leaf segments and a short pappus with hairs <2.5 mm long.

It is worth noting here that *C. leonidia* also shares remarkable similarities with *C. niederi* Heldr., although the latter is a member of *C.* sect. *Acrolophus*. In fact, the two species look quite alike at a first glance, as *C. niederi* has less dissected leaves with broader lobes and flat, long appendages like those of *C. leonidia*. The existence of several cilia and the long mucro in the more or less pubescent appendages of *C. niederi*, however, allow its safe distinction from *C. leonidia* (Fig. 4).

The morphological similarity between *C. leonidia* and *C. niederi* is scientifically important and stresses the issue of close affinity between species belonging to sect. *Phalolepis* and members of sect. *Acrolophus*. Wagenitz (1989) commented extensively on this matter and reported case studies of several closely related species pairs, one traditionally placed in sect. *Acrolophus*, the other in sect. *Phalolepis*. As these pairs often grow in neighbouring areas they may have arisen directly from a common ancestor and this would indicate very close phylogenetic relationships. Alternatively, the distinction between these groups, based on appendage morphology, may be artificial (Wagenitz & Hellwig, 1996). As evidence of close morphological similarity between species of the two aforementioned sections is accumulated, it may be necessary to adopt a wider view and unite the two sections under a common category. Therefore, *C. leonidia* and other members of sect. *Phalolepis,* which have close resemblance to species of sect. *Acrolophus*, will be useful plants in any future investigation into the taxonomic and phylogenetic relationships within the genus *Centaurea*.

INTRASPECIFIC VARIATION

The two known populations of *Centaurea leonidia* present several noteworthy morphological differences, especially in the form and placement of the involucral bracts. The plants close to the Sintzas convent have shorter bracts (7–9 mm), with ovate appendages. Each appendage completely covers the lower part of the next bract and bears a mucro rarely longer than

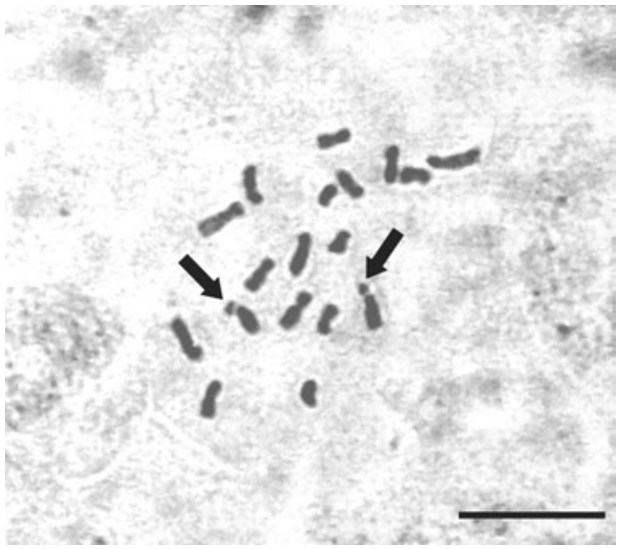

Figure 6. A chromosome metaphase plate of ***Centaurea leonidia*** with $2n = 18$. The satellites observed on a chromosome couple are marked with arrows. Scale bar = 10 μm.

1.5 mm. The plants growing on the slopes of Poundes, however, have longer (8–13 mm) and more attenuate bracts with ovate-triangular appendages and a long mucro reaching 2.1 mm (Fig. 5). In some cases the lower part of the bracts may be visible among the appendages. These bracts approach those of *C. niederi* more strongly but they lack well-developed cilia along the margins.

PHYTOGEOGRAPHY

Most species of *Centaurea* sect. *Phalolepis* in Greece are concentrated in the north-western parts of the country. Their number decreases rapidly in the southern and insular (especially Aegean) parts, with no member of the section known on the island of Crete. The discovery of a *Phalolepis* species in the south-east part of the mainland was rather unexpected and immediately raised suspicions that it would involve a still undescribed taxon. To our knowledge, *C. leonidia* is the first record of its section in Peloponnisos. The related species *C. heldreichii* and *C. niederi* are known from the south-western parts of Sterea Ellas and north-western Peloponnisos (Fig. 2). More precisely, *C. heldreichii* occurs on the rocks and cliffs of Mt. Paliovouna, near the villages of Vasiliki and Krioneri, opposite the city of Patras (western Sterea Ellas). It is a very local endemic that prefers similar habitats as those of *C. leonidia* but generally at lower altitude. *Centaurea niederi* is slightly more widespread, known from rocky slopes and cliffs of Mt Paliovouna and Mt Arakinthos in Sterea Ellas and Mt. Mavro Vouno with its neighbouring rocky hills in north-western Peloponnisos.

KARYOLOGY

Two plants of *Centaurea leonidia* were used for chromosome studies. We found the constant chromosome number of $2n = 18$ in all metaphase plates examined (Fig. 6). The species is therefore diploid, based on $x = 9$. The chromosomes are generally small and their morphology difficult to determine. However, metacentric, submetacentric and acrocentric chromosomes exist in the complement. Two distinct satellites mark a couple of apparently submetacentric chromosomes. The same number of $2n = 18$ has been found in the related *C. heldreichii* (Phitos & Damboldt, 1976) and *C. niederi* of section *Acrolophus* (Georgiadis & Phitos, 1976). Therefore, no differences in chromosome number and ploidy level were observed between *C. leonidia* and its relatives.

The uniform basic number of $x = 9$ characterizes the species of *Centaurea* sections *Acrolophus* and *Phalolepis*, with diploids, tetraploids and hexaploids having been recorded in Greece. This number is considered an advanced feature in the groups of Centaureinae (Garcia Jacas, Susanna & Ilarslan, 1996) and corresponds well with other morphologically derived characters. A comparatively recent evolutionary history of the group partly explains the diversity and the difficulty of classification observed in Greek representatives of these two sections.

ACKNOWLEDGEMENTS

We thank the curators and directors of ATHU, B, C and UPA for allowing access to their botanical collections and sending specimens on loan. We also thank Prof. Emer. D. Phitos for the Latin description of the species, Prof. G. Kamari for comments on the chromosome morphology, Ms Zoe Tziakou for the illustrations and Dr G. Liakopoulos for assisting with the recording of the chromosome metaphase plate.

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