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Morphology, Anatomy, Ecology, Pollen and Achene Features of *Centaurea polyclada* DC. (Sect. *Acrolophus*) in Turkey

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Abstract: *Centaurea polyclada* DC is an endemic species belonging to the family *Compositae* (*Asteraceae*) Sect. *Acrolophus*. Morphology, anatomy, ecology, pollen and achene features of the species have been studied. *C. polyclada* is a perennial species growing up 60 cm height. Leaf segments and involucre bracts are in different shape at the base and upper part. The root xylem and leaf mesophyll contain secretory canals. Spongy parenchyma in the leaf is highly reduced. The stem epidermis has papilla like ejections. The pollen is tricolporate. *C. polyclada* grows in the soil poor in calcium, medium in phosphorus and rich in organic matter content.

Key words: *Centaurea polyclada*, morphology, anatomy, ecology

INTRODUCTION

The genus *Centaurea* L. (*Compositae*) is represented by 500-600 taxa in the world^[1-3]. Endemism rate of the genus in Turkey is very high (60.7%)^[4-8]. 114 of the total 187 taxa are known to be endemic to the country. The fact that it has a high proportion of endemism, strengthen the opinion that the gene centre of *Centaurea* is Turkey. *Centaurea* is the third richest genus among the genera found in the Turkish Flora after *Astragalus* and *Verbascum*. The aim of this original investigation is to put forth morphological, polynological, anatomical and ecological features of the species for the first time.

MATERIALS AND METHODS

Soil and plants specimens used in this study were collected from Çanakkale in 1989. Herbarium specimens are preserved in the in the Herbarium of Biology Department at Canakkale Onsekiz Mart University. Voucher specimens: Turkey, A1(A), Canakkale, Biga, Karabiga, 1100 m, NE step (on south-west slopes), 11.07.1989, Uysal 9. The morphological observations and biometric measurements were made on fresh as well as herbarium specimens. A total of 30 measurements results were evaluated statistically. For SEM study, dry pollen grains were transferred to stubs and coated with gold for studying and taking pictures of the pollen grains. A jeol 100 x CXII scanning electron microscope was used. The

terminology used is mainly that of Punt *et al.*^[9]. For anatomical studies, plant parts fixed in 70% alcohol were used. Cross sections of root, stem and leaf were taken with the help of Rotary Microtom in 7 µ thickness and stained by safranin and crystal violet. Investigations were carried out under a light microscope and photographs taken by a microphotography apparatus (JENA). For soil and plant analysis methods outlined by Ozturk *et al.*^[10] in detail were used. Soil samples were examined according to Bouyoucos^[11] and Wakley-Black^[12]. Maximum water holding capacity, pH (±0.01) amount of organic matter, salt, potassium, CaCO₃, nitrogen and phosphorus of the soil samples were measured.

RESULTS

Morphological characteristics: Perennial (or sometimes only biennial). Stem erect, 25-60 cm, profusely and divarcatly branched, primary branches long, capitula at least partly on very short secondary (or tertiary) branches (Fig. 1A and B). Leaves scabrous below, arachnoid to tomentose above, lower 1-2 pinnatifid, median pinnatifid with linear segments 1-1.8(-2) mm broad, upper leaves linear, Involucre 7.5-10x3.8-5 (-6.4) mm, ovoid to conical (contracted towards top); phyllaries glabrous, smooth or slightly ribbed. Involucral bracts are differently shaped at the base, in the middle and at the upper part (Fig. 1C_{1,3}). Appendages very small to minute, straw-coloured, with 3-5 cilia (0.3-1 mm) on each side or

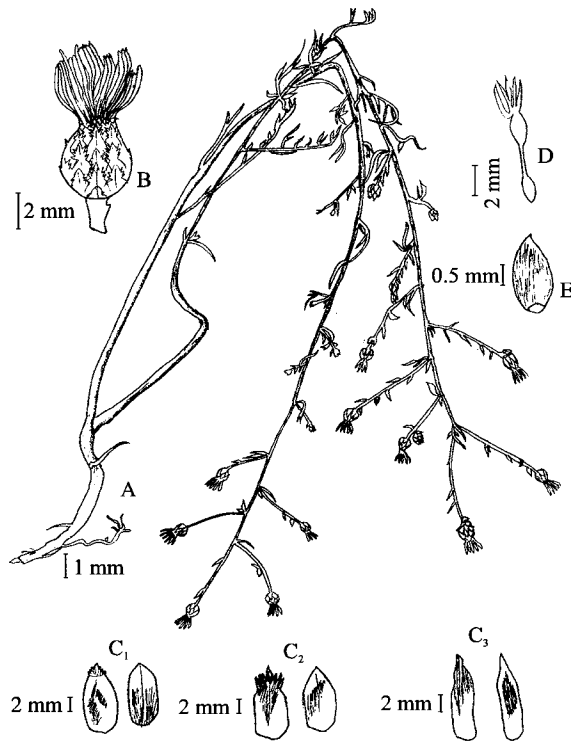


Fig. 1: *Centaurea polyclada* DC. A. General view. B. Capitulum C₁. Involucre bracts at the base. C₂. Involucre bracts in the middle C₃. Involucre bracts at the upper part. D. Flower E. Seed

with nearly entire border, ending in a 0.3-1 mm mucro. Flowers rose-purple, in capitulum and tubular (Fig. 1B and D). Fruits achene, achenes 1.6-5 mm, with 2-3 carpels, pappus absent or few minute scales (scarcely 0.5 mm). the surface of seeds is serrated (Fig. 1E). Achenes surface is with hair (Fig. 2a-d).

Achene: Achene is slightly obovate-rectangular and very slightly compressed on both sides. Apex of the achene is semi-circular. It is generally very small, 1.6-5 mm. Achene is without pappus or very rarely with 0.5 mm scales. The SEM study showed that all cells form a striate structure and strongly depressed on both dorsal and margin surfaces. Indumentum is sparsely long hairy and it seems that achene is glabrescent. Attachment of achene to capitulum is large V shaped.

Pollen grains: The pollen grain in *C. polyclada* is tricolporate. The detailed features of pollen are as follows: polar axis (P) 20,00 μ m, equatorial axis (E) 15,00 μ m, P/E 1,33, prolate; colpi tapering at both ends; spinulose, spinules sparsely distributed, width of the spinules at

base (W) 2,000 μ m, height of the spinules (H) 1,00 μ m, W/H 2,00, very large at base, apices sharp, with basal and subapical perforations, pores irregularly distributed (Fig. 3).

Anatomical characteristics

Root anatomy: *C. polyclada* is a perennial endemic species. A disintegrated periderm is present on outermost layer as a protective tissue, followed by a single layer of depressed epidermal cells. Below it, lies a cortex tissue with thin long and flattened but thick walled cells. The cortex covers a wide arcade up to the endodermis. There are groups of sclerenchyma cells in the cortex tissue. The phloem take place a small part in the vascular bundles, whereas xylem with tracheids, trachea and sclerenchymatic cells covers most of the bundles. There are secretory canals in the xylem tissue. The xylem is distributed all around the pith (Fig. 4a).

Stem anatomy: On outermost a thick cuticle layer is found, followed by single layered epidermis. Epidermis has abundant, thin and single glandular hairs. In addition, the epidermis has papilla like ejections and amaryllis type stomata. Chloronchymatic tissue with 3-4 layers covers a small area under epidermis. Below, endodermis lies and then groups of sclerenchyma cells. There are medullary rays with groups of sclerenchyma cells. Vascular bundles are scattered in a circular form after sclerenchymatic tissue with phloem on outer side and xylem inner. There are sclerenchymatic cells in the xylem tissue. Cambium is in depressed form. Pith is parenchymatous (Fig. 4b).

Leaf anatomy (leaflet): Leaf is equifacial with palisade on upper as well as lower layers. After spongy parenchyma we found 1-2 layered palisade parenchyma next to lower epidermis. A wavy thick cuticle lies on upper side with silicified epidermis. Spongy parenchyma occupies a small part and is highly reduced as in the other xerophytes (Fig. 4a). Spherical and one or two-three celled hairs cover the surface of the epidermis. A glandular hair and xerophytic stomata lie on both upper and lower surface of leaf (Fig. 4b). The largest bundle is present in the midvein and are secretory canals in leaf mesophyll.

Ecological characteristics: This endemic species distributed in the Northwest Anatolia and Northwest Aegean regions. It is a Mediterranean phytogeographic element. *C. polyclada* generally grows under *Pinus brutia* forests, macchies and dry meadows with *Cistus laurifolius* and *Centaurea solstitialis*. *C. polyclada* prefers soils with pH of 6.23, non-saline, CaCO₃ content being 0.21%. Texture of its soils, is sandy and maximum

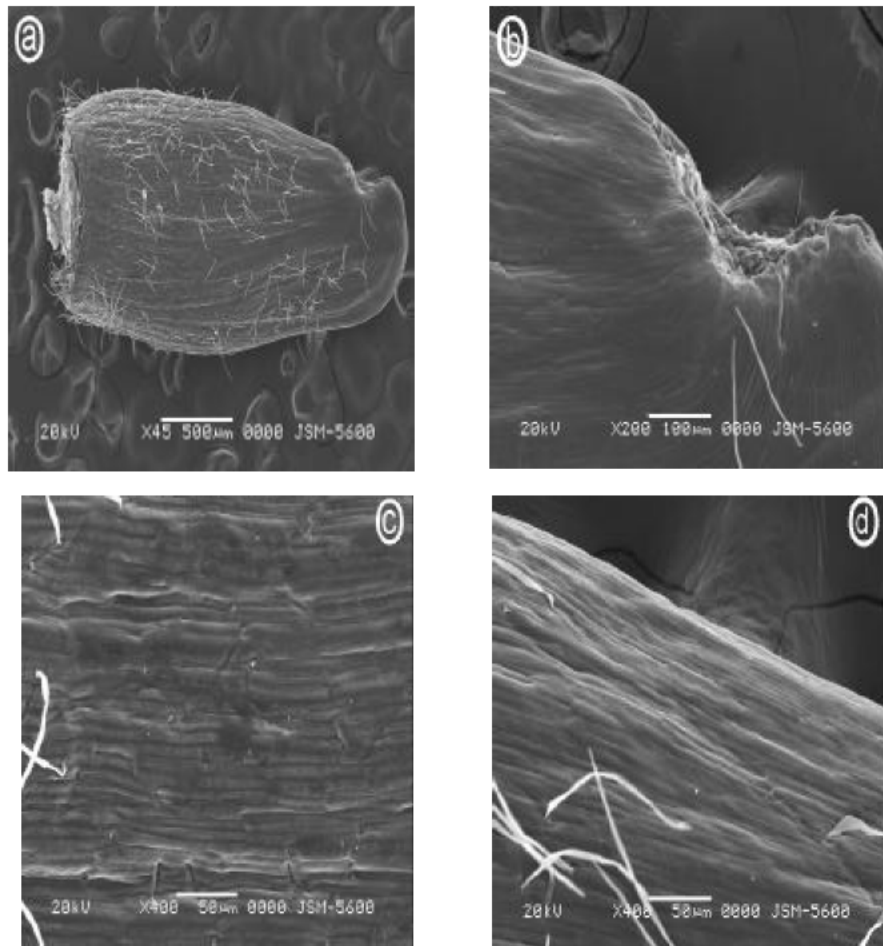


Fig. 2: *Centaurea polyclada* DC. achene pictures: a) General view of the achene, b) Dorsal surface, c) Margin surface, d) Attachment point

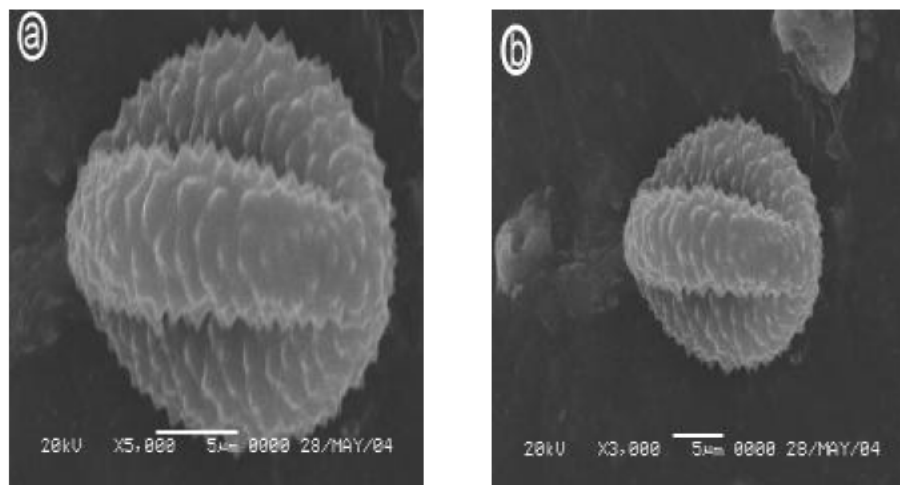


Fig. 3: *Centaurea polyclada* DC. pollen grain. a) General view of the pollen grain (3000X) showing the colpi, b) Spinulose pollen surface (6000X)

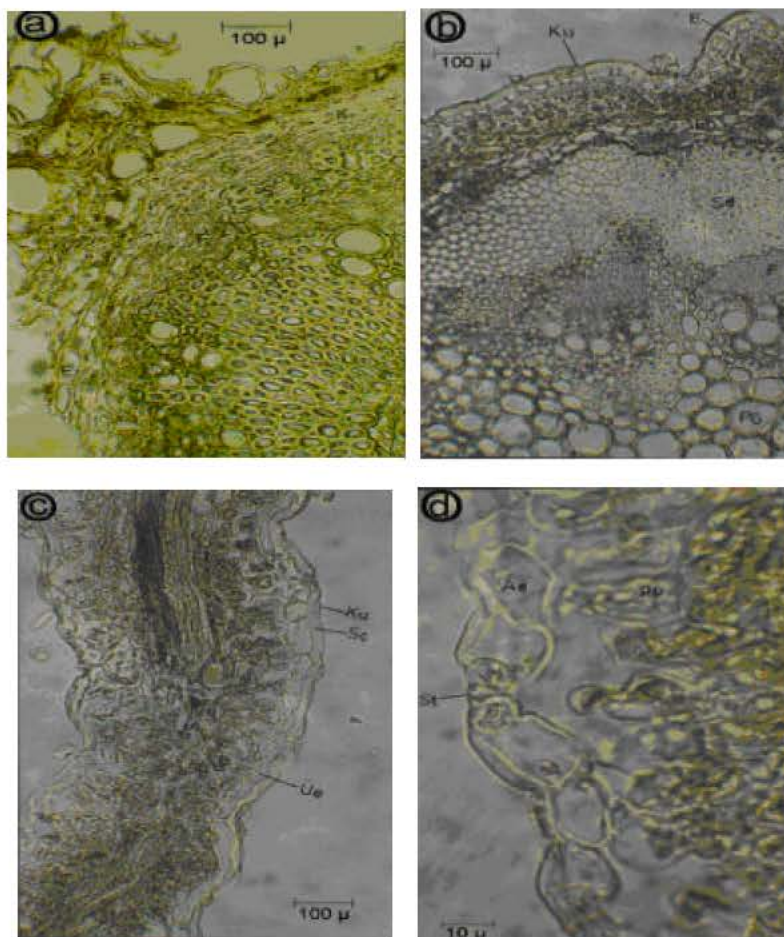


Fig. 4: *Centaurea polyclada* DC. a) Transverse section of root. (10x6,3). b) Transverse section of stem (10x6,3). c) Transverse section of leaf (10x6,3). d) Stomata in the leaf section (40x6,3) (Ek: Exodermis, K: Corteks X: Xylem Fl: Phloem S: Sclerenchyma Ku: Cuticle E: Epidermis En: Endodermis, Kd: Chlorenchymatic tissuse, Sd: Sclerenchymatic group, Po: Prenychmatic pith, Ue: Upper epidermis, pp: Palisade parenchyma, Sp: Spongy parenchyma, Sc: Silicified wall of cell, St: Stomata)

water holding capacity is 14.1%. Chemical analysis of the soil show that it comprises nitrogen 0.056%, phosphorus 0.015%, potassium 0.10% and organic matter content 3.491%.

DISCUSSION

Centaurea polyclada is a perennial species, with 25-60 cm height and branches at the upper part of the stem. Flowers are in a capitulum. Leaf segments and involucre bracts are different in shape at the base and upper part. Groups of sclerenchyma cells in the stem are situated under endodermis. The root xylem and leaf mesophyll contains secretory canals and stem epidermis has papilla like ejections. The importance of leaf anatomy

in *Centaurea derderifolia* and *Centaurea saligna* was reported by Kaya^[13]. Spongy parenchyma in the leaf is highly reduced as in the other xerophytes. It was determined that *C. polyclada* grows in low acidic soil without saline and poor CaCO₃ content. Texture of the soil is sandy and maximum water holding capacity is 14.1%. Chemical analysis of the soil show that it is rich in organic matter content, medium in nitrogen, medium degree rich in phosphorus, poor in potassium. Ecological characteristics of the species are in full agreement with its anatomical behaviours. The achene is slightly obovate-rectangular. It differs from the achenes of some other species of the genus *Centaurea* in having long hairs on the surface. Also the achene has a striate surface formed by depression of cells. The pollen grain is tricolporate and

distinctly spinulose as in many other members of the family *Compositae*^[14]. The achene is slightly obovate-rectangular. It differs from the achenes of some.

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