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Morphology, Anatomy, Ecology, Pollen and Achene Structure of *Centaurea consanguinea* DC. (Sect. *Acrolophus*)

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Abstract: *Centaurea consanguinea* 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. consanguinea* is a perennial species growing up 35-70 cm height. Leaf segments and involucral 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*, *C. consanguinea* DC., morphology, anatomy, ecology, pollen, achene

INTRODUCTION

The genus *Centaurea* L. comprises approximately 500 to 600 species distributed all around the world particularly in Asia, North Africa and America[1,2]. One of the genus *Centaurea* is the largest genus in Turkey and represented by 187 taxa, of which 114 are endemic (endemism ratio: 60.7%)[1-6]. High endemism ratio shows that Turkey is one of the gene centers of the genus.

C. consanguniea is an endemic species and shows different morphological variations in very interesting and different ecological conditions. In this study, in addition to the ecological features, anatomical, pollen and achene surface features of the species were studied.

MATERIALS AND METHODS

Plant specimens used in this study were collected from B8: Bingol: 110 km from Muş to Bingöl, step (on south-west slopes), 1100 m altitude, 08.07.2003 Leg. S. Çelik). The plant specimens were identified according to Wagenitz[1] and they are kept in the Department of Biology, Çanakkale Onsekiz Mart University. The specimens were examined and the measurements were made using a microscope and micrometer or ruler. Also, some features of the specimens were obtained in the field.

For palynological studies, the pollen grains were obtained from dried herbarium specimens. Several unopened buds (to make sure alien pollen grains were not present) were placed in a watch glass and squashed adding a few drops of wetting agent. The pollen grains were transferred to copper stubs, which were already prepared with double-sided adhesive tape and then stubs were coated with gold for 5-6 min for studying and taking pictures in SEM. A jeol 100 x CXII scanning electron microscope was used in the study. The terminology used is mainly that of Punt *et al.*[7].

In the present study of the anatomy of root, stem and leaf, the Wax-Embedding procedure was followed. Plant parts were first fixed by using FAA (formalin acetic alcohol) (Cutler 1978, Menemen and Jury 2001). The samples were passed through an alcohol and histoclear series for dehydration. Paraplast was added to the histoclear and the samples placed in an oven. Cross sections of root, stem and leaf were taken with the help of a rotary microtome in 7 μm thickness and stained by safranin and crystal violet. Investigations were carried out under a light microscope and photographs taken by a microphotography apparatus (JENA).

Soil specimens (0-10, 10-20 and 20-30 cm deep) were collected from the area where the plant specimens were obtained and brought into the laboratory for analysis (Table 1). The analyses were carried out according to Walkley and Black[8], Jackson[9], Chapmann and Pratt[10], Bouyoucus[11], Olsen and Sommers[12].

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RESULTS

Morphological characteristics: Perennial, 35-70 cm, profusely branched just above the base with spreading branches. Leaves slightly arachnoid, ±glabrescent (especially below); lower and median leaves pinnatipartite with few distant linear segments 1-3 mm broad (terminal segment up to 5 mm), upper ones simple. Capitula usually 2-3 (-5) together in small clusters at the end of branches. Involucre (7-) 8-9x3-5 mm, oblong to fusiform. Appendages large, spreading, straw-coloured, sometimes with a brown or purple spot, with (8-)9-13(-15) cilia (1-)1.5-2(-3) mm on each side, ending in a 0.5-1 mm micro. Flowers purple, marginal not radiant, hermaphrodite flowers 5-7 (Fig. 1). Achenes 3-3.5 mm; pappus (0.5-)1-2(-2.5) mm. The surface of seeds is serrated (Fig. 2a).

In addition to macro morphology of the species, micromorphology of the achene was studied. The SEM study showed that the achene surface is hairy (Fig. 2a-d) and cells form a striate structure and strongly depressed dorsal and margin surfaces.

Pollen grains: The pollen grain in *C. consanguinea* is tricolporate. A detailed description of the species is provided below: Polar axis (P)31.81 μm, equatorial axis (E) 19.57 μm, P/E 1.57, prolate; colpi tapering at both ends; spinulose, spinules sparsely distributed, Width of the spinules at base (W) 2.01 μM, Height of the spinules (H) 0.82 μm,W/H 2.45, very large at base, apices sharp, with basal and subapical distinct perforations, pores irregular distributed (Fig. 3a and b).

Anatomical characteristics

Root anatomy: *Centaurea consanguinea* is a perenial endemic species. Cross section of the root showed that a disintegrated periderm is present on outermost layer as a protective tissue. Below, it lies a cortex tissue. Flattened but thick walled cells. The cells in the cortex are flat and with thick walled. The cortex with groups of sclerenchyma cells occupies a wide arcade up to endodermis, that is not easily distinguished. Phloem take places a small part in the bundles contrary to xylem located all around the paranchymatous pith. Pith rays lie in the cortex (Fig. 4a).

Stem anatomy: Stem is with a thick cuticle layer on outermost, followed by a single layered epidermis which has papilla like ejections and amaryllis type stomata. Chloronchymatic tissue with 3-4 layers covers a small area

Fig. 1: Capitula of *C. consanguinea* DC

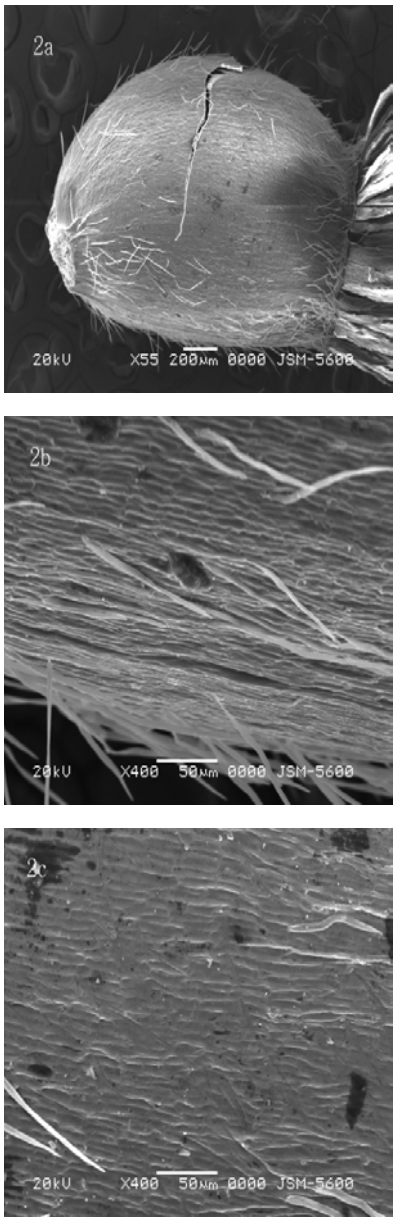

Fig. 2: *C. consanguinea* DC. achene photographed in SEM. a. General view, b. striate surface of the achene on dorsal, c. striate surface of the achene on margin

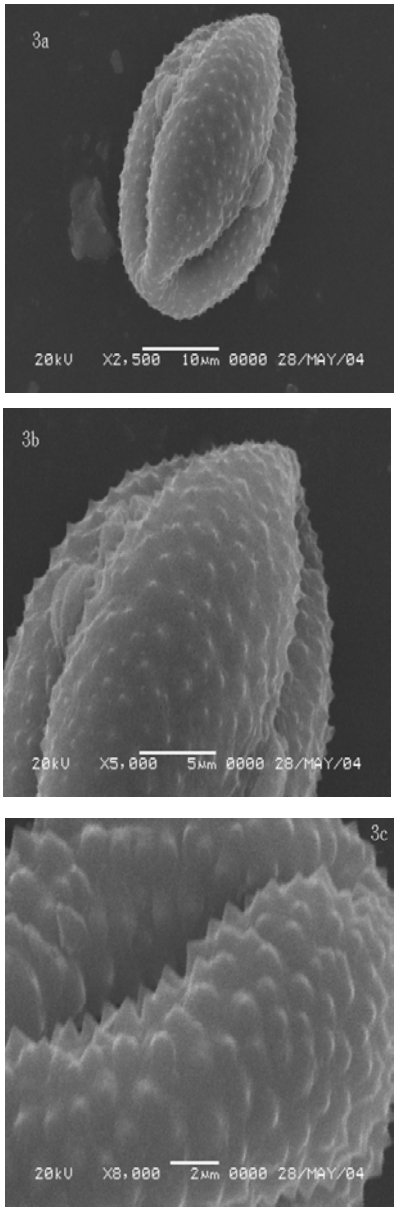

Fig. 3: *C. consanguinea* DC. pollen grain in SEM. a. General view, b. striate surface of the pollen on dorsal, c. striate surface of the pollen on margin

Fig. 4: *C. consanguinea* a. Transverse section of root. (10x5). b. Transverse section of stem (10x5). c. Transverse section of leaf (10 x 6.3) (Co: Cortex, Xy: Xylem, Ph: Phloem, Pd: Periderm, Pr: Pith ray, Sc: Sclerenchyma, Cu: Cuticle, E: Epidermis, Cl: Chlorenchyma, Pp: Palisade parenchyma, Sp: Spongy parenchyma, Vb:Vascular bundle)

under epidermis. Collenchyma cells are thick walled and located between epidermis and chloronchymatic layers. Below there are 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 and xylem iner sides. Vascular bundles are surrounded with a single parenchyma cell layer. Cambium is in depressed form. Pith is parenchymatous (Fig. 4b).

Leaf anatomy: It was obtained that the leaf is equifacial type, in which 2-3 layers of palisade parenchyma is found on both sides of spongy parenchyma, occupying a small part in the middle as in the other xerophytes. The epidermis is silicified and covered with a thick cuticle

layer. Mesophytic stomata is found on both sides of the leaf (amphystomatic). The bundle is surrounded by a single large parenchymatic cell layer and the largest one is located in the midvein (Fig. 4c).

Ecological characteristics: *C. consanguinea* is a natural and common species in the steppes of Turkey. It is generally adopted to terrestial climates and dominates to other species in the areas where it grows.

C. consanguinea grows together with the following species: *Anchusa arvensis* (L.) M. Bieb., *Anchusa azurea* Miller var. *azurea*, *Arabis brachycarpa* Rupr., *Barbarea lutea* Cullen and Coode, *Pimpinella saxifraga* L., *Prangos ferulacea* (L.) Lindl., *Anthemis cretica* L. subsp. *albida* (Boiss.) Grierson, *Arctium tomentosum* Miller Var. *glabrum* (Kornicke) Arenes, *Carduus adpressus* C.A. Mey. ve *Centaurea armena* Boiss.

This species was classified by Ekim[13] as LR (Ic) (Lower Risk, least concern). This study confirmed that the report made by Ekim[13] is correct, because the species distributed in very large and different areas.

In the course of studying ecological features of *C. consanguinea,* soil specimens were collected from its natural distributional areas. Their physical and chemical analyses were shown in Table 1.

Table 1: Soil analysis of *Centaurea consanguinea*

	0-10 cm	10-20 cm	20-30 cm
pH	7.40	7.60	7.80
$CaCO_3$% total	0.55	0.70	0.85
Organic Mat.%	2.80	2.10	1.10
P_2O_5%	45	34	19
N%	0.65	0.35	0.20
Ca^{++} ppm	1451	1300	1050
Mg^{++} ppm	1200	1050	900
K^{+} ppm	7000	6000	4500
Na^{+} ppm	18	15	11

DISCUSSION

C. consanguinea is a perennial species, with 35-70 cm height and branches at the upper part of the stem. Flowers are in a capitulum. Leaves are slightly arachnoid, lower and median leaves pinnatipartite with a few distant linear segments.

Groups of sclerenchyma cells in the stem are situated under endodermis. The root xylem and leaf mesophyll contains secretory canals. Stem epidermis has papilla like ejections. The importance of leaf anatomy in *C. derderifolia* and *C. saligna* was reported by Kaya[14]. Spongy parenchyma in the leaf is higly reduced as in the other xerophytes. In addition, leaf anatomy in *C. polyclada* was also reported by Uysal *et al.*[15].

It was determined that *C. consanguinea* grows in very low acidic soil with poor saline, $CaC0_3$ and organic matter content. In terms of feeding elements, the soil is poor in phosphorus (%) and potassium (%) and the other in nomal levels.

Population size of a plant, variations in its morphology and number of seed production are mostly affected by genetic changes during time, existence of predators and ecological factors[16-19].

Ecological characteristics of the species are in full agreement with its anatomical behavours.

The achene differs from those found in 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*[20].

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