

THE ENDOTHECIUM IN *INULA* L., AND ITS ALLIED GENERA (INULEAE – COMPOSITAE) FROM PAKISTAN AND KASHMIR

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Abstract

The endothecium in 22 species of *Inula* L., and its allied genera (*Pentanema* Cass., *Duhaldea* DC., *Dittrichia* Greuter and *Iphiona* Cass.) was examined from Pakistan and Kashmir by light microscopy. Three types of endothelial tissues i.e., polar, radial and transitional are recognized. In the genus *Inula* radial and transitional endothecium are present whereas, in the genera *Pentanema*, *Dittrichia* and *Iphiona* is radial while the genus *Duhaldea* is characterized by polar endothecium.

Introduction

Endothecium is usually termed for layers of anther wall between fibrous layer and the sporogenous tissues or all layers of anther wall excluding epidermis (Eames, 1961). The endothecium forming the distinct ribs or bars are differentiated on the anticlinal, periclinal and transverse walls of the cell (Esau, 1977). According to these configuration of ribs, there are three main types of endothelial tissues (Dormer, 1962; Nordenstam, 1976, 1978; Wetter, 1983). When the ribs are restricted to the transverse or horizontal walls, endothelial tissues are polarized. When ribs are all around, the configuration is said to be radial. But when the endothelial cells are uniformly thickened or in undistinguished manner with no distinct ribs these are said to be transitional endothelial tissues. The exact function of these thickening is ambiguous but most probably they act by creating tension in the maturing anthers and help in pollen dispersal (Esau, 1977; Endress, 1994; Tebbitt & Maciver, 1999). From time to time many workers utilized endothelial tissues with taxonomic interpretations in various taxa such as in Asteraceae (Dormer, 1962; Vincent & Getliffe, 1988; Anderberg, 1991), Apiaceae (Arora & Tiagi, 1977), Onagraceae (Eyde, 1977), Araceae (French, 1985), Iridaceae (Manning & Goldblatt, 1990), Orchidaceae (Freudenstein, 1991), Leguminosae (Manning & Stirton, 1994) and Begoniaceae (Tebbit & Maciver, 1999).

There are various reports on endothelial tissues of various taxa but there are no reports on *Inula* and its related genera from the area under consideration. The present report describes the endothelial type of *Inula* L., *Pentanema* Cass., *Duhaldea* DC., *Dittrichia* Greuter and *Iphiona* Cass., from Pakistan and Kashmir.

Materials and Methods

Twenty two species belonging to the genera *Inula* L., *Pentanema* Cass., *Duhaldea* DC., *Dittrichia* Greuter and *Iphiona* Cass., were investigated for endothelial tissues. A list of specimens investigated is given in Table 1. Syngenesious anthers were cleared by heating in 50% lactic acid. The cleared anthers were dissected and mounted in lactic acid. The endothelial thickening was observed from the abaxial surface of the anther under compound microscope (Nikon Type – 102).

Table 1. Endothecium pattern in *Inula* L., and its allied genera.

Name of taxa	Endothecial type	Voucher specimen collector, number, herbarium
<i>Inula koelzii</i>	Transitional	W. Koelz 2900a (KUH); W. Koelz 2827a (NY)
<i>I. royleana</i>	Transitional	Y. Nasir & Rubina Akhtar 12996 (RAW); M. Qaiser & Rizwan Y. Hashmi 7868 (KUH)
<i>I. racemosa</i>	Transitional	R.R. Stewart 14052 (KUH); R.R. Stewart 19550 (RAW)
<i>I. stewartii</i>	Transitional	R. R. Stewart s.n. (RAW)
<i>I. orientalis</i>	Radial	S. Abedin & M. Qaiser 8887 (KUH); Tahir Ali, M. Qaiser & M. Ajmal 503 (KUH)
<i>I. clarkei</i>	Radial	Hans Hartmann s.n. (RAW); E. Nasir & G.L. Webster 5804 (RAW)
<i>I. obtusifolia</i>	Radial	M. Qaiser, S. Omer & S.Z. Hussain 8414 (KUH); R.R. Stewart 18803 (RAW)
<i>I. britannica</i>	Radial	R.R. Stewart 54 (RAW)
<i>I. acuminata</i>	Radial	Stainton 3077 (RAW); R.R. Stewart 26356 (RAW)
<i>I. falconeri</i>	Radial	R.R. Stewart 20484 (KUH); M.A. Siddiqui, Y. Nasir & Zaffar 4182 (K)
<i>I. rhizocephala</i>	Radial	R.R. Stewart 18859 (RAW); S. Omer & M. Qaiser 2360 (KUH)
<i>Pentanema glanduligerum</i>	Radial	G.R. Sarwar & S. Omer 256 (KUH); Stainton 294 (RAW)
<i>P. indicum</i>	Radial	A.Rashid 26985 (RAW); Farrukh Hussain s.n (RAW)
<i>P. divaricatum</i>	Radial	S. Abedin & Abrar Hussain 6232 (KUH); S.M.H Jafri 2854 (KUH)
<i>P. vestitum</i>	Radial	Y. Nasir & Rubina Akhtar 11863 (RAW); S. Abedin 2659 (KUH)
<i>Duhaldea cappa</i>	Polar	A. Ghafoor & Tahir Ali 4005 (KUH); S.A. Farooqui & M. Qaiser 3172 (KUH)
<i>D. eupatorioides</i>	Polar	R.R. Stewart & I.D. Stewart 4145 (RAW)
<i>D. cuspidata</i>	Polar	Tahir Ali, M. Qaiser & M. Ajmal 367 (KUH); Y. Nasir & Nazir 10519 (RAW)
<i>D. latifolia</i>	Polar	Royle, 113.2, LIV
<i>Dittrichia graveolens</i>	Radial	J.L. Stewart 245 (K)
<i>Iphiona aucheri</i>	Radial	Tahir Ali & G.R. Sarwar 2868 (KUH); Tahir Ali 1478 (KUH)
<i>I. grantioides</i>	Radial	S. Omer & Rizwan Y. Hashmi 2003 (KUH); A. Ghafoor & S. Omer 1825 (KUH)

Fig. 1. Light micrographs showing endotheacial tissues: A, *I. Koelzii*; B, *I. stewartii*; C, *I. orientalis*; D, *I. clarkei*; E, *I. acuminata*; F, *I. falconeri*; G, *I. rhizocephala*; H, *Pentanema glanduligerum*; I. *P. indicum* (Scale bar=20 μ m).

Fig. 2. Light micrographs showing endothelial tissues: A, *Pentanema vestitum*; B, *P. divaricatum*; C, *Duhaldea cappa*; D, *D. eupatorioides*; E, *D. cuspidata*; F, *D. latifolia*; G, *Dittrichia graveolens*; H, *Iphiona aucheri*; I, *I. grantioides* (Scale bar= A, B, C, E, F, H, I = 20 μ m; D, G = 30 μ m).

Result and Discussion

According to the endothecium thickening, all the studied taxa are placed in three different categories i.e., polar, radial and transitional endothelial tissues (Dormer, 1962; Nordenstan, 1976, 1978). Anderberg (1991) described the radial endothecium in *Inula* L., but the present studies reveal that in *Inula* both radial and transitional types are present (Table 1). In *Inula koelzii* Dawar & Qaiser, *I. racemosa* Hook. f., *I. royleana* DC., and *I. stewartii* Dawar & Qaiser, endothelial thickenings are uniform and indistinguished i.e. transitional type (Fig. 1A, B). Whereas, in the remaining species of *Inula*, radial endothelial tissues are observed (Fig. 1C-G). It is also interesting to note that the group of above four species of *Inula* is also distinguished from remaining species due to the presence of upper sessile and semiamplexicaul leaves and lower ones are attenuate in a long winged petiole, cypselas 3-4 mm long $\pm$ glabrous and 16-24 -ribbed. Whereas, in remaining species leaves are not winged petiolate, cypselas 8-12- ribbed and hairy. In *Duhaldea*, endothelial tissues are polarized (Fig. 2C-F), while in *Pentanema* (Fig. 1H, I; 2A, B), *Dittrichia* (Fig. 2G) and *Iphiona* (Fig. 2H, I) radial type is found. However, our findings in *Dittrichia* and *Iphiona* are not in accordance to those of Anderberg (1991) where he described polar endothelial tissues in both the genera.

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