

**A MICROMORPHOLOGICAL STUDY FOR THE GENERIC
DELIMITATION OF *INULA* L. (S.STR.) AND ITS ALLIED
GENERA (INULEAE-COMPOSITAE) FROM
PAKISTAN AND KASHMIR**

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Abstract

Micromorphological characters viz., receptacular surface and anther apices strengthen the existence of 22 taxa of *Inula* L., (s.str.) and its allied genera (*Pentanema* Cass., *Duhaldea* DC., *Dittrichia* Greuter and *Iphiona* Cass.) from Pakistan and Kashmir. The receptacles are without scaly ridges in the genera *Inula* L. (s.str.) and *Pentanema*, while the genera *Duhaldea*, *Dittrichia* and *Iphiona* have unevenly incised scaly ridges on receptacle. Acute-obtuse anther apices are present in *Inula*, *Pentanema*, *Dittrichia* and *Iphiona*. The genus *Duhaldea* is characterized by the presence of truncate-emarginate anther apices.

Introduction

Inula L. (s.str.) and its allied genera viz., *Pentanema* Cass., *Duhaldea* DC., *Dittrichia* Greuter and *Iphiona* Cass., are collectively recognized with 22 species from Pakistan and Kashmir (Abid & Qaiser, 2004).

The recent developments in taxonomy and introduction of various techniques have made an impact on the criterion for the classification of some of the important fields which have been incorporated in taxonomy of Compositae such as the use of microscopy for the detailed study of micromorphological characters viz., palynology (Erdtman, 1952; Blackmore, 1981; Dawar *et al.*, 2002), cypsela morphology (Haq & Godward, 1984; Abid & Qaiser, 2002), pappus morphology (Dittrich, 1968). Similarly, the use of anatomical characters has also played an important role in the taxonomy of this important family (Vincent & Getliffe, 1988; Anderberg, 1991; Abid & Qaiser, 2004). However, micromorphological characters of receptacular surface and anther apices are either totally ignored or only seldom mentioned inspite of stability as characters, except the studies of Anderberg (1991) and Bremer (1994) but their findings do not totally cover the taxa of area under consideration.

The purpose of the present paper is two fold. Firstly there are no detailed reports on receptacular surface and anther apices of these taxa from our area. Secondly it is to provide additional micromorphological characters in order to strengthen the recognition of 22 taxa belonging to *Inula* L., (s.str.) and its allied genera from Pakistan and Kashmir.

Materials and Methods

Mature anthers and receptacles of 22 species belonging to *Inula*, *Pentanema*, *Duhaldea*, *Dittrichia* and *Iphiona* from herbarium material were examined. A list of specimens investigated is given in Table 1. For receptacular surface, mature receptacles were mounted on a metallic stub with the help of double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber. Scanning Electron Microscopic (SEM) examination was carried out on a Hitachi Scanning Microscope (HSM-S570).

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

Name of taxa	Receptacular surface	Anther apices	Voucher specimen collector, number, herbarium
<i>Inula koelzii</i>	Without scaly ridges	Acute-obtuse	W. Koelz 2900a (KUH); W. Koelz 2827a (NY)
<i>I. royleana</i>	Without scaly ridges	Acute-obtuse	Y. Nasir & Rubina Akhtar 12996 (RAW); M. Qaiser & Rizwan Y. Hashmi 7868 (KUH)
<i>I. racemosa</i>	Without scaly ridges	Acute-obtuse	R.R. Stewart 14052 (KUH); R.R. Stewart 19550 (RAW)
<i>I. stewartii</i>	Without scaly ridges	Acute-obtuse	R. R. Stewart s.n. (RAW)
<i>I. orientalis</i>	Without scaly ridges	Acute-obtuse	S. Abedin & M. Qaiser 8887 (KUH); Tahir Ali, M. Qaiser & M. Ajmal 503 (KUH)
<i>I. clarkei</i>	Without scaly ridges	Acute-obtuse	Hans Hartmann s.n. (RAW); E. Nasir & G.L. Webster 5804 (RAW)
<i>I. obtusifolia</i>	Without scaly ridges	Acute-obtuse	M. Qaiser, S. Omer & S.Z. Hussain 8414 (KUH); R.R. Stewart 18803 (RAW)
<i>I. britannica</i>	Without scaly ridges	Acute-obtuse	R.R. Stewart 54 (RAW)
<i>I. acuminata</i>	Without scaly ridges	Acute-obtuse	Stainton 3077 (RAW); R.R. Stewart 26356 (RAW)
<i>I. falconeri</i>	Without scaly ridges	Acute-obtuse	R.R. Stewart 20484 (KUH); M.A. Siddiqui, Y. Nasir & Zaffar 4182 (K)
<i>I. rhizocephala</i>	Without scaly ridges	Acute-obtuse	R.R. Stewart 18859 (RAW); S. Omer & M. Qaiser 2360 (KUH)
<i>Pentanema glanduligerum</i>	Without scaly ridges	Acute-obtuse	G.R. Sarwar & S. Omer 256 (KUH); Stainton 294 (RAW)
<i>P. indicum</i>	Without scaly ridges	Acute-obtuse	A.Rashid 26985 (RAW); Farrukh Hussain s.n (RAW)
<i>P. divaricatum</i>	Without scaly ridges	Acute-obtuse	S. Abedin & Abrar Hussain 6232 (KUH); S.M.H Jafri 2854 (KUH)
<i>P. vestitum</i>	Without scaly ridges	Acute-obtuse	Y. Nasir & Rubina Akhtar 11863 (RAW); S. Abedin 2659 (KUH)
<i>Duhaldea cappa</i>	With scaly ridges	Truncate-emarginate	A. Ghafoor & Tahir Ali 4005 (KUH); S.A. Farooqui & M. Qaiser 3172 (KUH)
<i>D. eupatorioides</i>	With scaly ridges	Truncate-emarginate	R.R. Stewart & I.D. Stewart 4145 (RAW)
<i>D. cuspidata</i>	With scaly ridges	Truncate-emarginate	Tahir Ali, M. Qaiser & M. Ajmal 367 (KUH); Y. Nasir & Nazir 10519 (RAW)
<i>D. latifolia</i>	With scaly ridges	Truncate-emarginate	Royle, 113.2, LIV
<i>Dittrichia graveolens</i>	With scaly ridges	Acute-obtuse	J.L. Stewart 245 (K)
<i>Iphiona aucheri</i>	With scaly ridges	Acute-obtuse	Tahir Ali & G.R. Sarwar 2868 (KUH); Tahir Ali 1478 (KUH)
<i>I. grantioides</i>	With scaly ridges	Acute-obtuse	S. Omer & Rizwan Y. Hashmi 2003 (KUH); A. Ghafoor & S. Omer 1825 (KUH)

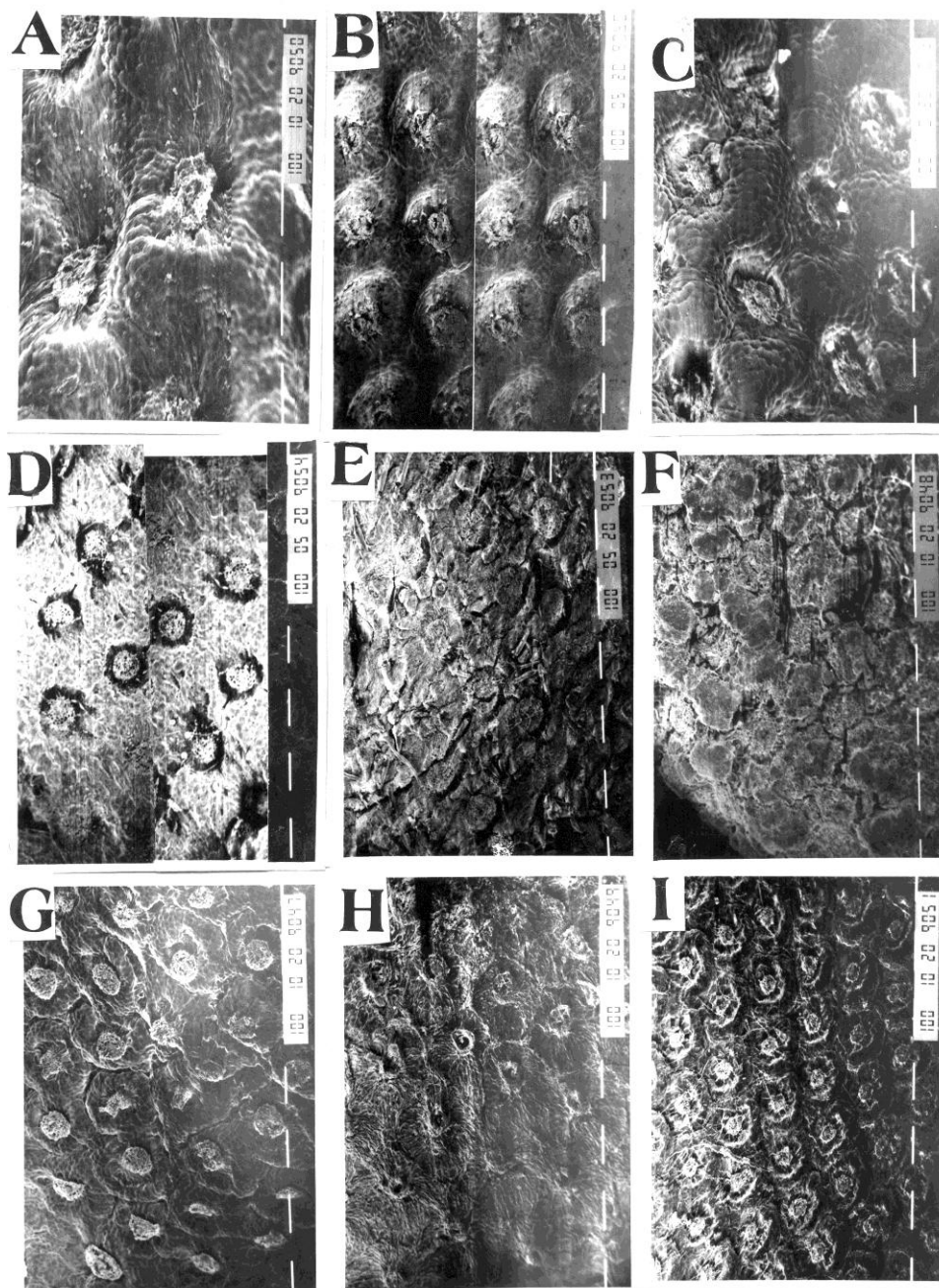


Fig. 1. Scanning micrographs (SEM) showing receptacular surface: A, *Inula orientalis*; B, *I. clarkei*; C, *I. rhizocephala*; D, *I. britannica*; E, *I. acuminata*; F, *I. falconeri*; G, *Pentanema glanduligerum*; H, *P. indicum*; I, *P. vestitum* (1 scale bar = 100 µm).

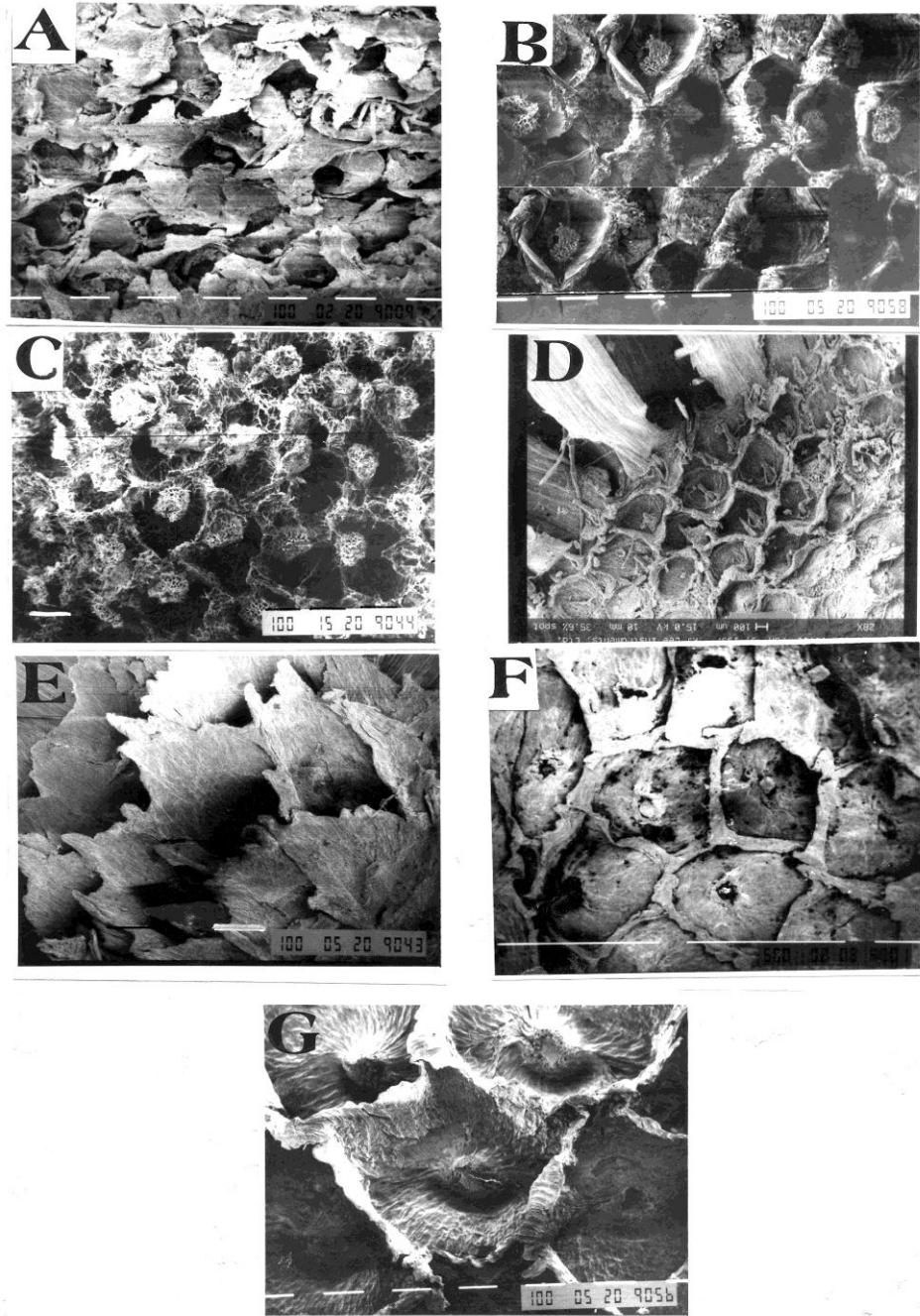


Fig. 2. Scanning micrographs (SEM) showing receptacular surface: A, *Duhaldea cappa*; B, *D. eupatorioides*; C, *D. cuspidata*; D, *D. latifolia*; E, *Dittrichia graveolens*; F, *Iphiona aucheri*, G, *I. grantioides* (1 scale bar = 100 μ m).

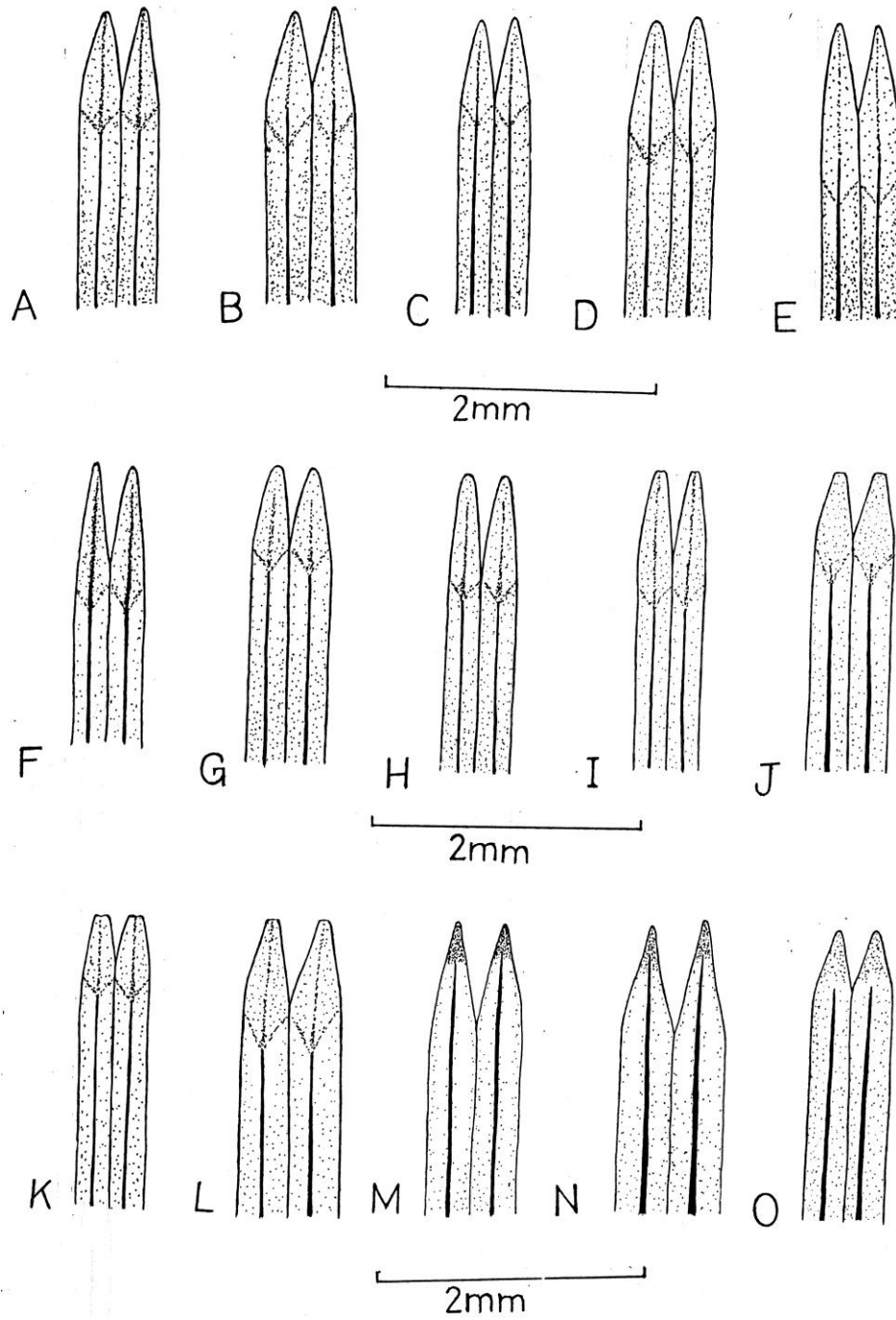


Fig. 3. Anther apices: A-F, *Inula*; G,H, *Pentanema*; I-L, *Duhaldea*; M,N, *Iphiona*; O, *Dittrichia*.

For anther apices, syngenesious anthers were cleared by heating in water. The cleared anthers were dissected and mounted in 50% lactic acid and light microscopy was carried out under compound microscope (Nikon Type-102).

Results and Discussion

Table 1 indicates the occurrence of two different type of receptacle surface i.e., receptacle with uneven incised ridges and receptacle without these ridges. Similarly there are two different types of anther apices i.e., with acute-obtuse and truncate-emarginate apices. Our findings are in agreement with that of Anderberg (1991) and Bremer (1994) who have also reported similar two types of receptacle and anther apices from various taxa belonging to *Inula* (s.str.) and other allied genera. The genera *Inula* L., (s.str.) and *Pentanema* Cass., are characterized by acute-obtuse anther apices and receptacle without scaly ridges (Fig. 3A-H; Fig. 1A-I). There seems to be no exception from this contention and two new species viz., *I. koelzii* Dawar & Qaiser and *I. stewartii* Abid & Qaiser described by Dawar & Qaiser (1997) and Abid & Qaiser (2002) respectively have similar type of anther apices and receptacle type. The genus *Duhaldea* is unique by having truncate-emarginate anther apices and receptacle with scaly ridges (Fig. 3I-L; Fig. 2A-D). Recently Dawar & Qaiser (1999) transferred a species from *Inula* to *Duhaldea* which had similar type of anther apices and receptacle surface. The remaining two genera i.e., *Dittrichia* Greuter and *Iphiona* Cass., have acute-obtuse anther apices (Fig. 3M-O) and the receptacle with uneven incised scaly ridges (Fig. 2E-G).

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