

COMPARATIVE ANATOMY AND POLLEN FEATURES OF AMBLYOCARPUM AND CARPESIMUM (ASTERACERAE: INULEAE) IN IRAN

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Received 23 01 2010. Accepted for publication 12 05 2010

Zarin, P., Ghahremaninejad, F., & Maassoumi, A. A. 2010 06 30: Comparative anatomy and pollen features of *Amblyocarpum* and *Carpesium* (Asteraceae: Inuleae) in Iran. -Iran. J. Bot. 16 (1): 49-53. Tehran.

Amblyocarpum Fisch. & Mey. and *Carpesium* L. are small genera in the tribe *Inuleae* s. str. *Amblyocarpum* includes one species (*A. inuloides*) and the closely related genus *Carpesium* includes two species (*C. cernuum* and *C. abrotanoides*). These species are studied with SEM for the pollen and anatomical (stem and peduncle) characters. The results support the use of these characters for defining the taxonomy of these species.

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Key words. Anatomy, Pollen, *Amblyocarpum*, *Carpesium*, *Inuleae*, *Asteraceae*, Iran.

مقایسه تشریحی و ویژگیهای دانه گرده جنس های *Amblyocarpum* و *Carpesium* از تبار *Inuleae* (Asteraceae) در ایران

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جنس های *Amblyocarpum* Fisch. & C. A. Mey. و *Carpesium* L. از جنس های کوچک تبار *Inuleae* s. str. می باشند. جنس *Amblyocarpum* فقط دارای یک گونه به نام *Amblyocarpum inuloides* و جنس نزدیک آن یعنی *Carpesium* دارای دو گونه *C. cernuum* و *abrotanoides* در ایران می باشد. در این بررسی، این سه گونه از ایران مورد مطالعه آناتومی ساقه و دمگل آذین و اسکینینگ سطح دانه گرده قرار گرفتند. نتایج حاصله تأیید کننده کاربرد این ویژگیها در تاکسونومی این گونه ها می باشد.

Introduction

The micromorphological characters and anatomy of the family *Asteraceae* have been studied by a number of taxonomists (Dawar & al. 2002; Bolick 1991, Anderberg 1991; Stebbins 1977, Merxmuller et al. 1977; Skvarla & Turner 1966, Abid & Zehra 2007, Abid & Qaiser 2002; 2004, 2007, Leins 1971, Metcalfe & Chalk 1950). In the tribe *Inuleae* various micromorphological characters have proved significant for taxonomic interpretation such as pollen grains characters (Skvarla & Turner 1966; Leins 1971; Dawar & al. 2002).

The genera *Amblyocarpum* Fisch. & C. A. Mey. and *Carpesium* L. both have disciform capitula and cypselas considerably longer than the corolla and are part of the "Inula complex" of *Inuleae* subtribe *Inulinae* (Englund & al. 2009). The monotypic genus *Amblyocarpum* with a rather inuloid habit is the sister group of highly specialized genus *Carpesium*, with bottlenecked cypselas, tubular female florets, and more widely distributed style hairs (Anderberg 1994).

The pollen morphology has shown to be informative at specific level in this group (Perveen 1999). The purpose of the present study is to provide palynological and anatomical data about the three species (*A.*

inuloides Fisch. & C. A. Mey., *C. abrotanoides* L. and *C. cernuum* L.) representing two genera of the tribe *Inuleae* s.str which would be helpful for finding specific and generic relationships.

Materials and methods

Stem and peduncle anatomy. In order to study anatomical characters, herbarium materials were fixed in ethanol and glycerin solutions, before being sectioned. Sections of the stem and peduncle were prepared by hand cutting. They were stained with methyl green and carmine-vest. These sections were then observed using an Olympus light microscope and photographed by Canon digital camera. *A. inuloides* with 7, *C. abrotanoides* with 8 and *C. cernuum* with 15 frequency were studied.

Pollen grains. Pollen material was obtained from the herbarium specimens archived at the TARI, W and FAR herbaria. Prior to Scanning Electron microscopy (SEM) observation, the pollen grains were dusted onto SEM stubs and coated with gold using a Philips XL30 SEM. In this part only two species *C. cernuum* and *A. inuloides* were studied, because the pollen grains of *C. abrotanoides* specimens were immature.

Names and herbarium accession numbers of studied species are: *C. cernuum* (Rahmanian, 6658, TARI; Terme & Matin 35074, W), *A. inuloides* (Amini, 6631, TARI, W; Moradi 22116, FAR), and *C. abrotanoides* (Riazi, 6651, TARI).

Results and discussion

Based on the stem anatomy features of these genera, the genus *Amblyocarpum* is distinguished in some characters from *Carpesium*, including tangential collenchyma, pith parenchyma cells shape, and mea in these cells. The *Carpesium*'s collenchyma is angular. Pith parenchyma cells shape is round to elliptic in *Carpesium*, and it has mea and cavity, too (Table 1 & Fig. 1). Also, peduncle anatomy features were influential in separating these genera such as the articulate setaceous (non glandular) to glandular epidermal hairs which are present in *Amblyocarpum* but the glandular epidermal hairs are absent in *Carpesium*. *Amblyocarpum* has parenchyma cells between vascular bundles but *Carpesium* does not have them. Dermal parenchyma has 6-7 layers and their cells have various shapes in *Amblyocarpum*, but these are 7-9 layers with hexagonal to rounded forms in *Carpesium* (Fig. 2 & Table 2). All the mentioned characters are diagnostic anatomical evidences and important for the separation of the genera. Other similarities in anatomy of stem and peduncle of the genera are the reason of their relative closeness in *Inuleae* s. str (Tables 1 & 2).

All anatomical characters in *C. cernuum* and *C. abrotanoides* are so similar that they can confirm the position of these species in one genus (Figs. 1 & 2, Tables 1 & 2).

The SEM of pollen grains in this study showed diagnostic characters between these two genera. Polar length is 16.66 μm in *A. inuloides* but it is 15.62 μm in *C. cernuum*, equatorial length is 21.42 μm in *A. inuloides* but it is 18.33 μm in *C. cernuum*, spine length is 3.92 μm in *A. inuloides* but it is 3.12 μm in *C. cernuum*, spine base length is 3.57 μm in *A. inuloides* but it is 2.81 μm in *C. cernuum* and distance between spines is 5.37 μm in *A. inuloides* but it is 4.06 μm in *C. cernuum*. The polar length, equatorial length, spine length, spine base length and distance between spines are characters of pollen grains that show differences of the genera in this study (Table 3, Fig. 3). Thus the SEM of pollen grains here supports the separation of these genera, too. The ratio of equatorial to polar length that is 1.28 in *A. inuloides* and 1.17 in *C. cernuum* indicates elliptical shape of these pollen grains. (Table 3, Fig. 3). However what is important in this study is the value of anatomical and micromorphological characters in the taxonomic problems in generic level.

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Table 1. Stem anatomical characters in the studied species of *Amblyocarpum* and *Carpesium*.

Characters \ Species	<i>A. inuloides</i>	<i>C. abrotanoides</i>	<i>C. cernuum</i>
Epidermal cell shape	Regular	Regular	Regular
Epidermal hair	Articulate setaceous (non glandular) to glandular	Articulate setaceous (non glandular)	Articulate setaceous (non glandular)
Collenchyma type	Tangential	Tangential & angular	Tangential & angular
Dermal parenchyma layers	6-7	6-8	6-9
Dermal parenchyma cell shape	Irregular	Irregular	Irregular
Sclerenchymal fibers in external part of vascular bundles	Aggregative	Aggregative	Aggregative
Fibers in between vascular bundles	Present	Present	Present
Parenchymal cell shape between vascular bundles	Rounded to elliptic	Absent	Absent
Mea in parenchymal cells between vascular bundles	Present	Absent	Absent
Mea in pith parenchymal cells	Mea	Mea to cavity	Mea to cavity

Table 2. Peduncle anatomical characters in the studied species of *Amblyocarpum* and *Carpesium*.

Characters \ Species	<i>A. inuloides</i>	<i>C. abrotanoides</i>	<i>C. cernuum</i>
Epidermal cell shape	Irregular	Irregular	Irregular
Epidermal hair	Articulate setaceous (non glandular) to glandular	Articulate setaceous (non glandular)	Articulate setaceous (non glandular)
Collenchyma	Tangential	Tangential	Tangential
Dermal parenchyma layers	6-7	6-9	6-9
Dermal parenchyma cell shape	Irregular	Irregular to hexagonal and rounded	Irregular to hexagonal and rounded
Sclerenchymal fiber in external part of vascular bundles	Aggregative to surrounding the phloem	Aggregative to surrounding the phloem	Aggregative to surrounding the phloem
Fibers in between Vascular bundles	+	+	+
Shape of parenchymal cells between vascular bundles	Subrounded	Absent	Absent
Mea in parenchymal cells between vascular bundles	Present	Absent	Absent
Mea in pith parenchymal cells	Cavity	Cavity	Cavity

Table 3. Pollen grain characters in the studied species of *Amblyocarpum* and *Carpesium*. (in μm).

Characters \ Species	Polar length	Equatorial length	Ratio of Equatorial to polar length	Spine length	Spine base length	Ratio of spine to base length	Distance between spines
<i>A. inuloides</i>	16.66	21.42	1.28	3.92	3.57	1.09	5.37
<i>C. cernuum</i>	15.62	18.33	1.17	3.12	2.81	1.11	4.06

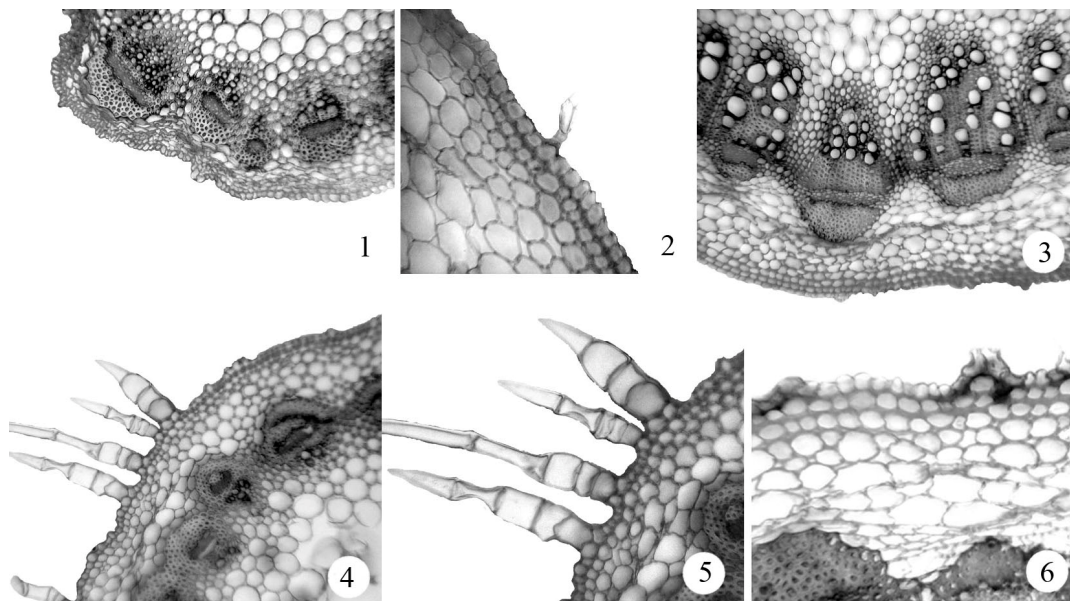


Fig. 1. Stem cross sections. 1. *Amblyocarpum inuloides* (200 ×). 2. *A. inuloides* (400 ×). 3. *Carpesium abrotanoides* (100 ×). 4. *C. cernuum* (100 ×). 5. *C. cernuum* (200 ×). 6. *C. abrotanoides* (200 ×).

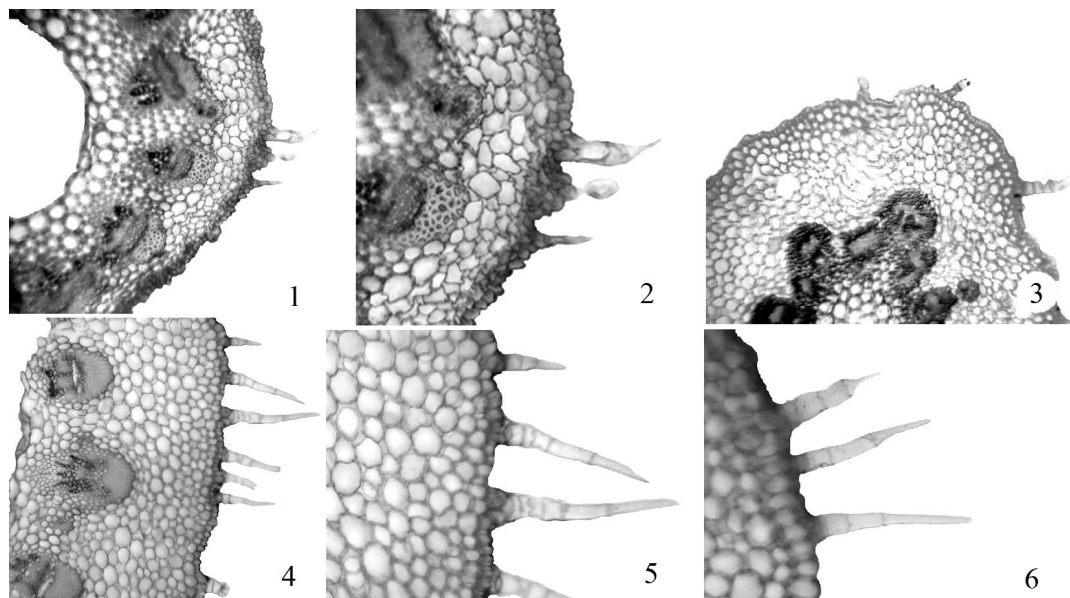


Fig. 2. Peduncle cross sections. 1. *Amblyocarpum inuloides* (200 ×). 2. *A. inuloides* (400 ×). 3. *Carpesium abrotanoides* (200 ×). 4. *C. cernuum* (100 ×). 5. *C. cernuum* (200 ×). 6. *C. abrotanoides* (400 ×).

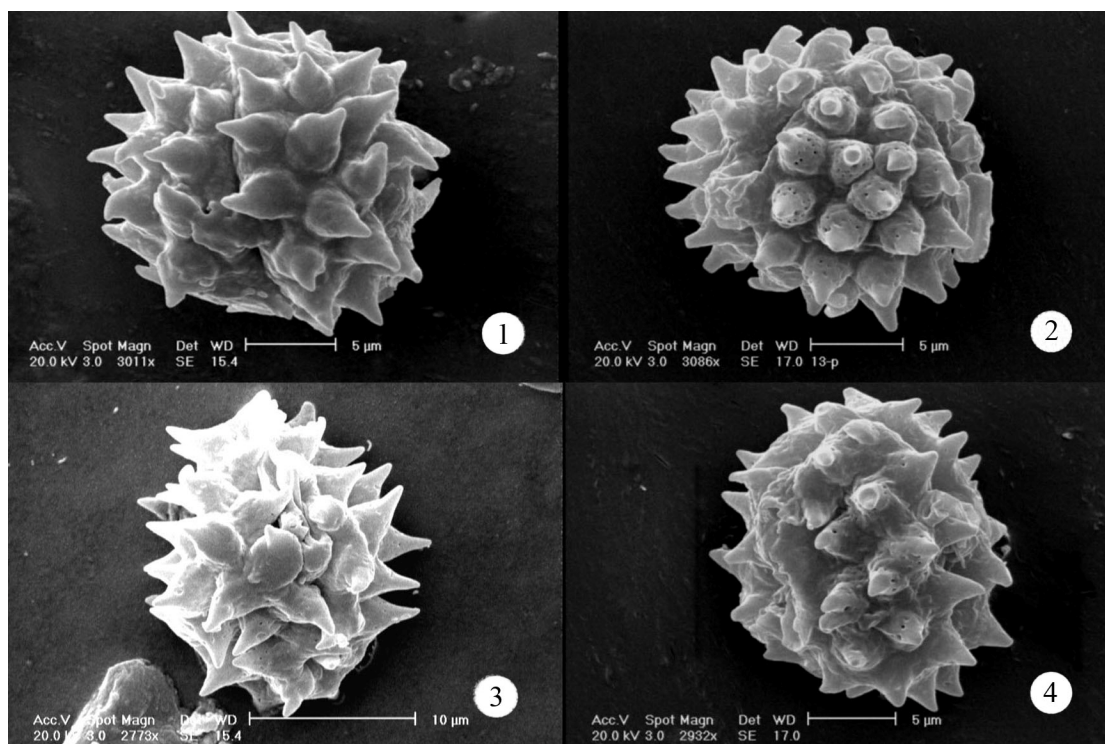


Fig. 3. Scanning Electron Micrographs of pollen grains in polar and equatorial view. 1. *Amblyocarpum inuloides* (polar view). 2. *Carpesium cernuum* (polar view). 3. *A. inuloides* (equatorial view). 4. *C. cernuum* (equatorial view).

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