

## Contributions to the Systematic Knowledge of *Chrysophthalmum montanum* (Asteraceae)

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### ABSTRACT

In Turkey, the genus *Chrysophthalmum* Sch.Bip. ex Walp. is represented by 3 taxa, namely *Chrysophthalmum montanum* (DC.) Boiss., *C. dichotomum* Boiss. & Heldr. and *C. gueneri* Aytac & Anderb. *C. montanum* is herbaceous plant that grows on rock cracks and limestone cliffs, in the eastern and southeastern regions of Turkey. In this study, pollen and cypselae morphology of this species was investigated with light microscope (LM) and scanning electron microscope (SEM). Further, the previous description of the species has been expanded. The pollen grains of the species are tricolporate, radially symmetrical, isopolar, shape oblate-spheroidal, ornamentation echinate-perforate. The cypselae of *C. montanum* are brownish, oblong, and glabrous. Pappus uniseriate, with 25-49 bristles, smooth, white and free at base.

### Research Article

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## *Chrysophthalmum montanum* (Asteraceae)'un Sistematik Bilgisine Katkıları

### ÖZET

Türkiye'de *Chrysophthalmum* Sch.Bip. ex Walp. cinsi *Chrysophthalmum montanum* (DC.) Boiss., *C. dichotomum* Boiss. & Heldr. and *C. gueneri* Aytac & Anderb. olmak üzere 3 taksonla temsil edilmektedir. *C. montanum*, Türkiye'nin Doğu ve Güneydoğu bölgelerinde kaya çatlakları ve kalker kayalıklarında yetişen otsu bir bitkidir. Bu çalışmada, bu türün polen ve sipsela morfolojisi ışık mikroskobu (LM) ve taramalı elektron mikroskobu (SEM) ile incelenmiştir. Ayrıca, türün önceki deskripsiyonu genişletilmiştir. Türün polen taneleri trikolporat, radial olarak simetrik, izopolar, şekli oblat-sferoidal, süslemesi ekinat-perforattır. *C. montanum*'un sipselası kahverengimsi, dikdörtgen ve tüysüzdür. Pappus bir sıralı, 25-49 kıllı, pürüzsüz, beyaz ve tabanda serbesttir.

### Araştırma Makalesi

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### INTRODUCTION

The Asteraceae family is the largest family of Dicotyledons and includes approximately 1911 genera and 33000 species (The Plant List, 2013). The Asteraceae family is structurally characterized by a variety of sesquiterpenes and therefore it has been comprehensively examined for their cytotoxic, antimicrobial and anticancer activities (Koukoulitsa et al., 2002; Wang et al., 2014; Ayaz et al., 2019). The tribe *Inuleae* is Eurasian, Eastern and South African tribe and includes about 66 genera and 687 species (Anderberg, 1991). The genus *Chrysophthalmum* L., a member of tribe *Inuleae* of the family Compositae, is generally distributed in the South-Eastern of Turkey and Iran region (Aytac and Anderberg, 2001).

The genus *Chrysophthalmum* is represented by four species worldwide. In the Flora of Turkey, the genus

*Chrysophthalmum* has three species, namely *Chrysophthalmum montanum* (DC.) Boiss., *C. dichotomum* Boiss. & Heldr. and *C. gueneri* Aytac & Anderb. (Grierson, 1975; Aytac and Anderberg, 2001; Ayaz et al., 2017).

Several studies have been conducted on *Chrysophthalmum* species so far. The cytotoxic, phytotoxic and insecticidal effects of *C. montanum* and *C. gueneri* were investigated by Ayaz et al. (2017); Ayaz et al. (2018a). Selvi et al. (2014) examined the micromorphological and anatomical features of the *Chrysophthalmum* growing in Turkey. The pollen morphology of three species of the genus *Chrysophthalmum* were studied by Kılıç et al. (2019). Ayaz et al. (2018b) investigated phytotoxic, cytotoxic and insecticidal activities of *C. dichotomum*. Ayaz et al. (2020) analysed antiproliferative constituents from the aerial parts of *C. montanum*.

*C. montanum* is an Irano-Turanian element which grows on rock crevices and limestone cliffs, in the Southeastern and eastern regions of Turkey (Grierson, 1975). Pollen and cypsela micromorphology play significant roles in modern plant taxonomy (Barthlott, 1984). Similarly, Selvi et al. (2014) stated that the characteristics of stems, leaves, trichomes and cypsela are important in distinguishing the *Chrysophthalmum* species. The main purpose of this study is to investigate morphological, palynological, cypsela morphological features of *C. montanum* and to use these characters for systematic purposes.

## MATERIAL and METHODS

In this study, the plant samples of *C. montanum* were collected from natural habitats:

—Turkey. C5 Kayseri: Yahyalı, Aladağ, Derebağ Waterfall, on limestone-calcareous slopes, 1448 m., 38°03'06.08"N, 035°17'36.04" E, 14.07.2018, *B. Atasagun 1099* (ERCH). Samples collected from the field were turned into herbarium specimens and these samples were used in the description studies. The averages of 30 measurements from different samples were used. The morphology of these specimens was examined using a stereo-binocular microscope. Collected plant samples were diagnosed and observed results were checked from the Flora of Turkey.

The pollen grains of *C. montanum* was obtained from dried herbarium specimens. The pollen slides were prepared according to Wodehouse (1935) method for LM study. On average, 30 pollen grains were measured for all quantitative characters. For scanning electron microscopy (SEM) studies, the dry pollen grains and cypselae were transferred to stubs using double-sided adhesive tape and coated with gold-palladium. GeminiSEM 500 computer-controlled field emission scanning electron microscope was used for the examination. The terminology chiefly follows Faegri and Iversen (1992) and Punt et al. (2007).

Seeds collected from natural populations or herbarium specimens were used to study seed micromorphological features. A digital stereo microscope (Leica EZ4HD) and scanning electron microscope (LEO 440) were used for seed morphology. On an average, 30 measurements were made for all quantitative characters. The terminology mainly follows Punt et al. (2007).

## RESULTS

### Morphological characteristics

**Description:** Rhizomatous perennial. Stems erect or ascending, 25-50 cm tall, branching from upper nodes, glandular-villous. Lower leaves persistent at anthesis, narrowly oblanceolate, 1.5-13.5 × 0.3-1 cm (incl. petiole), densely glandular-villous, margin entire, rarely covered with spreading long whitish hairs, acute or acuminate at apex, attenuate at base. Cauline

leaves narrowly oblanceolate, 5-8.5 × 0.6-0.9 cm, sparsely glandular-villous, margin entire, acute or mucronulate, attenuate to semi-amplexicaul at base. Upper cauline leaves similar, but sessile, 4-8 × 0.4-1.1 cm, sparsely villous and weakly glandular hairy, semi-amplexicaul at base. Capitula heterogamous, disciform, 6-30 in racemes or corymbs, rarely solitary. Involucre 0.6-1.1 cm broad, phyllaries imbricate, 4-5-seriate. Outer phyllaries oblong-lanceolate, 1.86-3.66 × 0.8-1.46 mm, glandular-villous, margin entire and short ciliate, acute at apex. Median phyllaries membranous at base, oblong-lanceolate, 3.81-5.38 × 0.7-1.29 mm, long villous and glandular hairy, margin entire and ciliate, acute at apex. Inner phyllaries membranous, linear, 3.39-5.46 × 0.56-0.9 mm, glandular-villous, margin entire and ciliate, acute at apex. Palea linear, 0.2-0.3 × 3-5 mm. Female flowers 1-seriate, tubular, 5.08-6.24 × 0.3-0.57 mm, subglugate at apex. Disc flowers 6-6.56 × 0.47-0.67 mm. Cypsela 2.33-2.89 mm, c. 10 striate, glabrous. Pappus, 25-49, 0.35-0.57 mm, white, free at base.

Flowering and fruiting in July–August. (Figure 1).

### Pollen and Seed Morphology

The pollen grains of *C. montanum* are radially symmetrical, isopolar and have a tricolporate aperture. Polar axis (P) is 24.08 µm, equatorial axis (E) is 24.73 µm. The shape of pollen is oblate-spheroidal. Ornamentation is echinate-perforate. Exine thickness is 1.63 µm and intine 1 µm (Figure 2). Details of the pollen characteristics of *C. montanum* are shown in Table 1.

The cypselae of *C. montanum* are 2.33-2.89 mm long, oblong, mature one brownish, c. 10 striate, glabrous. Surface of cypsela is irregular sulcate. Pappus uniseriate, with 25-49 bristles, 0.35-0.57 mm long, smooth, white and free at base (Figure 3).

## DISCUSSION

*C. montanum* grows on rock crevices and limestone cliffs, in the Southeastern and Eastern regions of Turkey (Grierson, 1975). The morphology, pollen and cypsela micromorphology of *C. montanum* were investigated comprehensively in this study. The morphological results of this study were suitable for the description of *C. montanum* stated in the Flora of Turkey. However, there were minor differences, especially in terms of indumentum (Table 2). Prior description of *C. montanum* was supplemented and corrected in the light of the new observations on these plants.

The pollen morphology of some *Chrysophthalmum* taxa has been investigated by Kılıç et al. (2019). The general characteristics of *Chrysophthalmum* pollens are as follows: pollen grains are 3-colporate, spheroidal, echinate (Kılıç et al., 2019).

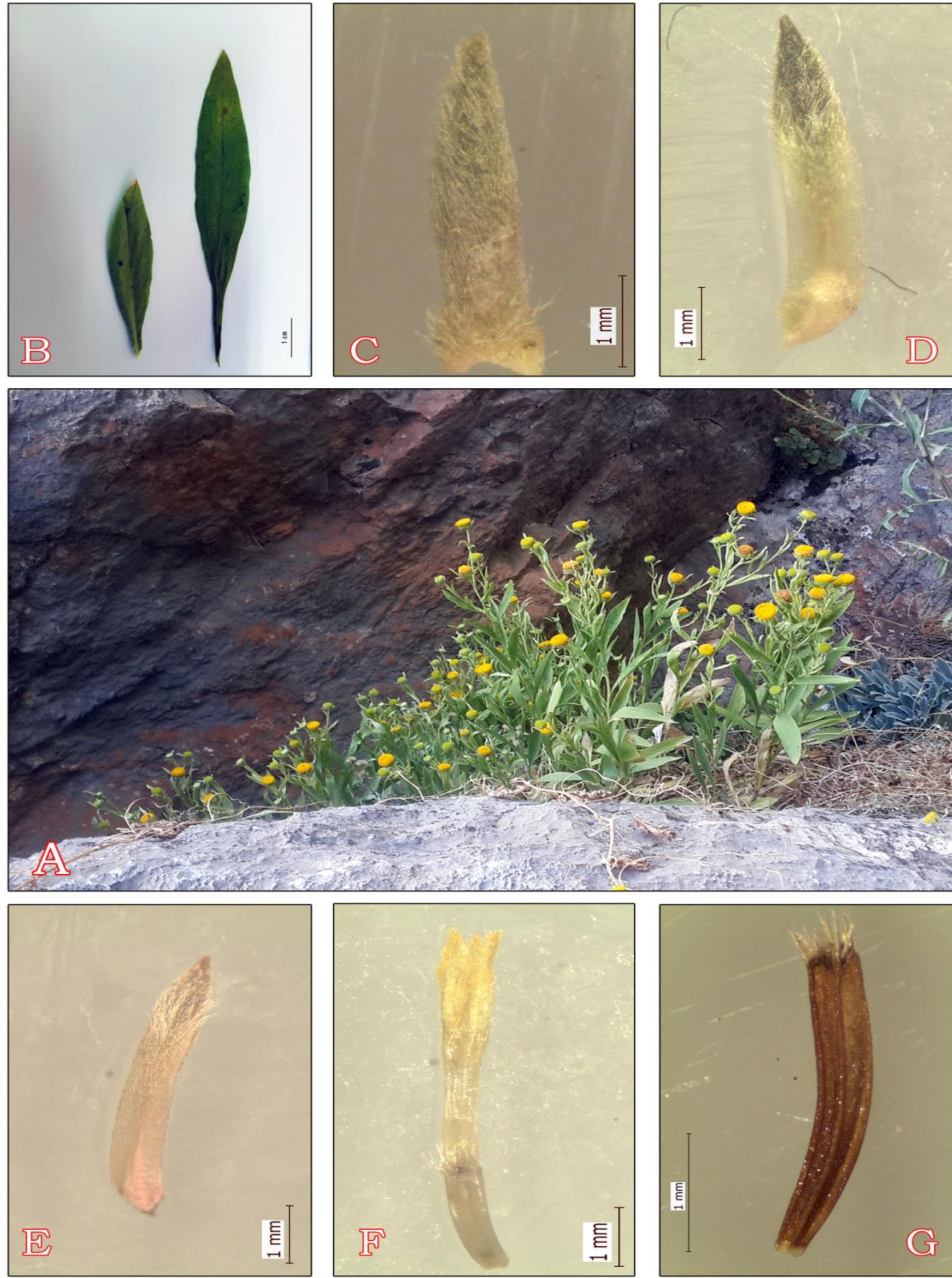


Figure 1. *C. montanum* A) Habitus, B) Cauline leaves, C) Outer phyllary, D) Median phyllary, E) Inner phyllary, F) Female flower, G) Cypsel.  
Şekil 1. *C. montanum*'ün A) Genel görünüş, B) Gövde yaprakları, C) Dış fillariler, D) Orta fillariler, E) İç fillariler, F) Dişi çiçek, G) Aken.

The pollen grains of *C. montanum* are radial symmetry, isopolar, oblate-spheroidal, tricolporate and echinate-perforate. Present pollen features were usually consistent with the study of Kılıç et al. (2019), but some features were different. The pollen shape of *C. montanum* is oblate-spheroidal in this study while it was reported as only spheroidal by Kılıç et al. (2019). Also, the t (apocolpium) of pollen grains of *C. montanum* was measured 17.02  $\mu\text{m}$  in this study, Kılıç et al. (2019)'s study measured as 7.15  $\mu\text{m}$ . There is also no information about L (AMB) in Kılıç et al. (2019). The pollen morphology of some *Inula* taxa which is the

closest genus to *Chrysophyllum* has been investigated by several authors. The general characteristics of *Inula* pollens are 3-colporate, oblate-spheroidal, echinate (Osman, 2006; Dosa, 2014). Current palynological findings are consistent with mentioned studies and some *Inula* species above (Osman, 2006; Dosa, 2014).

The morphological characteristic of cypsel in Asteraceae has significant systematic value and has been widely used for the phylogeny and classification in the family (Ciccarelli et al., 2007; Hussein and Eldemerdash, 2017; Ghimire et al., 2018).



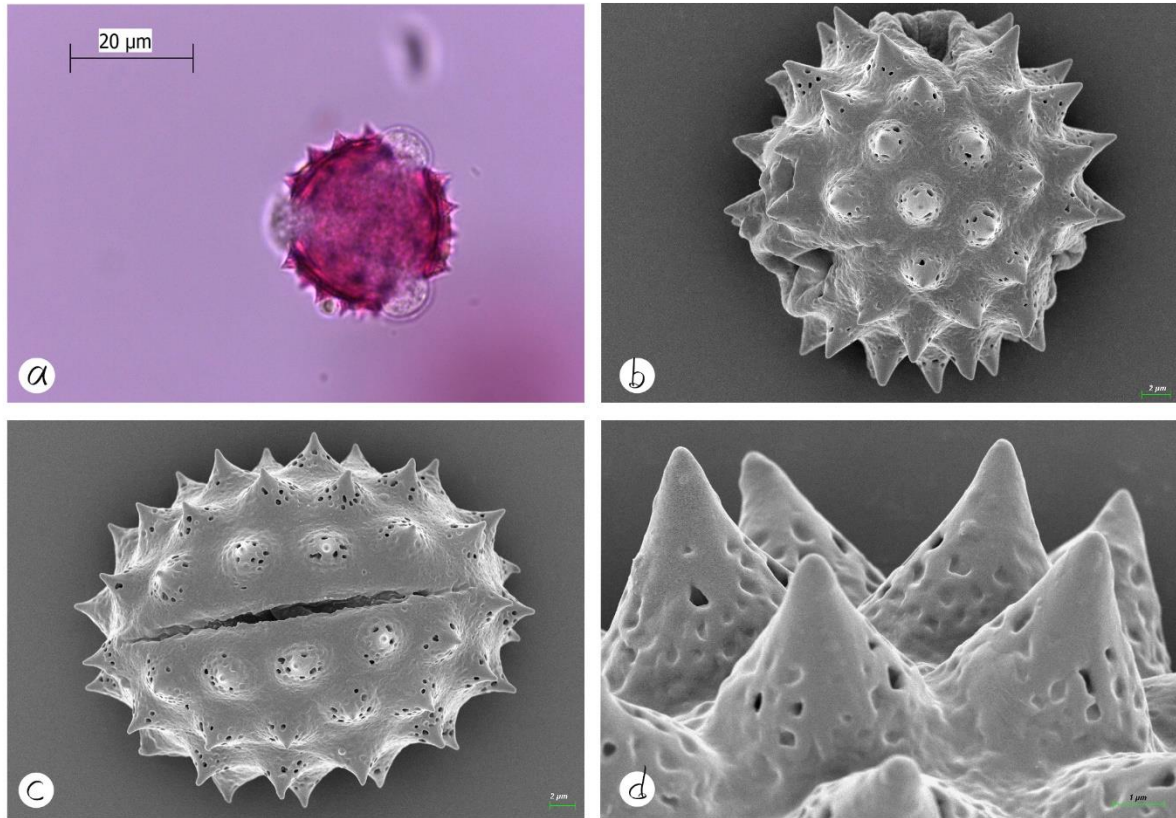


Figure 2. *C. montanum* a) General view of pollen grains in LM, b) Polar view of pollen grain in SEM, c) Equatorial view of pollen in SEM, d) Details of pollen surface in SEM.

Şekil 2. *C. montanum*'un a) Işık mikroskopunda polen tanelerinin genel görünüşü, b) Elektron mikroskopunda polen tanesinin polar görünüşü, c) Elektron mikroskopunda polen tanesinin ekvatoryal görünüşü, d) Elektron mikroskopunda polen yüzeyinin detaylı görünüşü.

Table 1. The pollen morphological characteristics of *C. montanum*

*Çizelge 1. C. montanum'un polen morfolojik özellikleri*

	<i>C. montanum</i>		
	M (µm) (Ortalama)	SE (Std. Hata)	Min. - Max. (µm)
P (polar axis)/ <i>polar eksen</i>	24.08	0.20	22-25.8
E (equatorial axis)/ <i>ekvatoryal eksen</i>	24.73	0.19	22.69-26.26
P/E	0.97	0.01	0.90-1.04
L (AMB) (equatorial diameter)/ <i>ekvatoryal çap</i>	23.6	0.17	21.83-25.39
clg (colpus length)/ <i>kolpus uzunluğu</i>	17.34	0.23	14.74-19.53
porus diam./ <i>por çapı</i>	6.09	0.63	5.37-6.82
t (apocolpium)/ <i>apokolpium</i>	17.02	0.12	16.04-18.64
dh (spine length)/ <i>diken uzunluğu</i>	3.46	0.09	2.32-4.58
dt (spine width)/ <i>diken genişliği</i>	3.89	0.09	2.57-5.43
Eksine	1.63	0.06	1.03-2.15
Intine	1	0.03	0.78-1.47
Polen shape/ <i>Polen şekli</i>	Oblate-spheroidale		
Aperture	Tricolporate		
Ornamentation/ <i>Süsleme</i>	Echinate-perforate		
Size/ <i>Ebat</i>	Small		

The cypselsae of *C. montanum* are oblong, 2.33-2.89 mm long, mature one brownish, c. 10 striate, glabrous. Pappus uniseriate, with 25-49 bristles, 0.35-0.57 mm long, smooth, white and free at base. The cypsela

morphology of *C. montanum*, *C. dichotomum* and *C. gueneri* taxa has been examined by Selvi et al. (2014). Selvi et al. (2014) stated that the general features of

*Chrysophthalmum* cypselae are narrowly obovate, obovate-oblongoid or narrowly elipsoidal to cylindrical, pale brown to dark brown, hairy or glabrous. The results of this study are in unconformity with Selvi et al. (2014). The cypselae shape of *C. montanum* is oblong in this study while it was reported as obovate, obovate-oblongoid or narrowly elipsoidal by them. Also, the cypselae size of *C. montanum* is 2.33-

2.89 mm long, while it was reported as 1.2–2.5 x 0.14–0.38 mm by Selvi et al. (2014). Consequently, the morphology, pollen and cypselae micromorphology of *C. montanum* were investigated extensively in this study. Morphological description of the species was improved and extended which contributed to the systematic knowledge of the genus *Chrysophthalmum*.

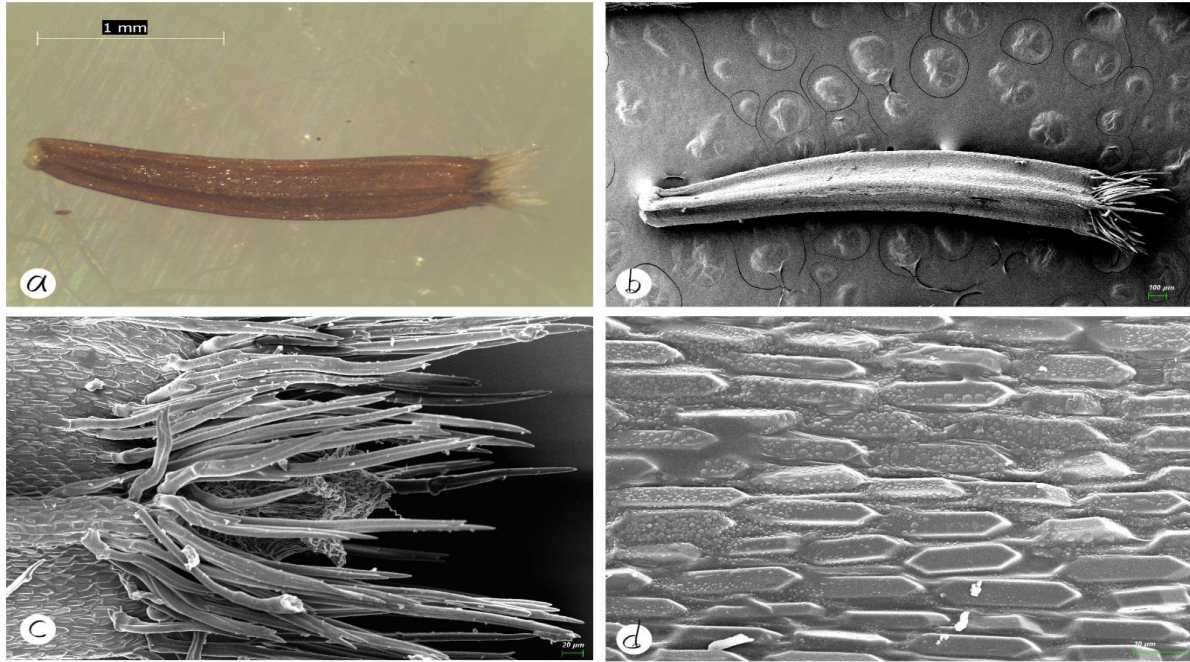


Figure 3. *C. montanum* a) Cypselae general view in LM, b) SEM photos of cypselae c) Pappus, d) Fruit wall details.  
Şekil 3. *C. montanum*'un a) Işık mikroskopunda akenin genel görünüşü, b) Elektron mikroskopunda akenin görünüşü, c) Tüylere, d) Meyve çeperinin detayları.

Table 2. Comparison of the morphological characteristics of *C. montanum* with previous study  
Çizelge. *C. montanum*'un morfolojik özelliklerinin önceki çalışma ile karşılaştırılması

	Flora of Turkey/ <i>Türkiye Florası</i> (Grierson, 1975)	Current study/ <i>Mevcut Çalışma</i>
Stem indumentum/ <i>Gövde tüyleri</i>	silkily pubescent	glandular-villous
Basal leaves/ <i>Taban yaprakları</i>	densely sericeous	densely glandular-villous
Phyllaries/ <i>Brakte</i>	Linear-lanceolate, adpressed-pubescent	Oblong-lanceolate, glandular-villous
Corollas of female flowers / <i>Dişi çiçeklerin korollası</i>	c. 4 mm	5.08-6.24 × 0.3-0.57 mm
Corollas of hermaphrodite flowers / <i>Erdişi çiçeklerin korollası</i>	4.5-5 mm	6-6.56 × 0.47-0.67 mm
Cypselae/ <i>Sipsela</i>	2 mm	2.33-2.89 mm, c. 10 striate
Pappus	c. 0.4 mm	25-49, 0.35-0.57 mm, free at base

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## Statement of Conflict of Interest

Author has declared no conflict of interest.

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