

COMPARATIVE CYPSELAR FEATURES OF TWO SPECIES OF *TAGETES* (TAGETEAE-ASTERACEAE) AND THEIR TAXONOMIC SIGNIFICANCE

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Abstract : Morphological and anatomical studies of cypselas in *Tagetes lucida* L. and *Tagetes tenuifolia* L. have been carried out in details with the help of light microscope. Some morphological features like cypselar surface hairs, carpopodium, detachment area, pappus bristles have potential value for characterization. Anatomically, phytomelanin layer is present in the mesocarpic region and which is continuous in case of *Tagetes tenuifolia* and discontinuous in case of *Tagetes lucida*. In the cypselas of *Tagetes lucida*, testa and endosperm layers are uniseriately arranged, whereas in *Tagetes tenuifolia*, testal layer is uniseriately arranged but endosperm layer is biseriately arranged. Based on the above mentioned morpho-anatomical features, an artificial key to the studied taxa has been constructed.

Keywords: Diacritical features; tageteae; asteraceae

INTRODUCTION

The tribe Tageteae contains 32 genera and approximately 270 species, which are found mostly in the South-Western USA and Mexico (Jeffrey, 2007). According to the observation of Loockerman et al. (2003), this tribe has approximately 216 New World species with a center of diversity in the Mexican highlands. According to Strother (1977), the genus *Tagetes* belongs to the Tribe Tageteae (Asteraceae) comprising of 50 species which are distributed in warmer parts of America. The name of this tribe was proposed by Cassini (1819), but the tribe was previously included in the tribe Heliantheae. Tageteae are generally annual or perennial herbs, although some members are shrubby or suffrutescent (Loockerman et al., 2003). The most striking character of this tribe is the presence of pellucid glands containing aromatic oils on the leaves and phyllaries. According to the opinion of Soule (1993), a number of species of *Tagetes* are used as medicinal beverages, or sold as green herbs or vegetables in Latin America. Majority of the earlier taxonomist including Cassini, (1829); Lessing (1832); De Candolle (1836); had been placed this tribe within the subfamily Asteroideae. Bremer (1987, 1994); has mentioned this group as a distinct tribe, which is closely related with the tribe Heliantheae sensu lato. Strother (1977) has placed this tribe into two subtribes. *Pectis* is a genus, which is placed within the first subtribe and remaining genera have been included under 2nd subtribe. In spite of being a fairly large genus in *Tageteae*, the cypselar morphological and anatomical features have not been studied in details. The aims of this study is to elaborate the detailed morpho-anatomical features of cypselas of this genus, with the help of light microscope.

MATERIAL AND METHOD

Mature, identified, cypselas of *Tagetes lucida* and *Tagetes tenuifolia* were collected from Botanischer Garten der Universität Zürich with the collection number-XX0Z-20031315 and XX0Z-20110213 respectively. Cypselas were processed, following the work of Mukherjee and Sarkar (1994). For anatomical studies techniques of Johansens (1940) were followed with Safranin and lightgreen and ultimately mounted in Canada balsum.

RESULTS AND DISCUSSION

Tagetes lucida

Cypselar Morphology (Fig.1 A-G, 3 A-D)

Cypselas homomorphic, 7 mm x 0.05 mm including awn, 5 mm x 0.05 mm excluding awn, black, obovate, margin entire, straight, upper part truncate whereas lower part tapered. Ellipsoidal in cross sectional configuration. Surface pubescent. Surface hair appressed to ascending in orientation with the surface, made up of body and basal cells. Body cells of surface hair with biseriately forked type. The tip portion of body cells arranged at different plain. Within the surface 16 ribs present, alternating with furrow. Furrows wider than ribs. At the upper portion of cypselas, stylopodium present, inconspicuous, fully immersed into the nectar. Pappus awn like, represented by ear like structure. Within the surface, phytomelanin layer observed. At the basal region of cypselas, carpopodium present, narrow than the base, symmetric, quadrangular. Carpopodial cells with thick-walled, pentangular, not pitted, arranged in single row.

Cypselar Anatomy (Fig.1 H-I)

Cypselas elliptic in cross sectional configuration. Ribs present; 16 in number, in conspicuous. Cypselar wall 0.03 mm and 0.02 mm wide at ribs and furrow

region respectively. Pericarp thick, differentiated into epicarp and mesocarp. Epicarp uniseriate, made up of thin walled, rectangular, compactly arranged, parenchyma cells, provided with cuticle. Internal to the epicarp mesocarp present, homogenous, made up of compactly arranged, more or less pentangular, sclerenchyma cells. In between the epicarp and mesocarp, phytomelanin layer present, discontinuously arranged. Testa attached with cypselar wall, made up of thick walled, horizontally placed, parenchyma cells, uniseriately arranged. Endosperm persists in mature cypselar wall, uniseriate, made up of, barrel shaped, parenchyma cells, uniseriately arranged. Mature embryo occupies a major part of cypselar wall, cotyledons 2 in number, arranged at right angle to the axis of cypselar wall, containing 12 resin ducts (6 ducts in each cotyledon).

Tagetes tenuifolia

Cypselar morphology (Fig. 2 A-E, 3 E-G)

Cypselar homomorphic, 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn, dark brown, linear, straight. Surface pubescent, surface hair adpressed to ascending in orientation, made up of body and basal cells. The tip portion of body cell with biseriately forked type, situated in a different

plane. Within the surface, phytomelanin layer exist. Stylopodium inconspicuously developed. At the upper portion of cypselar, pappus present; awn like, homomorphic, yellow brown, arranged in a single circle. At the basal region of cypselar, carpodium present; symmetric, more or less rounded. Carpodial cells with thick walled, arranged in 3 rows.

Cypselar anatomy (Fig. 2 F-G)

Cypselar more or less elliptic in cross sectional configuration. Pericarp thick, on an average 0.02 mm, differentiated into epicarp and mesocarp. Epicarp uni-seriately arranged, parenchymatous. Internal to the epicarp, mesocarp present; made up of continuously arranged, sclerenchyma cells. Just below the epicarp region, phytomelanin layer present, continuously arranged. Testa attached with cypselar wall, approximately 0.005 mm, made up of crusted layer of parenchyma cells, uni-seriately arranged. Endosperm persists in mature cypselar wall, thick walled, parenchymatous, biseriately arranged. Mature embryo occupies a major part of cypselar wall, cotyledons 2 in number, arranged oblique to the axis of cypselar wall, containing 6 resin ducts (3 ducts in each cotyledon).

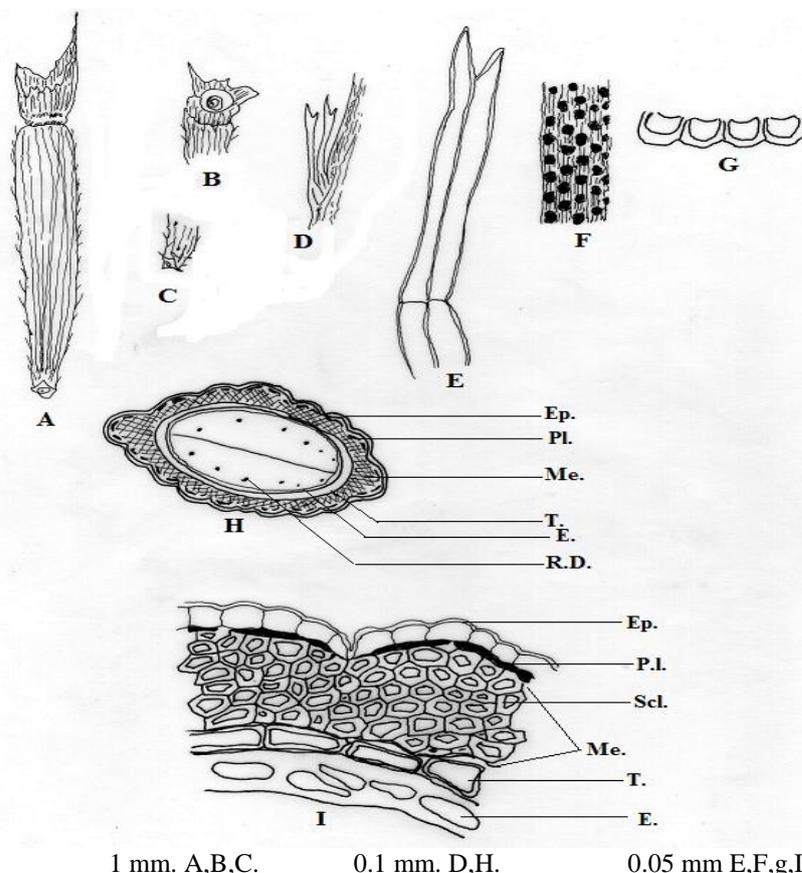
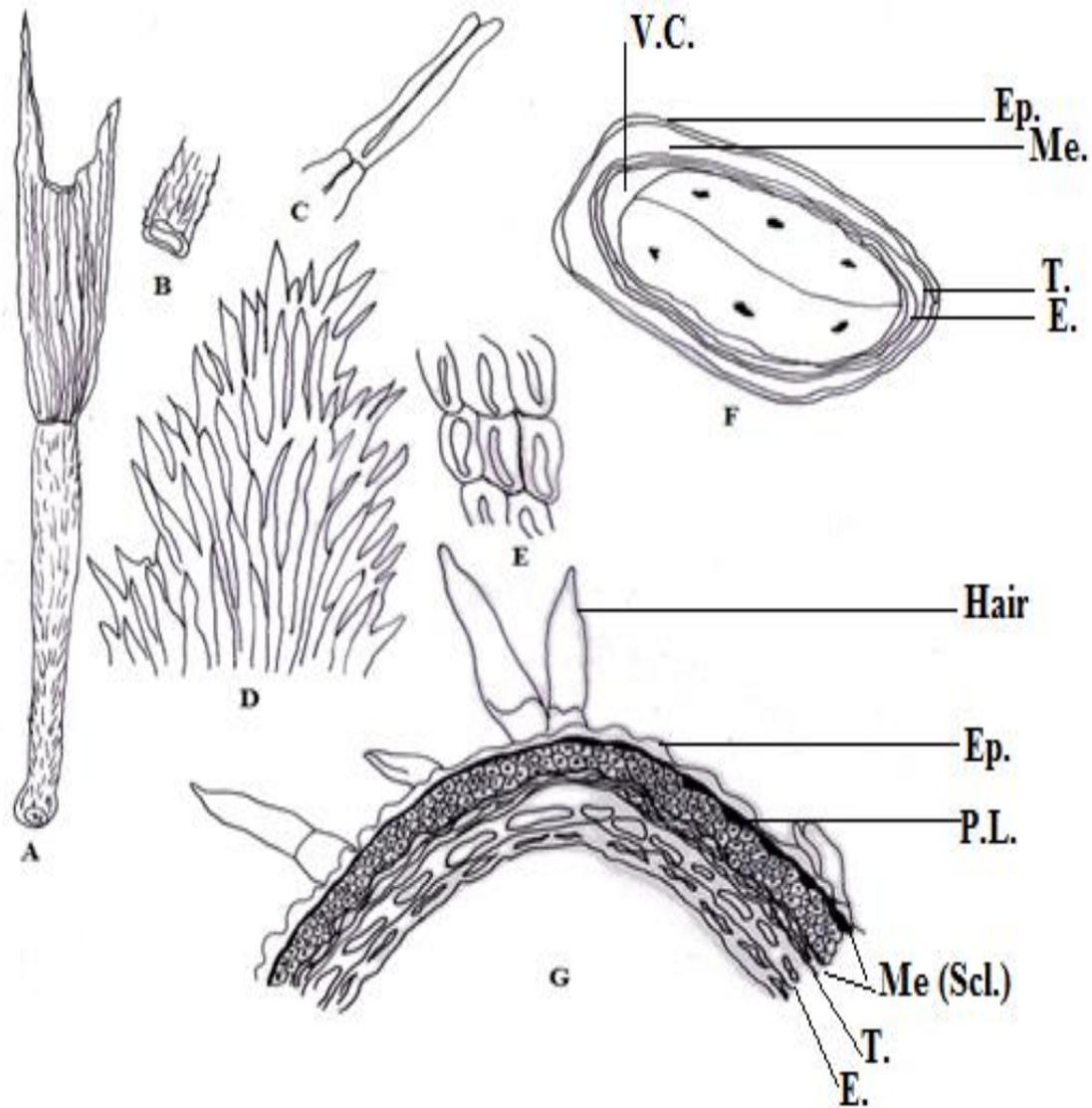


Fig.1: Cypselar morpho-anatomy of the species *Tagetes lucida*

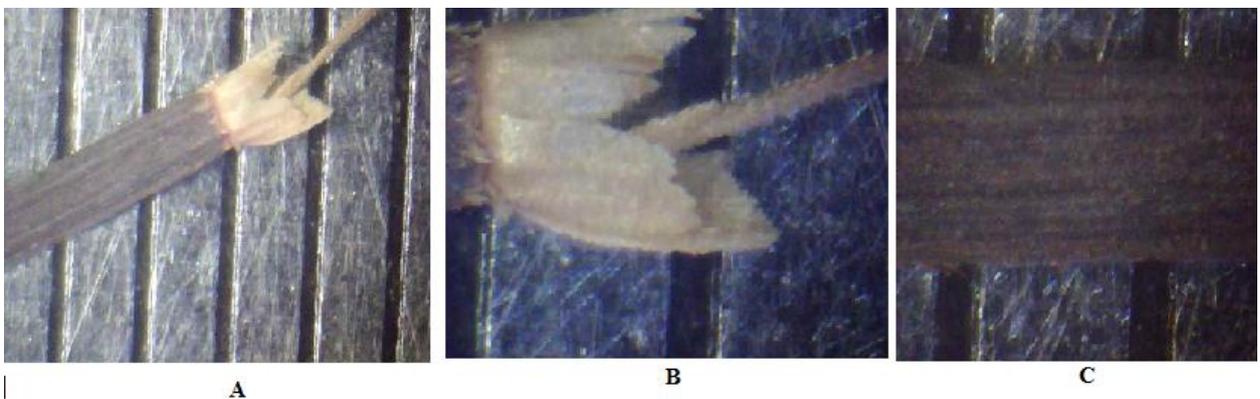
1.A-G: Cypselar morphology: A-Cypselar, B-Upper part, C-Lower part, D- Surface showing hairs, E-An intact surface hair, F-Surface showing phytomelanin deposition, G-Carpodium cells; 1.H-I: Cypselar anatomy: H-Diagrammatic view, I-Cellular view.



1 mm A,B 0.1 mm C,D, F 0.05 mm E,G

Fig.2: Cypsellar morpho-anatomy of the species *Tagetes tenuifolia*
 1.A-E: Cypsellar morphology: A-Cypselus, B-Basal part, C-Surface hair, D- Part of pappus, E-Carpodial cells; F-G- Cypsellar anatomy: F-Diagrammatic view, G-Cellular view.

Abbreviations: Ep-Epicarp, Me-Mesocarp, Pl-Phytomelanin layer, T-Testa, Scl-Sclerenchyma, E-Endosperm, RD-Resin duct, V.C.-Vellicular cavity



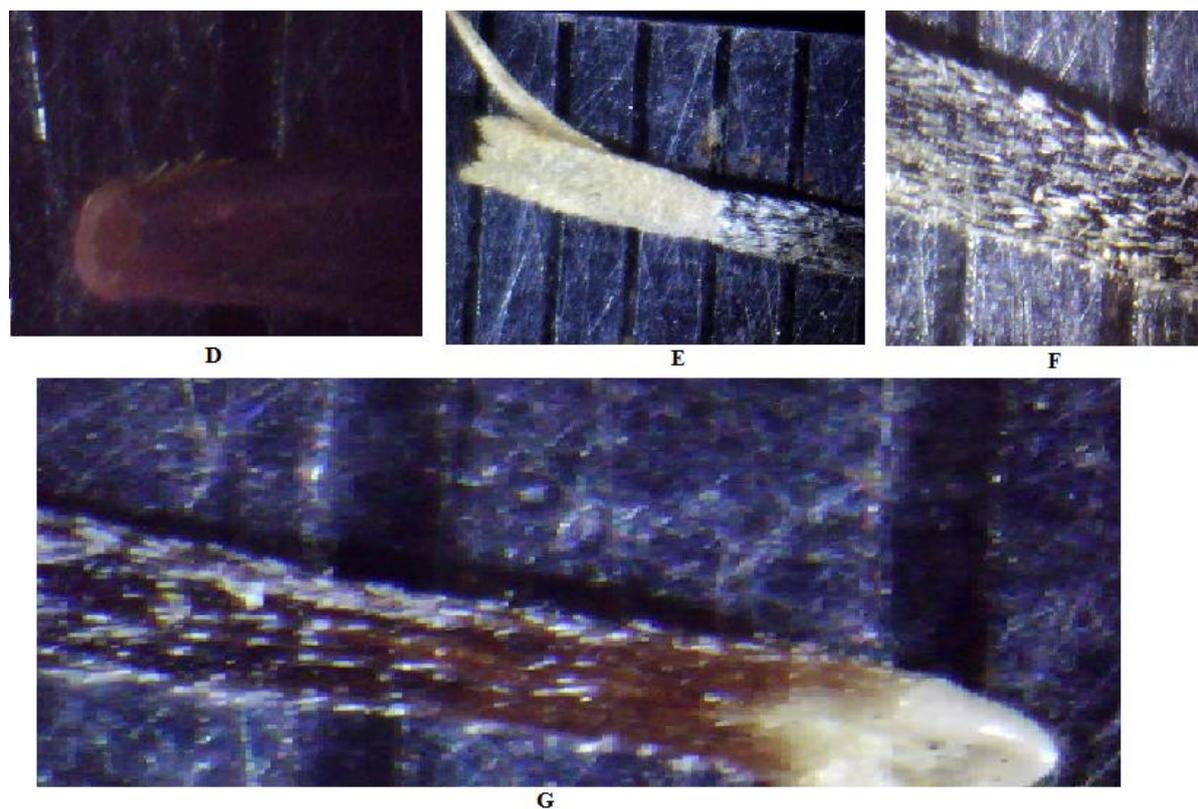


Fig. 3. Micro photographs of studied cypselas.

3. A-D- *Tagetes lucida*: A-Cypselum, B-Pappus, C-Surface, D-Carpodium; E-G- *Tagetes tenuifolia*: E-Cypselum, F-Surface showing hairs, G- Basal portion of cypselum, showing carpodium

Table 1: Comparative morpho-anatomical features of studied cypselas

Tagetes lucida	Tagetes tenuifolia
1. Cypselum homomorphic, 7 mm x 0.05 mm including awn, 5 mm x 0.05 mm excluding awn.	1. Cypselum homomorphic, 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn
2. Cypselum black in colour	2. Cypselum dark brown in colour
3. Cypselum obovate in shape	3. Cypselum linear in shape
4. Surface containing 16 ribs	4. Surface containing 4 ribs
5. Carpodium quadrangular in shape	5. Carpodium more or less rounded in shape
6. Carpodium cells are arranged in single row	6. Carpodium cells are arranged in three rows
7. Testa uni-seriately arranged, parenchymatous, horizontally placed.	7. Testa uni-seriately arranged, made up of crusted layer of parenchyma cells.
8. Endosperm uni-seriately arranged, parenchymatous.	8. Endosperm bi-seriately arranged, parenchymatous.
9. Cotyledons placed at right angle to the axis of cypselum	9. Cotyledons placed obliquely to the axis of cypselum
10. Each cotyledon containing 6 resin ducts	10. Each cotyledon containing 3 resin ducts

The studied cypselas are homomorphic. Surface is pubescent. Surface hair is twin type, ascending in orientation with the surface, made up of body and basal cells. This type of surface marking is also present in case of *Tagetes minuta*, of this tribe (Mukherjee and Sarkar, 1999). Pappus is an important taxonomic character of cypselum. Pappus is also present in *Tagetes minuta*, of this tribe. General morphology of the cypselum of this species is more or less equal with some primitive members of the tribe Senecioneae. In this connection, Mukherjee

(1992), has mentioned a connecting link between the tribe Tageteae and Senecioneae. Not only the tribe Senecioneae, it is also related with the tribes of other Heliantheae Alliance Group (Panero and Funk, 2002; 2008; Funk et al, 2009; Cawford and Tadesse, 2014; Pandey et al, 2014). According to the information of Bremer (1996) this group has been treated as a subtribe in Helenieae. The similarity between the tribe Tageteae and Heliantheae are as follows

1. Presence of awn like pappus

2. Presence of phytomelanin layer
3. Mode of arrangement of mechanical tissue (Sclerenchyma tissue) in the pericarpic zone.
4. Nature of testa and endosperm.

From this above mention observation, it may be concluded that, the tribe Tageteae is closely related with the tribes of other Heliantheae Allianeae Group such as Heliantheae, Helenieae, Eupatorieae, Bahieae, Coreopsideae, Madieae, Millerieae, Perityleae, Polymnieae due to the presence of awns and phytomelanin pigment etc.

Key to the studied cypsels

1a. Cypsela 7 mm x 0.05 mm including awns and 5 mm x 0.05 mm excluding awns; obovate; carpoidial cells uniseriately arrange; phytomelanin layer discontinuously arranged; testal layer made up of horizontally placed, parenchyma cells; endosperm layer uni-seriately arranged..... *Tagetes lucida*

1b. Cypsela 15 mm x 1 mm including awn, 9 mm x 1 mm excluding awn; linear; carpoidial cells triseriately arrange; phytomelanin layer continuously arranged; testal layer made up of crusted layer of parenchyma cells; endosperm layer biseriately arranged..... *Tagetes tenuifolia*

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