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Diacritical features of cypselas in two taxa of the tribe Arctotideae (Compositae)

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ABSTRACT

The present paper deals with the morphological and histological features of cypselas in two taxa (*Berkheya purpurea* and *Gazania krebsiana*) of the tribe Arctotideae of Compositae. The stable and diacritical morphological features of cypselas are the presence of pappus, surface hair, stylopodium, carpopodium *etc*. Among the studied cypselas, in the cypsela of *Berkheya purpurea*; scaly pappus is present whereas in the cypsela of *Gazania krebsiana,* pappus is serrulate setose type. In both the studied cypselas, surface is pubescent type. Stylopodia are inconspicuously developed, fully immersed in the nectar. In the cypsela of *Berkheya purpurea*, true carpopodium is absent *i.e*. presence of pseudocarpopodium whereas in the cypsela of *Gazania krebsiana*, true carpopodium is present and carpopodial cells are arranged in 3-4 rows. Anatomically, pericarpic zone is clearly differentiated into epicarpic and mesocarpic zone. In the cypsela of *Gazania krebsiana*, within the mesocarpic region; vellicular cavity is present whereas in other studied cypsela, vellicular cavity is absent. In the cypsela of *Berkheya purpurea,* testal layer is bi-seriately arranged but in *Gazania krebsiana*, testal layer is uniseriately arranged, U- shaped and parenchymatous. In both the studied cypselas, endosperm layer is uni-seriately arranged, parenchymatous. An artificial key is made for the easy identification of studied taxa on the basis of morpho-anatomical characters of mature cypselas.

Key words: Cypselar morpho-anatomy; Arctotideae; Compositae.

The tribe Arctotideae consists of 17 genera and approximately 215 species by Kadereit & Jeffrey[4], which are distributed in South Africa, except *Cymbonotus* which is native in South Australia by Kadereit & Jeffrey[4]. Acording to Karis *et al*.[5], this tribe is diagnosed by a combination of morphological features. These features are not present in all included

genera, even after the molecular analysis. Several authors[6,11,12] have done the study, on the basis of pollen morphology of this tribe. Cypselar morpho-anatomy have been elucidated as significant taxonomic parameter in this tribe by Mukherjee and Sarkar[8]. Though, in this tribe cypselas are generally obovoid, some time oblong to elliptic in shape. Surface hair is sericeous- villous type of twin hairs or glabrous by Kadereit & Jeffrey[4]. Pappus is either may be scaly type or bristles type. Sometime pappus is absent by Kadereit & Jeffrey[4]. However, the study on this tribe (Reese[10]) have not been elucidated adequately from the both morpho-anatomical view points of cypselas. So, this work has been taken to elaborate the cypselar features of studied species on the basis of both morpho-anatomical study.

The studied materials were collected from a herbarium (Botanischer Garten der Universitat Zurich, Switzerland) of the world. The name of the studied materials, their sources and collection numbers are given in the table-1.

Table-1. Showing the number of studied species, their source and collection number

Studied species	Sources with collection number
1. *Berkheya purpurea* (DC.) Mast.	*Botanischer Garten der Universitat Zurich (Z).* Collection Number: XXOZ-20041189
2. *Gazania krebsiana* Less.	*Botanischer Garten der Universitat Zurich (Z).* Collection Number: XXOZ-19810083

For morphological study, cypselas were softened by 4% NaOH solution. Then, they were stained in aqueous safranin solution (0.1%) to observe the different morphological parts with the help of simple dissecting microscope (Model No- 363 01, Meopta, PRAHA, Made in Czechoslovakia). For anatomical study, cross sections were done with the help of a sharp razor blade to observe the different anatomical region, under compound research microscope (Metzer).

Berkheya purpurea :

Morphology (Fig. 1 A-D)

Cypsela heteromorphic. Ray cypsela 5 mm x 3 mm including pappus, 3 mm x 3 mm excluding pappus, black brown, oblanceolate, straight, upper part truncate, whereas lower part tapered, entire margin. Disk cypsela 4 mm x 2 mm including pappus, 3 mm x 2 mm excluding pappus, black brown, narrow oblong, straight, upper part truncate, whereas lower part tapered, entire margin. More or less trigonous in cross section. Surface slightly pubescent, containing 8 ribs, alternating with furrow. Surface hair apprised to inclined in orientation with the surface, made up of body and basal cells. The tip portion of body cells of hairs situated in different plane. At the upper part of cypsela, scaly pappus present. Stylopodium inconspicuously developed, fully immersed into the nectar. At the basal region of cypsela,

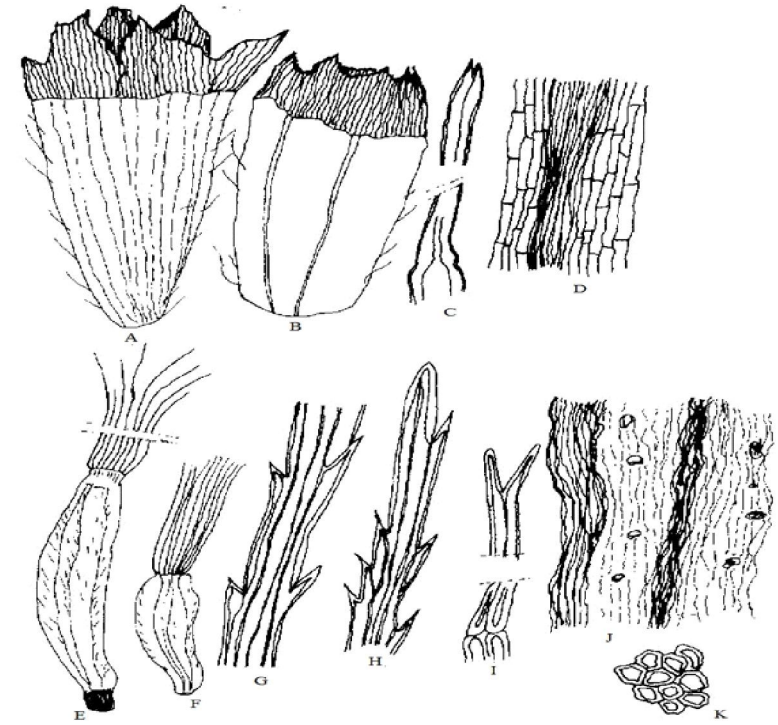


Fig-1. Morphology of studied cypselas

A-D- *Berkheya purpurea*: A- Ray cypsela, B-Disk cypsela, C- Surface hair, D- Surface structure; E- K- *Gazania krebsiana*: E- Ray cypsela, F- Disk cypsela, G- Middle part of pappus bristles, H- Upper part of pappus bristles, I- Surface hair, J- Surface structure, K- Carpopodial cells.

carpopodium present, narrower than the base, biconvex, asymmetric. Carpopodial cells not clearly distinct from the remaining part of cypsela.

SEM- Morphology (Fig. 3 A-B)

Surface pubescent, containing twin type of surface hair. Pappus is scaly type, arranged in single circle.

Anatomy (Fig. 2 A)

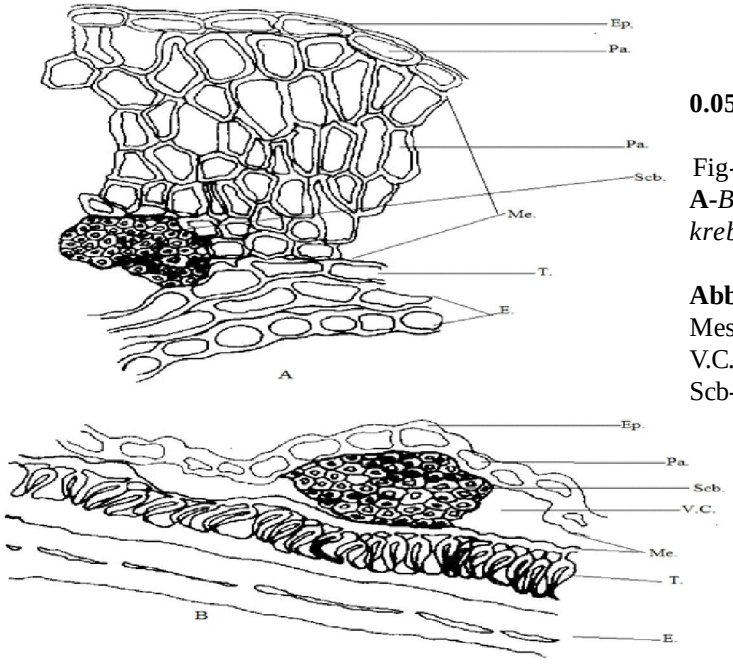
Cypsela more or less trigonous in cross section. Ribs present; 8 in number, conspicuous. Cypselar wall 0.1 mm and 0.05 mm wide at ribs and furrow region respectively. Pericarp thick, differentiated into two zones- epicarp and mesocarp. Epicarp uniseriate, made up of thick-walled, rectangular, compactely arranged, parenchyma cells, provided with cuticle. Internal to the epicarp, mesocarp present; homogenous, made up of compactely arranged, small to elongated, parenchyma cells

containing vascular trace below each ribs. Within the furrow region, vascular trace absent. Testa attach with cypselar wall, approximately 0.01 mm thick, made up of thick-walled, horizontally placed, parenchyma cells, biseriately arranged. Endosperm persists in mature cypsela, uniseriate, made up of barel shape swelling of parenchyma cells, uniseriately arranged. Mature embryo occupies a major part of the cypsela; cotyledons 2 in number. Cotyledonary resin ducts not clearly observed.

Gazania krebsiana :

Morphology (Fig. 1 E-K)

Cypsela heteromorphic. Ray cypsela 13 mm x 1 mm including pappus, 6 mm x 1 mm excluding pappus, black brown, oblanceolate, slightly curved, margin entire, upper part truncate whereas lower part tapered. Disk cypsela 8 mm x 1 mm including pappus, 4 mm x 1 mm excluding pappus, black brown, narrow oblanceolate, slightly curved, upper part truncate whereas lower part tapered. Ellipsoidal in cross sectional configuration. Surface pubescent containing 7 ribs, alternating with furrows. Furrows wider than ribs. Stylopodium inconspicuously develop, fully immersed in to the nectar. Surface hair ascending in orientation with the surface, made up of body and basal cells. The tip portion of the body cell of surface hair arranged in different plane. At the upper portion of cypsela pappus present; homomorphic, represented by 65-70, serrulate setose type of pappus bristles, unequal, white. At the basal region of cypsela carpopodium present, narrower than the base, symmetric, irregular ring like. Carpopodial cells with thick walled, quadrangular to pentangular, arranged in 3-4 rows.



0.05 mm A, B

Fig-2. Anatomy of studied cypselas **A-***Berkheya purpurea*, **B**- *Gazania krebsiana*

Abbriviations: Ep- Epicarp, Me- Mesocarp, T- Testa, E- Endosperm, V.C.- Vellicular cavity, Pa- Parenchyma, Scb- Sclerenchyma bundle.

SEM – Morphology (Fig. 3 C-D)

Surface pubescent, containing twin type of surface hair; made up of body and basal cells. The tip portion of body cells are biseriately forked type, arranged in different plain. Pappus is barbellate type, arranged in single circle.

Anatomy (Fig.2 B)

Cypsela elliptic in cross section. Ribs present; 7 in number, conspicuous. Cypselar wall 0.07 mm x 0.01 mm wide at ribs and furrow region respectively. Pericarp thin, differentiated into epicarp and mesocarp. Epicarp uniseriate, made up of thick-walled, oval-rectrangular, compactely arranged, parenchyma cells. Internal to the epicarp, mesocarp present; made up of thick-walled, compactely arranged, pentangular, sclerenchyma cells, just below the ribs. With in the furrow region, mesocarp absent. So, within the furrow region, pericarp represented by only epicarp. Within the mesocarpic region, vellicular cavity present. Testa attach with cypselar wall, approximately 0.02 mm thick, made up of U shape parenchyma cells, uniseriately arranged. Endosperm persists in mature cypsela, uniseriate, made up of thick-walled, horizontally placed, parenchyma cells. Mature embryo occupies a major part of the cypsela; cotyledons 2 in number, arranged at right angle to the axis of cypsela, containing 20 resin ducts (10 ducts in each cotyledon).

Two species (*Berkheya purpurea* and *Gazania krebsiana*) of the tribe Arctotideae, have been studied in detailed to observe the various type of morphological and anatomical features. Present morphological observation of cypselas are clearly indicate that these features can be used for taxonomic study as these characters can be used for the separation of taxa, among the 2 studied cypselas. The studied cypselas are black- brown in colour. This type colour variation has also been noted by Mukherjee and Sarkar[8]. Surface is pubescent in both the studied cypselas and bear, twin type of surface hairs. In all the studied cypselas, stylopodia are inconspicuously developed. Stylopodia are also inconspicuously developed in some other species (*Arctotheca calendula, Arctotis venusta etc*.) of this tribe[8]. In *Gazania krebsiana*, carpopodial cells with thick walled, quadrangular to pentangular, arranged in 3-4 rows, whereas in *Berkheya purpurea*, carpopodial cells are not clearly distinct from the remaining part of cypsela, *i.e*. pseudocarpopodium. Haque and Godward[2], have also reported the absence of carpopodium in case of *Arctotis stoechadifolia*. In the cypsela of *Berkheya purpurea*, scaly pappus is present whereas in case of *Gazania krebsiana*, pappus is homomorphic and represented by 65-70, serrulate setose type of pappus bristles.

It is generally considered that the pappus plays an important role in the dispersal of the one-seeded dry fruits, called achenes or cypselas[9]. An overview of the diversity in pappus structure within the subfamily Asteroideae was given by Mukherjee & Sarkar[8].

Anatomically, the studied cypselas are trigonus-ellipsoidal in cross-sectional configuration. The mode of orientation of epicarpic cells and their structures are very useful in taxonomic view point[8]. In all the studied

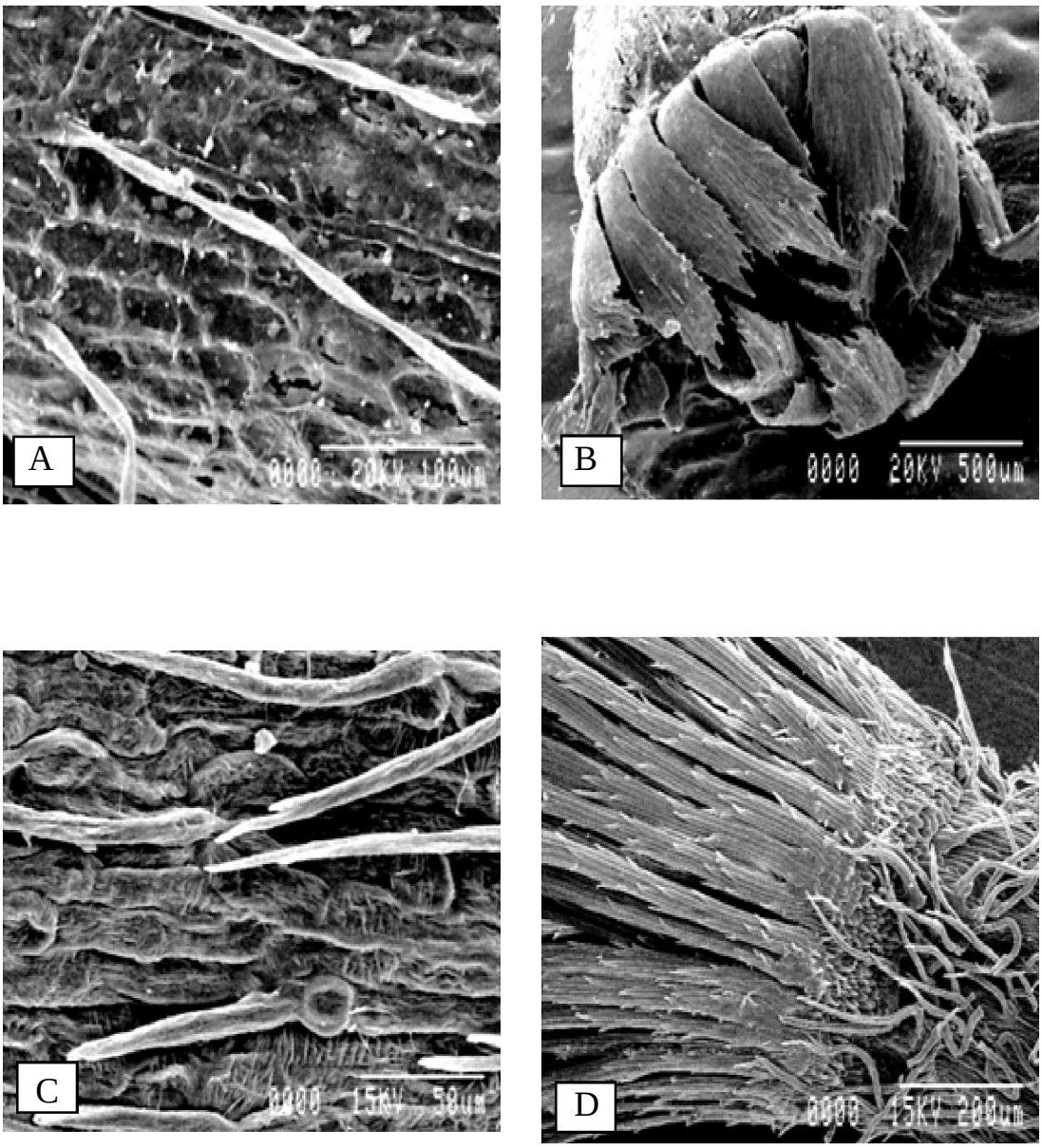


Fig. 3. (A-D)SEM photographs of studied cypselas

A-B- *Berkheya purpurea*: A-Surface structure, showing hairs, B- Upper part of cypsela, showing pappus; C-D- *Gazania krebsiana*: C- Surface structure, showing surface hair, D- Upper part of cypsela, showing pappus.

cypselas, epicarp is made up of thick-walled, oval-rectrangular, compactely arranged, parenchyma cells. In some other studied cypselas (*Arctotis* and *Arctotheca*), epicarpic cells are tangentially oriented. In all the studied cypselas, mesocarpic region is homogenously developed. In the cypsela of other studied species (*Arctotheca*) of this tribe, mesocarpic region is heterogeneously developed. Reese[10], has reported some arguments regarding the heterogeneously development of mesocarpic region in this tribe. So, according to Reese[10], it can be concluded that the mesocarpic region of the tribe Arctotideae is either homogenously or heterogeneously developed. In the cypsela of *Gazania krebsiana*, within the mesocarpic region; vellicular cavity is present whereas in other studied cypsela, vellicular cavity is absent in the mesocarpic region. Among the studied cypselas, testal layer is may be either bi-seriately (*Berkheya purpurea*) or uni-seriately (*Gazania krebsiana*) arranged. In the cypsela of *Gazania krebsiana*, testal layer is U- shape in nature. This shape (U) of testal layer is absent in the cypsela of *Berkheya purpurea*. Jana and Mukherjee[3], have reported the presence of U- shape testal layer in some species (*Solidago virgaurea* and *S. canadensis*) of the tribe Astereae. According to present observation, U-shape testal layer is also present in some species of the tribe Arctotideae. Internal to the testal layer, endosperm layer is present. This layer is uni-seriate in development, in case of both the studied cypselas. Uni-seriate endosperm layer is also present in some other studied genera (*Arctotheca* and *Arctotis*) of the tribe Arctotideae. According to Bartthlott[1], endosperm layer is usually with single layer in case of mature cypselas.

Key to the studied species:

1a. Ray cypsela 5 mm x 3 mm including pappus, 3 mm x 3 mm excluding pappus; scaly pappus present; pseudocarpopodia; vellicular cavity absent; testa bi-seriate; cotyledonary resin ducts not clearly observed…… ***Berkheya purpurea***

1b. Ray cypsela 13 mm x 1 mm including pappus, 6 mm x 1 mm excluding pappus; serrulate setose type of pappus bristles present; presence of true carpopodium; vellicular cavity present in mesocarpic region; testa uni-seriate; cotyledonary resin ducts 20 in number (10 ducts in each cotyledon)…… ***Gazania krebsiana***

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