

MORPHO - ANATOMICAL STUDIES OF CYPSELAS IN THE TRIBE SENECTIONEAE (ASTERACEAE)

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ABSTRACT ■ Senecioneae is one of the unique tribes recognized by Cassini among the 43 tribes of Asteraceae. Present study is based on the morpho-anatomical characters of cypsela among one species each of *Barkleyanthus* [*Barkleyanthussalicifolius* (Kunth) H. Robinson & Brettell], *Packera* [*Packeradimorphophylla* (Greene) W. A. Weber & Á. Löve] and *Senecio* (*Senecioelegans* L.) under the tribe Senecioneae. Morphological characters like apical part of the cypsela, surface hairs, structure of carpopodium, pappus bristles type and anatomical features such as pericarpic tissue arrangement, testal layers and endosperm are taxonomically significant. The studied characters has important role in isolation of taxa at species level. An artificial key is provided on the basis of macromorpho-anatomical features of cypselas for identification of the studied species. The objective of the present study is to analyse the detailed morpho-anatomical structures of the cypselas and also to show the relationships among them.

Key words: Asteraceae, Carpology, Senecioneae

INTRODUCTION

Morpho-anatomical characters play an important role in isolation of taxa at species level. One seeded, indehiscent, unilocular fruit of the plants belonging to the family Asteraceae is commonly known as cypsela (or achene). Micro-morphological and anatomical characters of these fruits have been critically examined by many workers to assign the plants in the family Asteraceae into different tribes more precisely.

The unique Tribe Senecioneae (Asteraceae) with “bifurcate styles with separate stigmatic areas, apically truncate sweeping hairs” was

recognized by Cassini (1819), Lessing (1832) and de Candolle (1836-1838), Bentham (1873), Robinson and Brettell, (1973), Turner and Powell (1977), Nordenstam (1977), Jeffrey and Chen (1984), Bremer (1994), and Pelser *et. al.* (2007). Recently, molecular phylogenies redefined the tribe Senecioneae more narrowly and it includes approximately 1000 species (Pelser *et. al., l.c.*) and 150 genera (Nordenstam, 2007).

Present study analyses morphological and anatomical characters of cypselas of three species under this tribe and tries to find the relationships among them.

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MATERIALS AND METHODS

The investigated cypselas (Table 1) were supplied by the 2nd author of the paper in the form of herbarium specimens from Harvard University Herbaria. The present study includes 3 species belonging to genus *Barkleyanthus*, *Packera* and *Senecio* under the Tribe Senecioneae of the family Asteraceae.

heteromorphic cypselas, all the above mentioned characters were studied for both the ray and disc cypselas. Observations were carefully noted. For both morphological and anatomical studies, cypselas were softened (Mukherjee and Sarkar, 1994), carefully dissected, stained (Johansen, 1940) and outline diagrams were drawn by prism type

Table 1: Sources of the plant material

Sl. No.	Name of the tribe	Name of the studied taxa	Locality	Collection No.
1	Senecioneae	<i>Barkleyanthussalicifolius</i> (Kunth) H. Robinson & Brettell	Harvard University Herbaria, Cambridge, USA	150
2	"	<i>Packeradimorphophylla</i> (Greene) W. A. Weber & Á. Löve	"	11372
3	"	<i>Senecioelegans</i> L.	"	63058

Fully matured and intact cypselas were collected for investigating stable and perfect stage of each character. Mature, preserved, dry 10 cypselas were randomly taken for each of the three species and observed for morphological (Table 2) and anatomical (Table 3) study under the Olympus Stereo dissecting microscope (DM) and Metzer binocular compound light microscope (LM).

Morphological characters like types, orientation, distribution, nature of hair, gland, carpodial cells, surface cells, other epidermal structures and anatomical features such as pericarpic tissue arrangement, testal layers, and endosperm were critically examined. Number, colour, arrangement, length of pappus were also observed.

Length and width of the cypselas were measured by graph paper, scale and in few cases by ocular and stage micrometer. In the present study the length of cypselas means the length of the body of cypselas from apical end excluding pappus up to the basal meristematic zone (carpopodium). The widest part of the cypselar body was measured as the width of the cypselas. In case of

Camera Lucida. Suitable images were taken using camera equipped microscope.

DISCUSSION

Cypselar Morphology

Present study includes cypselas of 1 species each of *Packera*, *Barkleyanthus* and *Senecio*. The length of the cypselas of different species is not a reliable distinguishing character because the length of one species overlaps with others. Cypselas are usually narrow oblong or oblanceolate (*Barkleyanthussalicifolius*) or seldom elliptic (*Senecioelegans*). Cypselas are often terete (*Senecio*) to sub-terete or sometimes compressed (*Barkleyanthus*). Number and shape of the ribs are significant for characterization of taxa.

Hairs are distributed in 1-4 rows on each furrow or randomly throughout the surface or at the furrows, except in *Packeradimorphophylla*, where it is absent, while mucilage hairs is absent in all the studied species. Nordenstam (1977) reported mucilaginous hairs in the members of Senecioneae and named the hairs as "twin or duplex hairs". While present LM observations

clearly show that tips of the twin hairs are obtuse or rounded but not sharply pointed. Similar observations were reported by other workers (Mukherjee, 2001b; Mitra and Mukherjee, 2003).

Stylopodium has significant role for characterization of the studied taxa. Stylopodium is knob on short column in two species (*Barkleyanthus* and *Senecio*). While, previous reports of short angular tube

Table 2: Comparative morphological features of the studied cypselas.

Name of taxa	Shape	Surface	Pappus	Carpodium
<i>Barkleyanthussalicifolius</i>	Narrow oblong or oblanceolate	Rough with tomentose hairs	Represented by 24 – 26, equal, free, homomorphic, unbranched, barbed bristles; occur in 2-3 rows	Symmetric, circular ring like
<i>Packeradimorphophylla</i>	Oblong	Glabrous	Represented by 23 – 25, equal, barbed bristles; occur in 2-3 rows	Ill developed
<i>Senecioelegans</i>	Elliptic	Ribbed; papillose hairs at ribs, rough at furrow	Represented by 28 – 30, equal, barbed bristles; occur in 3 rows	Symmetric, circular ring like

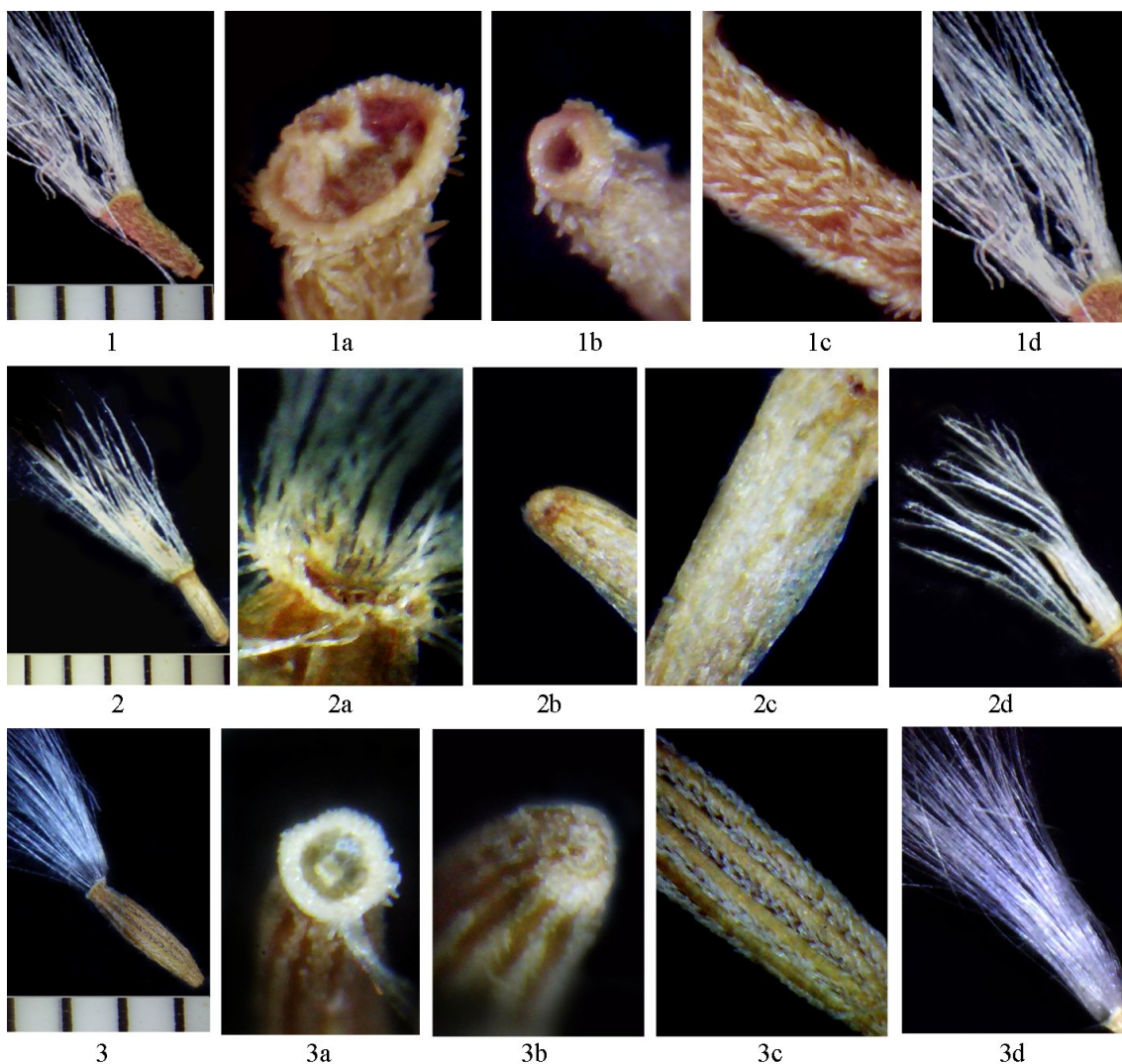
Table 3: Comparative anatomical features of the studied cypselas.

Name of taxa	<i>Barkleyanthussalicifolius</i>	<i>Packeradimorphophylla</i>	<i>Senecioelegans</i>
Cypselar shape in T.S.	Deformed spindle shaped in cross section	Ribbed spindle shaped in cross section	Ribbed oval in cross section
Mesocarpic parenchyma	Present	Present	Very small amount
Mesocarpic sclerotic cells	Absent	Absent	Thick walled, compactly arranged, hexagonal, with large round lumen
Cell content of testa	Disorganized, partially cellular	Partially cellular, irregularly oriented	Partially cellular, compactly arranged,
Testal cell shape	Layer of crusted parenchymatous cells	Thick walled, parenchymatous cells	Thick walled, parenchymatous cells
Endosperm	Thick walled, square, parenchymatous	Thick walled, irregular shaped, parenchymatous, compactly arranged	Thick walled, compressed, compact parenchymatous cells rectangular shaped,
Endosperm layer	2 – 3- seriate	3 – 4- seriate	Uniseriate
No. of secretory duct	Secretory ducts 3 in each cotyledon	Secretory ducts 3 in each cotyledon.	Secretory ducts 4 in each cotyledon

like stylopodium (Mitra and Mukherjee, *l.c.*) or stylopodium free from the nectary or the style base is situated at the top of the nectary (Category-IV - Mukherjee, 2005) also found.

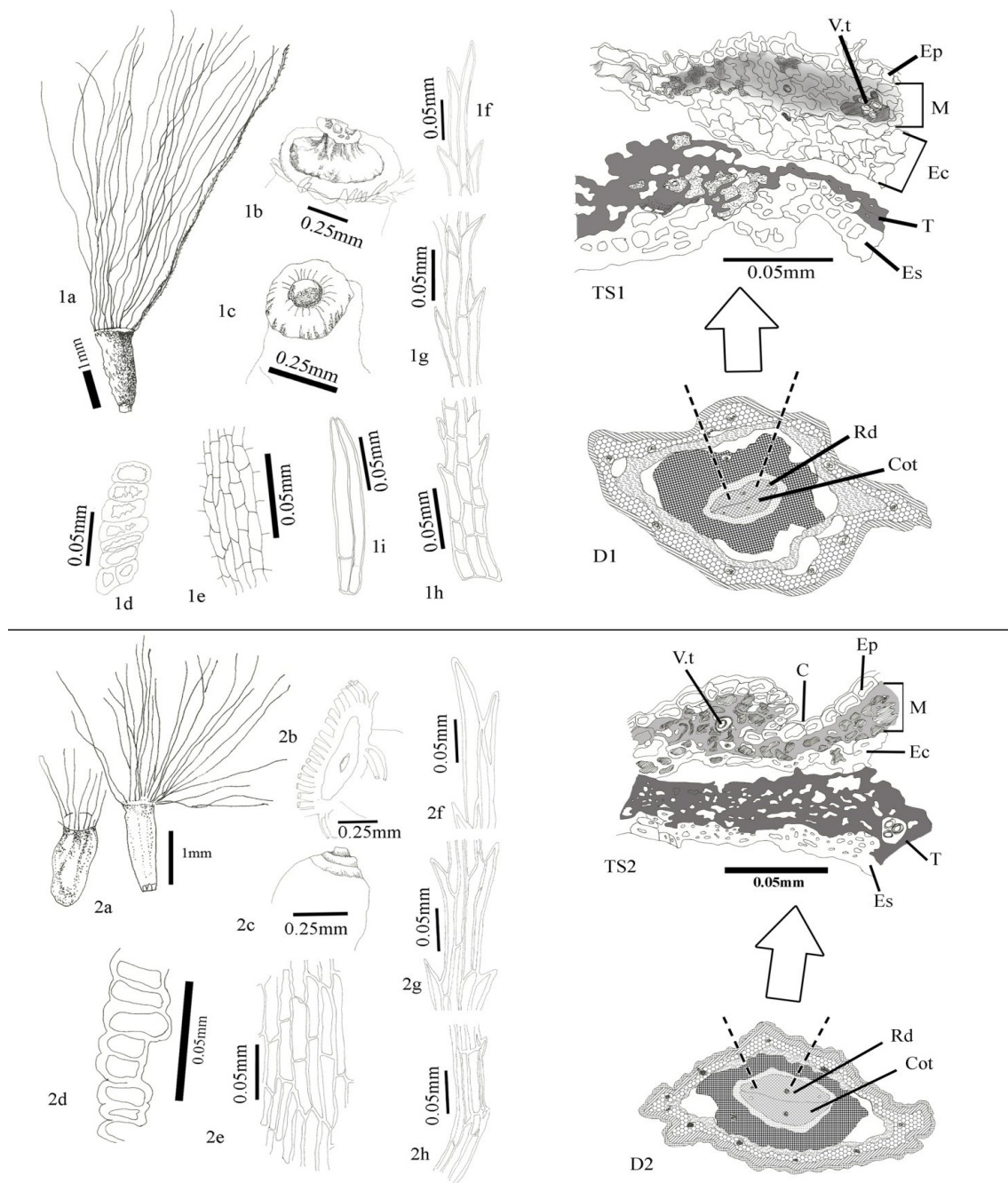
Carpopodium may be symmetric or asymmetric and thick-walled cells are arranged in 1-row (*Barkleyanthus* and *Packera*) or 4-angled complete ring in 2 rows as

reported by others (Mitra and Mukherjee, *l.c.*). Pappus is often represented by numerous persistent, barbellate bristles usually occur in 2-3 rows (*Barkleyanthus* and *Packera*), 3-seriate (Mitra and Mukherjee, *l.c.*) or absent (Nordenstam *et al.*, 2009; Jana and Mukherjee, 2013). These features of pappus could be employed for identification of taxa.

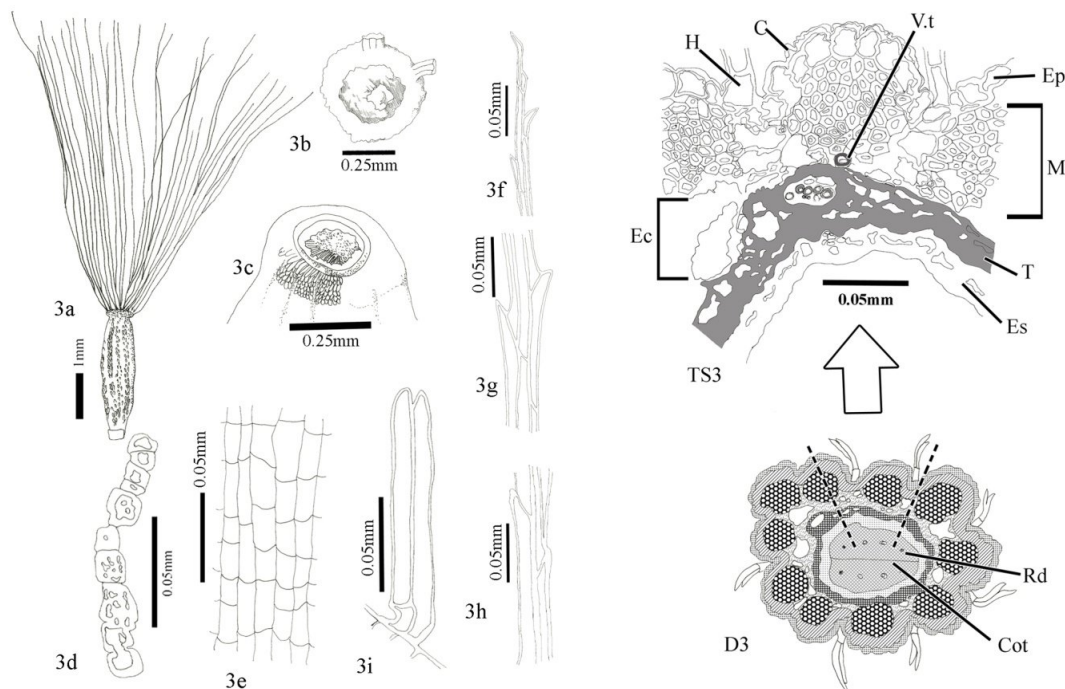


PHOTOMICROGRAPH OF CYPSELAR PARTS

Fig.1-1d-*Barkleyanthus salicifolius*; Fig.2-2d-*Packera dimorphophylla*; Fig.3-3d-*Senecio elegans*;
1,2,3-Cypselar, a-Stylopodium, b-Carpopodium, c-Cypselar wall, d- Pappus; 1 scale division = 1mm



Figs.: 1a-1i, TS1, D1- *Barkleyanthus salicifolius*; Figs.: TS1- A portion of the transverse section of cypselus; D1- Diagrammatic representation of T.S.; Figs.: 2a-2h, TS2, D2- *Packera dimorphophylla*; Figs.: TS2- A portion of the transverse section of cypselus; D2- Diagrammatic representation of T.S. a- Cypselus, b- Apical part of cypselus, c- Basal part of cypselus, d- Carpodium cell, e- Surface cell, f- Apical part of Pappus, g- Mid part of Pappus, h- Basal part of Pappus, i- Hair, C- cuticle, Ep- epicarp, M- mesocarp, Ec- endocarp, T- testa, V.t.- vascular trace, Es- endosperm, Cot- cotyledon, Rd- resin duct.



Figs.: 3a-3i, TS3, D3- *Senecio elegans*; Figs.: TS3- A portion of the transverse section of cypselus; D3- Diagrammatic representation of T.S.: a- Cypselus, b- Apical part of cypselus, c- Basal part of cypselus, d- Carpodium cell, e- Surface cell, f- Apical part of Pappus, g- Middle part of Pappus, h- Basal part of Pappus, i- Hair, C- cuticle, Ep- epicalyx, M- mesocarp, Ec- endocarp, T- testa, V.t.- vascular trace, Es- endosperm, Cot- cotyledon, Rd- resin

Cypselar Anatomy

Truly cypselar wall consists of pericarp, testa and endosperm. The mature pericarp shows a marked variation in the structure of mesocarpic zone. The number, size and shape of ribs are more or less diacritical feature of cypselas of the studied species. Number of sclerenchymatic braces is usually identical with the number of ribs as shown in parenthesis after each species mentioned below.

On the basis of distribution of different types of tissues within the mesocarpic zone, cypselas could be distinguished into following types:

1) Mesocarpic zone without phytomelanin layer. Sclerenchymatic braces unilobed, 10, separated by parenchymatous zone which is narrower than each sclerenchymatic brace -

Senecioelegans(10).

2) Mesocarpic zone with phytomelanin layer. Sclerenchymatic braces absent, parenchymatous zone forms continuous cylinder - *Packeradimorphophylla*(11), *Barkleyanthussalicifolius*(9). Mitra and Mukherjee (*l.c.*) also have the similar observation like the present study.

In the studied genera, the number of vascular traces ranges from 9 - 11 and pericarp devoid of secretory cavity except *Senecioelegans*. Sometimes vascular traces were observed in between the sclerenchymatous braces (Mukherjee, 2001). The pericarp of *Packeradimorphophylla* and *Barkleyanthussalicifolius*, are nearly similar, indicating their systematic affinity.

General structure of the testa is more or less uniform in studied species of *Senecioneae*. The

presence of crystals in the ovary wall or achene wall have taxonomic importance (Drury and Watson, 1965; Mukherjee, 2001). Such crystals are not found in the studied members.

Endosperm is often uniseriate (*Senecioelegans*) or 2-, 3- seriate (*Barkleyanthussalicifolius*) or 3-, 4- seriated (*Packeradimorphophylla*) in mature cypselas.

In general, internal structure of the cypselas in the studied members of *Senecioneae* are more or less identical with the members of the tribe Anthemideae (Kynclova 1970; Mukherjee and Sarkar 1991) indicating their systematic affinity. Therefore, cypselar features are equally important for the isolation of taxa at the generic and species level along with other floral features as advocated by many taxonomists.

AN ARTIFICIAL KEY TO THE STUDIED SPECIES OF THE TRIBES OF SENECTIONEAE

1a. Anticlinal walls of surface cells are straight in SEM analysis; epicarpic cells oval; mesocarpic sclerotic braces present; testa attached with pericarp; endosperm uniseriate *Senecioelegans*

1b. Anticlinal walls of surface cells are not straight in SEM analysis; epicarpic cells rectangular or square; mesocarpic sclerotic braces absent; testa separated from pericarp; endosperm multiseriate (2)

2a. Ribs prominent; cypselar surface pubescent; carpodium cells morphologically and anatomically differentiated; ribs not more than 10 *Barkleyanthussalicifolius*

2b. Ribs inconspicuous; cypselar surface glabrous; carpodium cells morphologically and anatomically not well differentiated; ribs more than 10 *Packeradimorphophylla*

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