MORPHO - ANATOMICAL STUDIES OF CYPSELAS IN THE TRIBE SENECIONEAE (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 [Barkleyanthus salicifolius (Kunth) H. Robinson & Brettell], Packera [Packera dimorphophylla (Greene) W. A. Weber & A. Löve] and Senecio (Senecio elegans 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 have 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 Havard University Herbaria. The present study includes 3 species belonging to genus Barkleyanthus, Packera and Senecio under the Tribe Senecioneae of the family Asteraceae.

### Table 1: Sources of the plant material

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the tribe</th>
<th>Name of the studied taxa</th>
<th>Locality</th>
<th>Collection No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Senecioneae</td>
<td>Barkleyanthussalicifolius (Kunth) H. Robinson &amp; Brettell</td>
<td>Havard University Herbaria, Cambridge, USA</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>&quot;</td>
<td>Packeradimorphophylla (Greene) W. A. Weber &amp; Á. Löve</td>
<td>&quot;</td>
<td>11372</td>
</tr>
<tr>
<td>3</td>
<td>&quot;</td>
<td>Senecioelegans</td>
<td>&quot;</td>
<td>63058</td>
</tr>
</tbody>
</table>

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, carpopodial 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 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 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 ob lanceolate (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).

Table 2: Comparative morphological features of the studied cypselas.

<table>
<thead>
<tr>
<th>Name of taxa</th>
<th>Shape</th>
<th>Surface</th>
<th>Pappus</th>
<th>Carpopodium</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Barkleyanthus salicifolius</em></td>
<td>Narrow oblong or oblongate</td>
<td>Rough with tomentose hairs</td>
<td>Represented by 24 – 26, equal, free, homomorph, unbranched, barbed bristles; occur in 2-3 rows</td>
<td>Symmetric, circular ring like</td>
</tr>
<tr>
<td><em>Packeradimorphophylla</em></td>
<td>Oblong</td>
<td>Glabrous</td>
<td>Represented by 23 – 25, equal, barbed bristles; occur in 2-3 rows</td>
<td>Ill developed</td>
</tr>
<tr>
<td><em>Senecio elegans</em></td>
<td>Elliptic</td>
<td>Ribbed; papillose hairs at ribs, rough at furrow</td>
<td>Represented by 28 – 30, equal, barbed bristles; occur in 3 rows</td>
<td>Symmetric, circular ring like</td>
</tr>
</tbody>
</table>

Table 3: Comparative anatomical features of the studied cypselas.

<table>
<thead>
<tr>
<th>Name of taxa</th>
<th><em>Barkleyanthus salicifolius</em></th>
<th><em>Packeradimorphophylla</em></th>
<th><em>Senecio elegans</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cypselar shape in T.S.</td>
<td>Deformed spindle shaped in cross section</td>
<td>Ribbed spindle shaped in cross section</td>
<td>Ribbed oval in cross section</td>
</tr>
<tr>
<td>Mesocarpic parenchyma</td>
<td>Present</td>
<td>Present</td>
<td>Very small amount</td>
</tr>
<tr>
<td>Mesocarpic sclerotic cells</td>
<td>Absent</td>
<td>Absent</td>
<td>Thick walled, compactly arranged, hexagonal, with large round lumen</td>
</tr>
<tr>
<td>Cell content of testa</td>
<td>Disorganized, partially cellular</td>
<td>Partially cellular, irregularly oriented</td>
<td>Partially cellular, compactly arranged, thick walled, parenchymatous cells</td>
</tr>
<tr>
<td>Testal cell shape</td>
<td>Layer of crusted parenchymatous cells</td>
<td>Thick walled, parenchymatous cells</td>
<td>Thick walled, compressed, compact parenchymatous cells rectangular shaped, uniseriate</td>
</tr>
<tr>
<td>Endosperm</td>
<td>Thick walled, square, parenchymatous</td>
<td>Thick walled, irregular shaped, parenchymatous, compactly arranged</td>
<td>Thick walled, compressed, compact parenchymatous cells rectangular shaped, uniseriate</td>
</tr>
<tr>
<td>Endosperm layer</td>
<td>2 – 3- seriate</td>
<td>3 – 4- seriate</td>
<td>Secretory ducts 4 in each cotyledon.</td>
</tr>
<tr>
<td>No. of secretory duct</td>
<td>Secretory ducts 3 in each cotyledon</td>
<td>Secretory ducts 3 in each cotyledon</td>
<td>Secretory ducts 4 in each cotyledon</td>
</tr>
</tbody>
</table>
like stylus (Mitra and Mukherjee, l.c.) or stylus free from the nectary or the style base is situated at the top of the nectary (Category-IV - Mukherjee, 2005) also found.

Carpodium 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-Cypsela, a-Stylodium, b-Carpodium, c-Cypsela wall, d-Pappus; 1 scale division = 1mm
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Figs.: 1a-1i, TS1, D1- Barkleyanthus salicifolius; Figs.: TS1- A portion of the transverse section of cypsela; D1- Diagrammatic representation of T.S.; Figs.: 2a-2h, TS2, D2- Pockera dmorphophylla; Figs.: TS2- A portion of the transverse section of cypsela; D2- Diagrammatic representation of T.S. a- Cypsela, b- Apical part of cypsela, c- Basal part of cypsela, d- Carpospore 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.

Indian Journal of Biological Sciences, Vol. # 21, 2015

ISSN 0972-8503
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 unlobed, 10, separated by parenchymatous zone which is narrower than each sclerenchymatic brace - Senecio elegans (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 Senecio elegans. 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
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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 SENECIONEAE

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

Senecioelegans

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

Barkleyanthussalicifolius

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

Packeradimorphophylla

Acknowledgements

Authors are grateful and thankful to the

Director of the Harvard University Herbaria, 22 Divinity Avenue, Cambridge, MA 02138, U.S.A. (A, GH) and Dr. Anthony R. Brach, Curatorial Assistant and Research Associate, Harvard University Herbaria, for sending mature identified cypselae for our studies.

REFERENCES


