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Diversity of Cypselar Features in Some Species of the Tribe Heliantheae, Family Compositae

Sourav Paul[1*] and Sobhan Kumar Mukherjee[2]

[1]*Department of Life Sciences, Central University of Tamil Nadu, Thiruvarur, Tamil Nadu, India*
[2]*Department of Botany, University of Kalyani, West Bengal, India*

ABSTRACT

The Heliantheae is morphologically most diverse tribe of the family Compositae, which is also manifested in their cypselar features and proven to be a useful source of various taxonomic treatments. Detailed macro and micro morphological characterization of cypselas of five different taxa namely- Spilanthes acmella, Tithonia diversifolia, Tridax procumbens, Wedelia wallichii, Zinnia elegans were performed.

Present analysis revealed a wide range of variations in cypsela surface features such as hair distribution pattern, hair types, phytomelanin deposition pattern, presence or absence of ribs etc. Well marked variations in pappus morphology are noticeable in the present taxa, which certainly could be used in higher level taxonomic decisions.

Though the features related to stylopodium and carpopodium are found to be comparatively less variable among the above said taxa. This cypselar overview of the studied taxa could be utilized for affinity study and for betterment of tribal and sub-tribal classification system along with other disciplines of systematic.

The tribe Heliantheae is one of the most primitive tribe of the Asteraceae. Morphoanatomical features of cypselas of 5 species belonging to the tribe Heliantheae have been studied for proper characterization of taxa. Based on observed characters, a key is presented for identification of the studied taxa.

Keywords: Heliantheae, Asteraceae, Cypsela

INTRODUCTION

The tribe Heliantheae is included under the sub-family Asteroideae of the family Asteraceae, having about 196 genera, 2500 species, belonging to 10 subtribes. The tribe is one of the most primitive tribes of the Asteraceae and the tribe is paraphyletic in nature. Brief cypselar external features have usually been included by different floristic workers during their preparation of floristic works, during their preparation of floristic accounts, but detailed features including both morphological and anatomical characters of cypselas have potential value for characterization of taxa. In this respect, Roth [1] has pointed out that 'not only is the external morphology of the achenium very characteristic, but also inner structure shows certain qualities which can be used taxonomically' [1]. The morphological and anatomical features of cypselas and their role in taxonomy for the tribe Heliantheae have been studied by several workers like Misra [2], Pandey [3], Saenz [4], Robinson [5] and Karis [6]. The present study is to supplement these observations.

MATERIALS AND METHODS

Some fully mature cypselas of each species were selected from the mass of each sample (Table 1). These were boiled for few minutes with water by adding few drops of glycerol. Then all specimens were preserved in FAA (Formalin-

Acetic acid-Alcohol) solution for study. After that, 5 cypselas were immersed within the 5% NaOH solution for few days, depending upon the amount of mechanical tissue of cypselas. Different parts of cypselas were stained in 0.5% aqueous safranin solution and different parts of cypselas were studied with the help of light compound microscope. Cross-section from each cypsela was taken from the middle part.

OBSERVATIONS

Cypselar morphology

Spilanthes acmella (L.) L.

Cypsela heteromorphic; both black; oblong-oval; ray cypselas larger than disc cypselas and triangular or triquetous in transaction; disc cypselas small and dorsiventrally compressed; 1.5 mm × 0.75 mm (at mid part); pappus O; cypselar margin ciliate; cypselar hairs very small and hook-lile present only along the 2 lateral sides; cypselar base truncate with a scar; surface glossy and provided with fine longitudinal and transverse striations (Figure 1).

1a: Disc cypsela × 20; 1b: Ray cypsela × 20; 1c: Cypselar lateral side; 1d: t.s. of ray cypsela (diagrammatic); 1e: t.s. of disc cypsela (diagrammatic); 1f: Ray cypsela × 20; 1g: Disc cypsela × 20; 1h: Cypselar basal part; 1i: Cypselar lateral margin

Cypselar anatomy

Spilanthes acmella (L.) L.

Cypsela more or less oval in transection; cotyledons plano-convex.

Pericarp glabrous, not very massive, epidermis parenchymatous consisting of more or less square cells; the epidermal cells at both the lateral ends of cypsela columnar and arranged in a beautiful fan shaped fashion; prominent black

Table 1: Heliantheae specimens

TRIBE: HELIANTHEAE (SPECIMENS)	
Spilanthes acmella (L.) L.	KAL-1264
Tithonia diversifolia A. Gray	KAL-1299
Tridax procumbens L.	KAL-1256
Wedelia wallichii Less.	KAL-1283
Zinnia elegans Jacq.	KAL-103

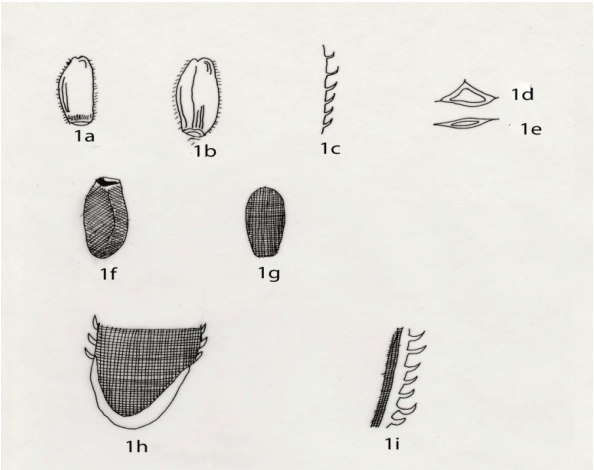

Figure 1: *Spilanthes acmella* (L.) L
1a: Disc cypsela × 20; 1b: Ray cypsela × 20; 1c: Cypselar lateral side; 1d: t.s. of ray cypsela (diagrammatic); 1e: t.s. of disc cypsela (diagrammatic); 1f: Ray cypsela × 20; 1g: Disc cypsela × 20; 1h: Cypselar basal part; 1i: Cypselar lateral margin

continuous phytomelan layer present in between the outer epidermis and the inner uniseriate parenchymatous layer cells of which are almost square or rectangular and smaller than those of the epidermis; on two lateral sides of cypsela small parenchymatous patches are present. Endosperm uniseriate, cell barrel shaped overlying the endosperm (Figure 2).

Cypselar morphology

Tithonia diversifolia A. Gray

Cypselas heteromorphic; disc cypsela 6.5-7.5 mm × 1.5-2.5 mm (excluding pappus); black; with shiny, coffee-coloured, straight, stiff, upwardly directed twin hairs present throughout the surface; both cypselas pappose; pappus biseriate; composed of inner whorl of a ring of 5 unequal, unequal (3-5 mm × 2-3 mm) leathery awn like bristles; carpopodium absent; ray cypselas slightly smaller than disc sypselas; tetrangular to triquetrous; the pappus bristles in the ray cypselas are shorter than those of disc ones; in both ray and disc cypselas the pappus scales are persistent; hairs in both ray and disc cypselas long, stiff, spiny and of twin type; hair are equal in length and equal only in the apex (Figure 3).

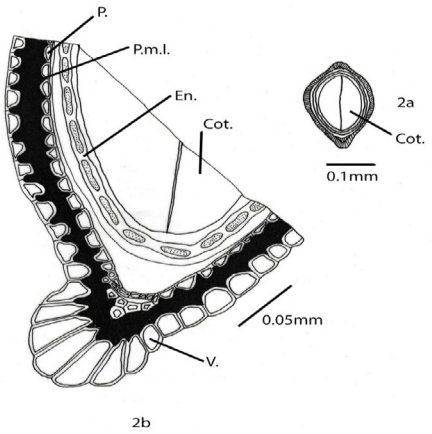

Figure 2: *Spilanthes acmella* (L.) L

2a: Cypselar t.s. (diagrammatic); 2b: A part of cypselar t.s.

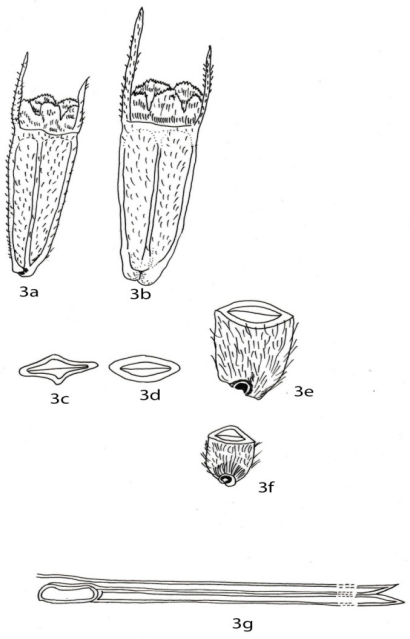

Figure 3: *Tithonia diversifolia* A. Gray

3a: Ray cypsela × 8; 3b: Disc cypsela × 8; 3c: t.s. of Ray cypsela (diagrammatic); 3d: t.s of disc cypsela (diagrammatic); 3e: Cypselar base; 3f: Twin hair on cypselar surface

Cypselar anatomy

Tithonia diversifolia A. Gray

Cypsela double convex lens shaped in transection; cotyledons plano-convex.

Pericarp differentiated into 5 zones:

(i) Outer parenchymatous zone is biseriate on elicited by epidermis containing long twin hairs; each are of twin hair is long with narrow lumen filled with yellowish brown pigmented segment of each thin hair almost equal or unequal in length and free at the apex. Epidermis covered by cuticle, epidermal cells rectangular, tangentially smaller than those of hypodermis.

(ii) Hypodermis uniseriate comprising of rectangular, radially elongated, pitted, compactly arranged parenchyma cells with yellowish brown.

(iii) Phytomelan layer continuous and wavy, present below the hypodermis.

(iv) Zone of sclerenchyma continuous, 8-12 celled thick and interrupted by several radially oriented ray of sclerotic cells containing dark yellowish brown contents, the cells of this zone are polygonal having narrow lumen; ray-cells, 6-8 seriate.

(v) Zone of parenchyma continuous, 3-4 seriate, 6-18 celled thick only below two lateral sides of cypsela, this layer contains moderately thick walled parenchyma comprising of tangentially elongated to oval cells with intercellular spaces. Vesicular traces two in number and situated in the two lateral sides of cypsela (Figure 4).

Testa broad, uniseriate, consisting of dumble shaped pitted parenchyma, thin non-cellular pellicle layer present below the testa. Endosperm uniseriate.

Cypselar morphology

Tridax procumbens L.

Cypselas homomorphic; oblong or turbinate; dark brown or ash coloured, 3 mm × 1-1.25 mm (excluding pappus); surface silky, due to presence of numerous overlapping white, double or twin hairs; cypselas with a ring of pappus of very long (5 mm-6.5 mm), plumose, grayish white bristles with dark brown basal part; 9-20 bristles united at the base to form a persistent ring; carpodium absent; apical cells of pappus bristle 2-3, unequal with nearly pointed apex; base of pappus bristle thick, papery bristle 2-3, unequal with nearly pointed apex; base of pappus bristle thick, papery and multi-celled and with fimbriate margin; barbs of the apical part of pappus bristles with blunt apex; arms of the double hair unequal in length (Figure 5).

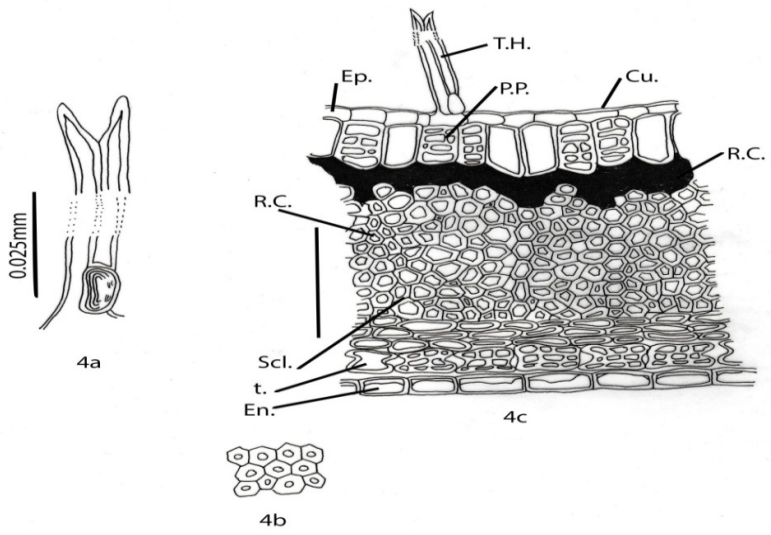

Figure 4: *Tithonia diversifolia* A. Gray

4a: "Twin" hair; 4b: Sclerotic tissue of pericarp; 4c: Cypselar t.s. (diagrammatic); 4d: A part of cypselar t.s.

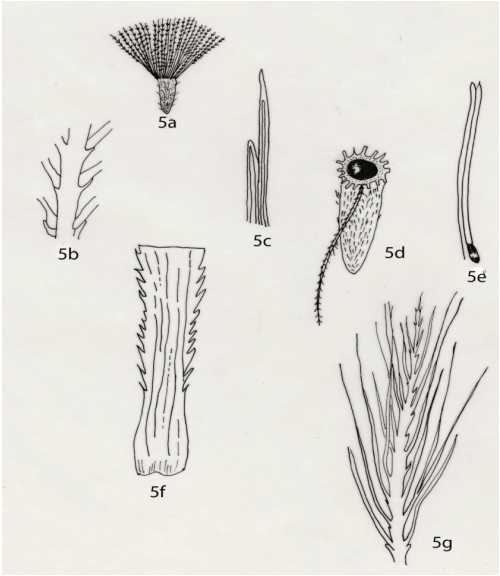

Figure 5: *Tridax procumbens* L.

5a: Cypsela × 5; 5b: Mid-part of pappus bristle showing base of the barb; 5c: Apical part of bristle; 5d: Cypselar twin hair; 5e: Cypsela (pappus detached) with one plumose pappus bristle; 5f: Basal part of pappus bristle; 5g: A complete pappus bristle

Cypselar anatomy

Tridax procumbens L.

Pericarp; Epidermis uniseriate, parenchymatous, constituent cells columnar, radially elongated and cuticularised; long twin hairs with unequal arms are present on the epidermis. A continuous phytomelan layer is present between the epidermal and an inner narrow zone of 2-celled thick sclerenchyma. Testa uniseriate, parenchymatous, cells barrel shaped (Figure 6).

Cypselar morphology

Wedelia wallichii Less

Cypsela obovate; 3-3.5 mm × 2 mm; contracted at the tip; carpodium absent; dorsiventrally compressed; ellipsoid or hemispherical in cross-section; reddish brown; with or without white small circular spots scattered on the cypsela; surface with profuse white, small hairs (simple with pointed tip) present at the apex of cypsela; pappus of unequal, fimbriate scale (0.5 mm long approximately) united at the base to form a very small neck; persistent, 1-2 celled pointed hairs with thick wall on the pericarp surface present (Figure 7).

Cypselar anatomy

Wedelia wallichii Less.

Cypsela triquetous in transection; cotyledons plano-convex, lens shaped.

Pericarp differentiated into 4 layers – (i) Outer parenchymatous zone overlying the phytomelan layer, 2-4 celled thick; epidermis covered by a thin cuticle; a few bicelled thick walled spiny hairs present on the epidermis. Cells of epidermis thin walled, tangentially elongated with glossy and transparent asteroid crystals or druses. (ii) Phytomelan layer present beneath the outer parenchyma zone; underlying the phytomelan layer, a continuous 6-10 celled thick zone 1-2 celled thick except below the two lateral sides where the zone is 3-7 celled thick and includes vascular trace (Figure 8).

Endosperm uniseriate.

Cypselar morphology

Zinnia elegans Jacq.

Cypselas heteromorphic; narrow striate; ray cypselas dorsiventrally compressed, hispidulous; 8 mm × 3-4 mm; pappus O; light brown or cream coloured with blackish mid dorsal part; obovate; with apical notch; apical arcs are two,

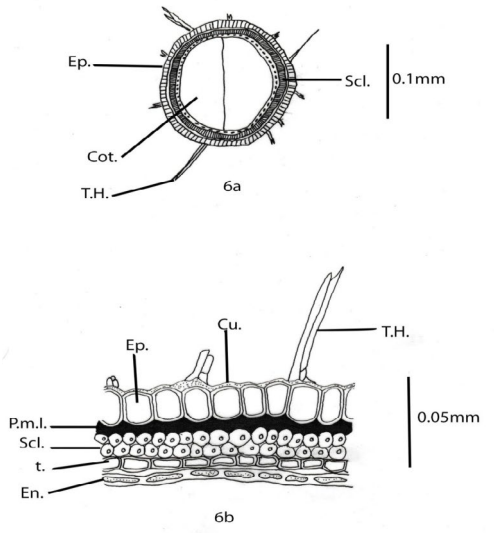

Figure 6: *Tridax procumbens* L.

6a: Cypselar t.s. (diagrammatic); 6b: A part of cypselar t.s.

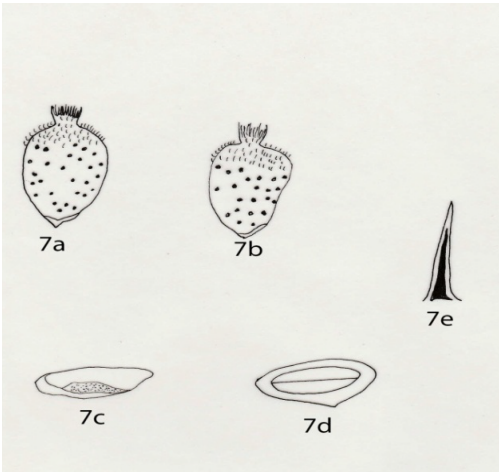

Figure 7: *Wedelia wallichii* Less.

7a: Cypsela (ventral surface) × 10; 7b: Cypsela (dorsal surface) × 10; 7c: Cypselar base (diagrammatic); 7d: Cypselar t.s. (diagrammatic); 7e: Cypselar hair

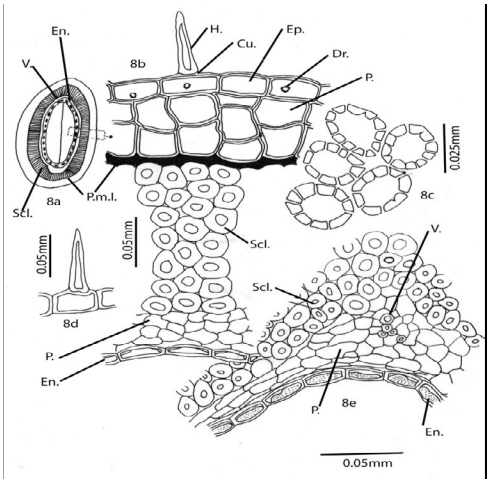

Figure 8: *Wedelia wallichii* Less.

8a: Cypselar t.s. (diagrammatic); 8b & 8c: Parts of cypselar t.s.; 8d: Sclerenchyma of pericarp; 8e: Cypselar hair

unequal; both kinds of cypselas dorsiventrally compressed, winged; wings cream coloured with longitudinal striations; basal part tapering; hairy scanty, more towards the margin or absent, upwardly directed; disc cypselas 7 mm × 3.5 mm; dorsiventrally compressed; apex of both cypselas truncate; carpopodium O; base pointed; disc cypselas rudimentary; 7 mm × 3.5 mm; slightly flattened ().

Cypselar anatomy

Zinnia elegans Jacq.

Transection of cypsela lens shaped with 2 lateral wings, surface glabrous, cotyledons plano-convex.

Pericarp differentiated into 3 zones:

(i)Outer parenchymatous layer: Epi- and hypodermal cells are parenchymatous rectangular and tangentially oriented; hypodermal cells smaller than the epidermal ones; hypodermis bi or tri seriate in the lateral wings of cypsela where the cells are elongated cuticle thin and smooth.

(ii)Middle zone of sclerenchyma extended upto the lateral wings; 2-celled thick throughout 6-8 celled thick at the lateral wings, entire and almost uniformly thickened; cells radially elongated or polygonal, thick-walled, having narrow lumen (Figure 10).

(iii)Inner zone of parenchyma many celled thick includes vascular traces in lateral wing; the remaining portion uniformly thickened; cells rectangular and tangentially elongated and almost compactly arranged and one vallecular canal present at each of the lateral wings.

Endosperm 2-seriate.

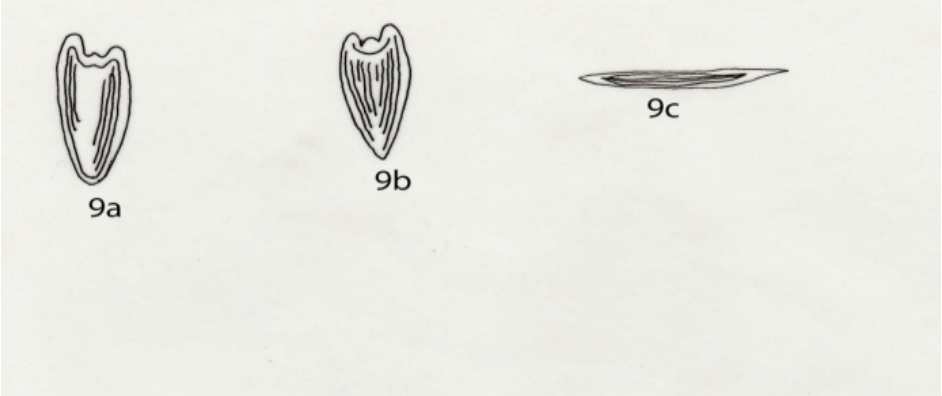

Figure 9: *Zinnia elegans* Jacq.
9a: Ray cypsela × 4; 9b: Disc cypsela × 4; 9c: Cypselar (both disc and ray) t.s. (diagrammatic)

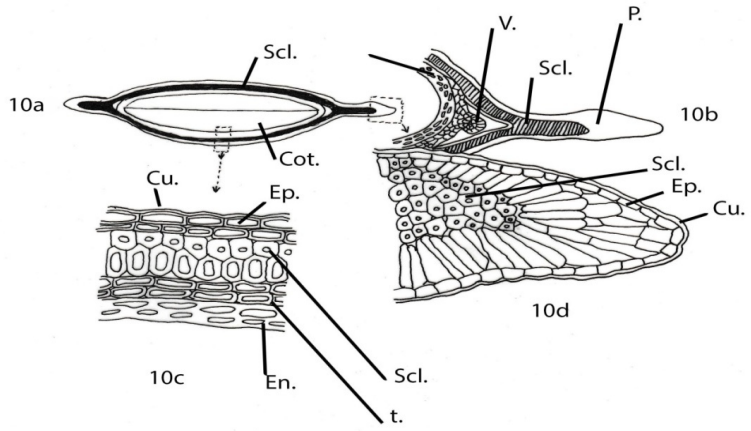

Figure 10: *Zinnia elegans* Jacq.
10a: Cypselar t.s. (diagrammatic); 10b: A small portion of cypselar t.s. (semi-diagrammatic); 10c & 10d: Parts of cypsela t.s.

RESULTS AND DISCUSSION

This tribe is one of the largest and morphologically and diverse among the studied tribes of Compositae. It is also regarded as the most primitive of traditionally recognized tribes of the family. Further splitting of this tribe in several subtribes and rearrangement were made by many taxonomists, e.g. Lessing [7], Bentham [8], Hoffman [9], Jepson [10], Bessey [11], Carlquist [12], Poljakov [13], etc.

A systematic review of the tribe Heliantheae has been done in 1973, which established some unifying diagnostic characters of this tribe. Along with vegetative and floral characters only a line of cypselar character is mentioned – "the pappus of disc and ray florets is of scales, awns or lacking (rarely setose)".

5 species belonging to 5 genera of the tribe Heliantheae have been presented in the present study. In this tribe the cypselas are either heteromorphic or homomorphic (e.g. *Tridax procumbens*). Cypselas are in majority of the cases cuneate or terete. Pericarp is usually hard due to presence of profuse amount of sclerotic tissue. The cypselas in majority of the cases possess "twin hairs" or "double hairs" on pericarp surface or mixture of both. In smooth-walled cypselas longitudinal black striations running parallel along the longitudinal axis of cypselas are seen.

In the observed species of this tribe no ribbed cypselar are observed. In *Zinnia elegans* the cypselas are winged. In *W. wallichii* the cypselar surface is smooth. Carpopodium is absent in majority of the genera of Heliantheae. Varied forms of pappus are noticed in this tribe, e.g. pappus of fimbriate scales (Tithonia) or awn, rarely of plumose hairs (*Tridax procumbens*). Pappus is absent in Wedelia, Spilanthes, Zinnia, etc.

Cypselas in rare cases are included in leathery bracts which are provided with hook like structures.

In spite of the variations in the morphology of the cypselas the inherent nature of the cypselas helps in identification of the different genera of this tribe.

CONCLUSION

Based on the above observations, it can be concluded that the members of the tribe Heliantheae are with diverse macro as well as micro morphological and anatomical features. These characters are a mixture of both primitive and advanced features. However, their value as taxonomic criteria will be greatly increased in combination with other lines of evidence.

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