



INTERNATIONAL JOURNAL OF PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

DIVERSITY OF CYPSELAR FEATURES IN SOME TAXA OF THE TRIBE ANTHEMIDEAE (ASTERACEAE)

SUSHANTA DAS, SUDIPTA ROY, BIDYUT KUMAR JANA, SOBHAN KR. MUKHERJEE

Taxonomy and Biosystematics Laboratory, Department of Botany, University of Kalyani, Kalyani-741235, Nadia, West Bengal, India.

Accepted Date: 22/02/2014; Published Date: 27/02/2014

Abstract: The cypselas of 11 species representing 8 genera as *Achillea* (2), *Artemisia* (1), *Chamaemelum* (1), *Leucanthemum* (1), *Lonas* (1), *Matricaria* (2), *Tanacetum* (1), *Tripleurospermum* (2) of the tribe Anthemideae have been examined morphologically. The significant morphological features of cypselas are the structure of carpodium, corona, stylopodium, nature of ribs, surface marking and surface glands. Based on these diacritical cypselar features, a key is prepared for the identification of studied taxa.

Keywords: Cypselar morphology, 11 taxa, Anthemideae, Compositae.



PAPER-QR CODE

Corresponding Author: Mr. SUSHANTA DAS

Access Online On:

www.ijprbs.com

How to Cite This Article:

Sushanta Das, IJPRBS, 2014; Volume 3(1): 410-424

INTRODUCTION

The tribe Anthemideae is included under sub family Asteroideae of the family Asteraceae. Anthemideae is one of the premier tribe where the application of morphological and anatomical features of cypselas have been employed for characterization of taxa. The tribe consists of 111 genera with 1,800 species, distributed throughout the world but with main concentrations in central Asia, the Mediterranean region and Southern Africa (Kubitzki, 2007). Briquet (1916), Hegi (1918, 1929), Giroux (1933), Horvatic (1963), Kynclova (1970), Heywood and Humphries (1977), Kallersjo (1985, 1990), Weberling and Reese (1988) have been attracted and fascinated by the tribe Anthemideae and have incorporated the characters of cypsela either from morphological or from anatomical observation or both, using light microscope. Brief cypselar external features have usually been included by different floristic workers during their preparation of floristic accounts, but details morphological features of cypselas have not been indicated. In this respect, Roth (1977) has pointed out that "Not only in the external morphology of the achenium very characteristic, but also it's inner structure shows certain qualities which can be used taxonomically." Cypselar features both from morphological and anatomical studies or either any one of them have been used for taxonomic evaluation in the tribe Anthemideae by some workers like Hegi (1918, 1929), Kynclova (1970), Heywood and Humphries (1977), Weberling and Reese (1988). Although these works have significant value, yet more works in this respect are needed to fulfil the lacunae of the previous data.

The principal objective of this work is to indicate the diacritical features of cypselar which can be employed as an ideal taxonomic marker for evaluation of taxa at or below the infrageneric level.

MATERIALS AND METHODS

Mature, identified cypselar of 11 species were obtained or collected by post from two herbaria of the world. The Herbarium of Botanischer Garten der Universitat Zurich, Zurich, Switzerland, which is abbreviated as Z, in Index Herbariorum (Holmgren *et al.*, 1981). Five specimens were obtained from aforesaid herbarium. Out of the 11 species, 6 species were collected from Botanical Garden of the University, Jyragontie 2, SF – 00550, Helsinki, Finland (H). All the genera and species are arranged alphabetically indicating their place of collection and collection number in the Table 1.

Table 1 : Studied species of the tribe Anthemideae.

	Name of the species	Place of collection and code no.	Collection number and collector Details
1.	<i>Achillea atrata</i> L.	Botanischer Garten der Universität Zurich, 127	CHOZ 20031694, Alt. St. Johann SG. Churfirton' 2045 masl 2003; Stocking fridge dry
2.	<i>Achillea ptarmica</i> L.	Botanical garden of the University Jyrangontiez SF – 00550, Helsinki, Finland, 1993 : 0044	Uusimaa, Elimaki, 02.10.1993 Paula Havas Matilainen 137/93 (H)
3.	<i>Artemisia vallesiaca</i> All.	Botanischer Garten der Universität Zurich, 138	CHOZ 20031890, Sion Vs, 612 m GSI 2003; Stocking : fridge, dry.
4.	<i>Chamaemelum nobile</i> (L.) All.	Botanischer Garten der Universität Zurich, 148	XXOZ 19940181 2003
5.	<i>Leucanthemum vulgare</i> Lam.	Botanical Garden of the University Jyrangontie 2 SF – 00550 Helsinki, 1993 : 0076	Uusimaa, Elimaki, 07.08.1993 Paula Havas Matilainen 25/93 (H)
6.	<i>Lonas annua</i> (L.) Vines et Druce	Botanischer Garten der Universität Zurich, 184	XXOZ 20010237 2003
7.	<i>Matricaria matricarioides</i> (Less.) Porter	Botanical garden of the University Jyrangontie 2 SF-00550 Helsinki, Finland, 1993 : 0078	Uusimaa, Helsinki 25.07.1993 Pirkko and Mikko Piirainen 2653 (H).
8.	<i>Matricaria recutita</i> L.	Museum Botanicum Universitatis, Helsinki, Botanical garden, Plants, 248	Finland, Uusimaa. Helsinki : Kumpula, Botanical Garden of the University, Alt. 4-16 m.s.n. origin : weed paula flaves Matilainen 19.7.1993
9.	<i>Tanacetum parthenium</i> (L.) Sch. - Bip.	Botanischer Garten der Universität Zurich, 206	XXOZ 19965019 2003
10.	<i>Tripleurospermum inodorum</i> Sch. - Bip.	Botanical Garden of the University Syrangontie 2 SF	Uusimaa, Helsinki 04.08.1993 Pirkko and Mikko Pirainen

		– 00550 Helsinki, Finland, 2662 (H) 1993 : 0091	
11.	<i>Tripleurospermum maritimum</i> (L.) Koch	Botanical Garden of the University Jyrangontie 2 SF – 00550 Helsinki, Finland	Uusimaa, Helsinki, 03.10.1993 Pentti Alanko 76797 (H).

Some fully mature cypselar of each species were selected from the mass of each sample. These were boiled for few minutes with water by adding few drops of glycerol. Then, all specimens were preserved in FAA solution for this study. After that, 5 cypselar were immersed within the 2-5% NaOH solution for few days, depending upon the amount of mechanical tissue of cypselas. Different parts of cypselar were studied with the help of light compound microscope. Cross sections of cypselar were taken from the middle part. Terminology for descriptions of cypselar were adopted from the earlier workers which are already mentioned.

OBSERVATION

1. *Achillea atrata* L.

Cypselar morphology (Figs. IA, IIIA, IVA, VA, VIA)

Cypsela homomorphic i.e. not differentiated into disc and ray cypsela. Cypsela 2.4 – 2.5 mm x 0.8 – 1.2 mm, greyish yellow in colour, to oblong to oblanceolate, straight, tapered at both ends but more towards base, compressed anterior posteriorly, with two prominent lateral ribs. Cypsela surface glabrous and striated. Vascular trace found within the rib after clearing the cypselar wall. Stylopodium present and it represented by means of a short elongated broken base of style not covered by carona, with one prominent vascular trace. Carpopodium more or less symmetric, complete ellipsoid or triangular ring like in appearance from top view, diameter more or less same as the base of the body. Carpopodial cells thickwalled, ovoid in shape and arranged in 1-2 rows.

Cross section of cypsella shows more or less tetragonal in shape with 3 distinct ribs and furrows; pericarp moderately thick. Other margin bounded by epidermal cells. Vallecular cavity exists in each lobe. Cotyledons two and parallel to the axis. Pappus is usually absent in *Achillea*.

2. *Achillea ptarmica* L.

Cypselar morphology (Figs. I, IIIB, IVB, VB, VIB)

Cypsela homomorphic, 1.8 – 2 mm x 0.5 – 1 m, greyish yellow, narrow oblong to oblanceolate, straight, slightly tapered towards base, conspicuously compressed anterior posteriorly, triangular with 2 prominent lateral ribs and one ill developed posterior rib in CS. Cypselar

surface similar to *A. atrata*. Stylopodium inconspicuous, style base enlarged, seated on the top of the nectary with one vascular trace. Carpopodium similar to other species. Pappus absent. Surface striated with tabular non-thickened epicarpic cells.

Cross section of cypsella shows more or less triangular with 2 lateral ribs. Outer margin bounded by single layer of epidermal cells. Pericarp moderately-thick. Sclerenchyma bundle present in each of the winged lobe. Cotyledons two i.e. right angle to the axis.

3. *Artemisia vallesiaca* All.

Cypselar morphology (Figs. IC, IIIC, IVC, VC, VIC)

Cypsela homomorphic, 0.8 – 1 mm x 0.4 – 0.5 mm, narrow oblanceolate, greyish yellow or a few brownish yellow, slightly tapered towards the apex, base more or less rounded. Cypsela surface glabrous. Stylopodium present and it represented by means of a short broken base of style not covered by corona. Stylopodial cell more or less elliptical ovoid. Carpopodium more or less symmetric, complete ellipsoid ringlike in appearance from top view. Carpopodial cells thick-walled, 4-5 layered, oval in shape. Pappus completely absent.

Cross section of cypsela shows elliptic rounded in shape. There is no ribs or furrows. Pericarp very thin. Cotyledons-2, plano convex, parallel with the axis.

4. *Chamaemelum nobile* (L.) All.

Cypselar morphology (Figs. ID, IIID, IVD, VD, VID)

Cypsela homomorphic, 2 – 2.2 mm x 0.5 – 1 mm, brownish yellow, straight, oblanceolate long narrow or taper towards base, apex rounded and dilated, inconspicuously ribbed, faintly compressed anterior-posteriorly with inconspicuous 4 ribs. Cypsela surface glabrous, 3-4 vascular traces are found within the wall after clearing. Stylopodium prominent and it represented by means of a short elongated broken base of style covered by corona. Carpopodium prominent more or less symmetric, complete, elliptic ring like appearance from top view. Carpopodial cells oval or rounded, arranged in 3-5 layers. Pappus represented by distinct corona.

Cross section of cypsela shows more or less rounded forming inconspicuously 4 lobed. Pericarp very thin. Outer margin bounded by epidermal cell. Cotyledons-2, plane-convex, situated parallel to axis.

5. *Leucanthemum vulgare* Lam.

Cypselar morphology (Figs. IE, IIIE, IVE, VE, VIE)

Cypselar homomorphic, 1.8 – 2 mm x 0.6 – 0.8 mm, greyish yellow, oblong, straight, slightly tapered towards the base with ten conspicuous ribs. Cypselar surface slightly pubescent and striated. Vascular trace found within the ribs after clearing the cypselar wall. Stylopodium prominent and it represented by means of a short elongated broken base of style. Carpopodium prominent, ring like in appearance from the top view. Carpopodial cells square to rectangular, thick-walled, arranged, in 3-5 rows. Pappus absent.

Cross section of cypselar shows 10 ribs and each rib apex has mucilage vesicle. Pericarp moderately thick, 10 sclerenchyma braces exist within pericarp. Outer surface constructed by epidermal cell. Cotyledones-2, planoconvex, situated parallel to the axis.

6. *Lonas annua* (L.) Vines et Druce

Cypselar morphology (Figs. IF, IIIF, IVF, VF, VIF)

Cypselar homomorphic, 2 – 2.2 mm x 0.6 – 0.9 mm, oblanceolate to ovate, basal portion gradually narrowing and ending by a meristematic ring-carpopodium. Cypselar compressed anterior-posteriorly with 2 prominent lateral ribs and one anterior rib. Cypselar surface glabrous and striated. Vascular trace found within the rib after clearing the cypselar wall. Stylopodium not prominent and it surrounded by distinct wide corona. Carpopodium symmetric, ring like in appearance. Carpopodial cells thick-walled, ovoid in shape and 2-cell layers thick. Pappus represented by a cupshaped corona with irregularly lobed margin. Coronal cells thick-walled and vertically elongated.

Cross section and cypselar shows more or less oval with 3 prominent ribs. Mucilage vesicle present on top of the two lateral ribs and each rib consists of vascular trace. Cotyledons-2, planer-convex, parallel to the axis.

7. *Matricaria matricaroides* (Less.) Porter

Cypselar morphology (Figs. IIG, IIIG, IVG, VG, VIG)

Cypselar homomorphic, 2 – 2.1 mm x 0.5 – 0.9 mm, greyish black to black, oblong to narrow oblong, straight, truncate at both ends, slightly compressed anterior posteriorly with 6 conspicuous ribs. Each rib contain vascular traces just under the epidermic cell layer. Cypselar surface glabrous. Stylopodium well developed tubular and solid. Carpopodium symmetric, complete ring like Carpopodial cells thick-walled round to oval in shape and arranged in 2-3

rows. Pappus represented by a corona with regular margin. Coronal cells thick-walled and vertically elongated.

Cross section of cypsela exhibits more or less hexangular outline 6 inconspicuous ribs. Pericarp thick. Mucilage vesicle occasionally present on the surface. Cotyledons-2, Plano-convex parallel to the axis.

8. *Matricaria recutita* L.

Cypselar morphology (Figs. IIH, IIIH, IVH, VH, VIH)

Cypsela homomorphic, 0.8 – 1 mm x 0.3 – 0.6 mm, greyish yellow, long, narrow, distinctly curved, upper portion i.e. beneath the stylopodium more swollen than the base. Cypsela glabrous striated with 6 conspicuous and 3-4 inconspicuous ribs and furrows. Stylopodium present, covered by corona with regular margin. Carpopodium symmetric, complete ring like. Carpopodial cell-rounded to ovoid, thick-walled, mainly in 1 row and a few places in 2 rows (2 different sizes i.e. unequal sizes). Pappus modified into corona.

Cross section of cypsela circular outline with 6 conspicuous and 3 inconspicuous ribs and furrows. Mucilage vesicle present on the top of each lobe or rib. Vascular traces found beneath the each lobe. Cotyledons-2, Planoconvex, right angles to the axis.

9. *Tanacetum parthenium* (L.) Sch. Bip.

Cypselar morphology (Figs. II. (I), III (I), IV. (I), V. (I), VI. (I))

Cypsela homomorphic, 2 – 2.2 mm x 0.5 – 1 mm, pale yellow to brownish yellow, oblanceolate, truncate or dilated apex and gradually tapered towards the base, straight, subterete, with 5-6 conspicuous ribs and furrows. Surface of rib glabrous; but surface of the furrows glandular. Stylopodium well developed, hollow, tubular, with more or less capitate apex. Carpopodium asymmetric, complete ring like, diameter same as the base of the body. Carpopodial cells thick-walled, arranged horizontally in 1-3 rows. Pappus reduced to wide cupshaped corona with irregularly lobed margin.

Cross section of cypsela shows \pm pentangular to hexangular outline with 5-6 conspicuous ribs and furrows. Pericarp moderately thick, 7-8 sclerenchyma bundles exist within the pericarp. Cotyledons-2, plano-convex, parallel to the axis.

10. *Tripleurospermum inodorum* Schultz. Bip.

Cypselar morphology (Figs. IIJ, IIIJ, IVJ, VJ, VIJ)

Cypsela homomorphic, 1.5 – 2 mm x 0.8 – 1.2 mm, greyish black oblong to ovate, straight, truncate at both ends, compressed dorsio-ventrally with 2 lateral ribs and 1 posterior rib. Abaxial surface and furrow regions of adaxial side cross rugose, but other parts of surface glabrous. Two semicircular black resin-glands found at the apex of the abaxial side, visible after clearing of cypselar wall. Stylopodium well developed, tubular and solid. Carpopodium symmetric complete ring like as wide as the base of the cypsela. Carpopodial cells thick-walled, and arranged in 3-4 rows, more or less ellipsoid to circular. Pappus reduced to a cupshaped corona with irregularly lobed margin.

Cross section of cypsela shows triangular outline with 2 conspicuous triangular outline, 2 conspicuous triangular lateral ribs and 1 anterior rib. Pericarp thick. Two circular glands (resin glands) found at the apex of the anterior side. Cotyledons-2, planoconvex, parallel to axis.

11. *Tripleurospermum maritimum* (L.) Koch,

Cypselar morphology (Figs. IIK, IIK, IVK, VK, VIK)

Cypsela homomorphic, 1.5 – 2.5 mm x 0.7 – 1.25 mm, greyish black to black, obovate to narrow obovate, straight, truncate at both ends, slightly compressed laterally, with 3 conspicuous ribs, 2 on lateral sides and 1 on adaxial side. Abaxial surface and furrow regions of adaxial surface cross rugose or cross wrinkled, other parts of surface glabrous. Two semicircular yellow, resin glands found at the apex of the abaxial side after clearing of cypselar wall. Stylopodium well developed, tubular and solid. Carpopodium symmetric, complete ring like, narrower than the base of the body. Carpopodial cells thick-walled and arranged in 2-3 rows more or less ellipsoid to circular. Detachment area straight basal. Pappus reduced to a cup shaped corona with irregularly lobed margin. Coronal cells thick-walled and vertically elongated.

Cross section of cypsela exhibit distinctly triangular outline, with 3 conspicuous, triangular ribs and two circular resinglands at the apex of the anterior side. Cotyledons-2 planoconvex, obliquely placed. Vallecular cavity present in each lobe.

DISCUSSION

On the basis of present morphological studies of cypsela, the tribe Anthemideae is characterised by the following features. Cypselar homomorphic with or without ribs and furrows, usually glabrous or wrinkled; stylopodium usually present; carpopodium always present but with variable thickness; pappus represents by corona or noncoronate. Cypselas are homomorphic, usually straight, rarely slightly curved (*Matricaria matricaroides*) or conspicuously curved (*Matricaria recutita*). Size of the cypsela is variable in different taxa. Length of cypsela is usually over 2 mm and upto 2.5 mm as in *Tripleurospermum maritimum* and *Achillea atrata* but it is significantly smaller i.e. less than 1 mm e.g. *Artemisia vallesiaca* and

Matricaria recutita. Shape of cypsela is often oblanceolate to obovate type, but occasionally lanceolate as in *Matricaria matricaroides* or rather oblong (*Leucanthemum vulgare*). Cypselar surface is usually glabrous or sometimes wrinkled as in *Tripleurospermum*. Presence of twin type of hairs is the characteristic feature of the family Asteraceae, which are not found in this tribe. Typical type of pappus structures i.e. bristles, scales or setae is also absent in this tribe, which are usually found in majority of the other tribes. Here pappus is represented by weakly developed corona (*Leucanthemum, Matricaria*), conspicuously developed corona (*Lonas, Tripleurospermum*) or non coronate as in *Achillea, Artemisia* or more or less absent in *Achillea*. Margin of the corona (entire lobed or irregular) is taxonomically significant. Cross sectional configuration of cypsela has significant role for characterization of taxa. It may be ellipsoid without any lobed or ribs (*Artemisia*) or triangular to tetragonal or pentagonal with 5-9 lobes or seldom with 10 conspicuous ribs and furrowed (*Leucanthemum vulgare*). Colour of the cypsela has no significant role for isolation of taxa, since it depends on the maturity of the cypsela. Distribution of cells in stylopodium is not taxonomically valuable for this tribe because these are not greatly variable from species to species. Carpopodium is a basal meristematic zone of cypsela by which is attached to the receptacle. It is present in all the studied species, but the thickness of cells in rows is variable, which has diacritical role for isolation of taxa. Carpopodium is often complete ring like with variable numbers of cell rows. It is usually variable from 2-5 rows, sometimes in 1-2 (*Matricaria recutita*) or 1-3 rows as in *Tanacetum parthenium* or 3-8 rows (*Chamaemelum nobile*). Orientations of these cells are also important. It may be tangentially or vertically oriented. The distribution of carpopodium cells and morphological nature of carpopodium of these taxa have been presented earlier by Mukherjee and Sarkar in 1992 and the structure of carpopodium in this tribe have been noted by Haque and Godward (1984). This observation is to some extent, identical with the present observation. The diameter of carpopodium in comparison to the diameter of the cypselar base is valuable in certain presenting investigated taxa which are mentioned in key to the studied taxa. Although nature and tissue distribution of pericarp are taxonomically valuable, but present study shows that pericarp is extremely thin in *Artemisia vallesica* or moderately thin in *Chamaemelum nobile* or thick as in many cases or exceptionally thick as in *Tripleurospermum martimum*. Distribution of vallecular canal, mucilage vesicles, numbers and distribution of sclerenchyma braces can be considered as taxonomic marker for isolation of taxa especially for the tribe Anthemidae. Present morphological investigation of cypselar clearly indicates that cypselar features can be used for identification of taxa upto species level.

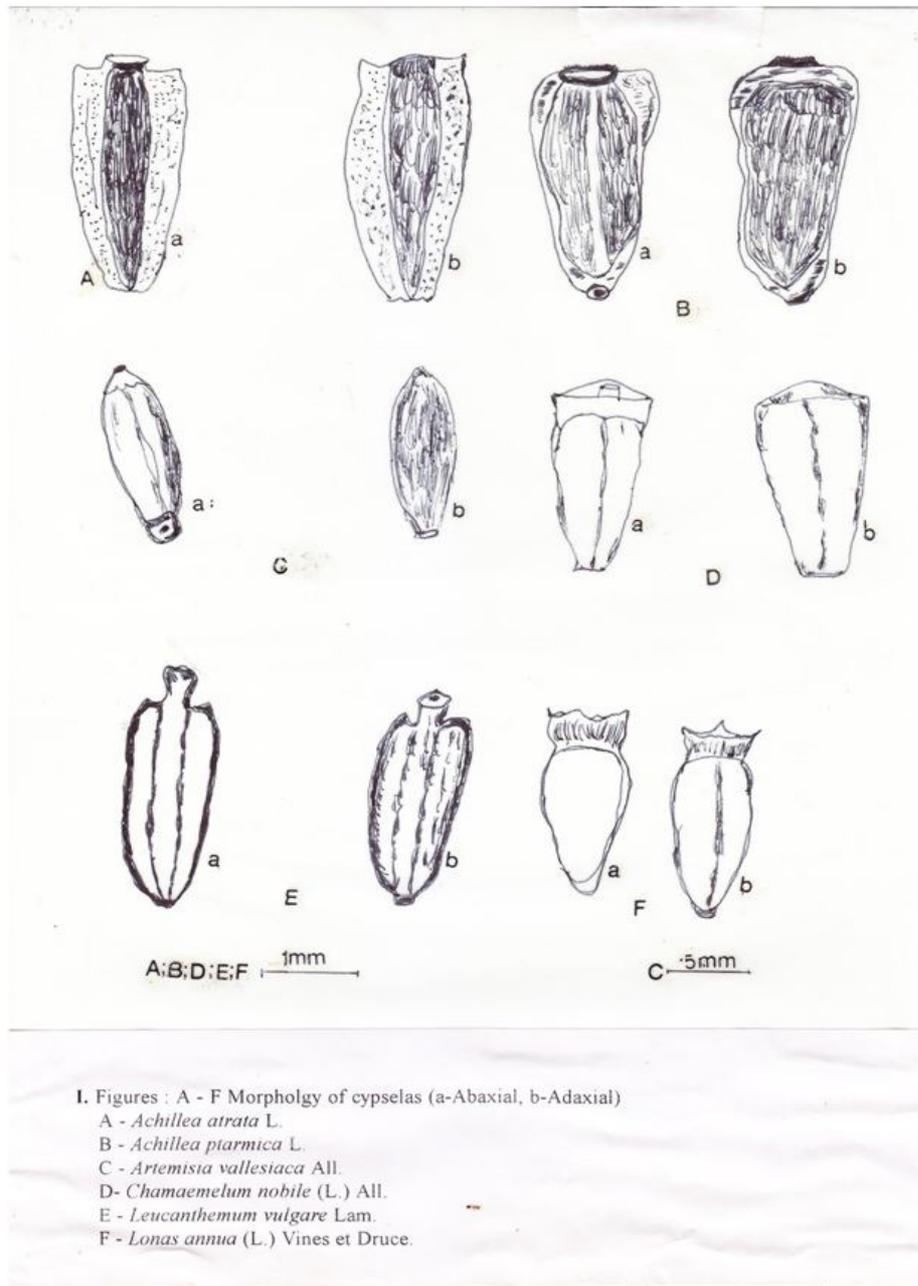
Artificial key to the studied species

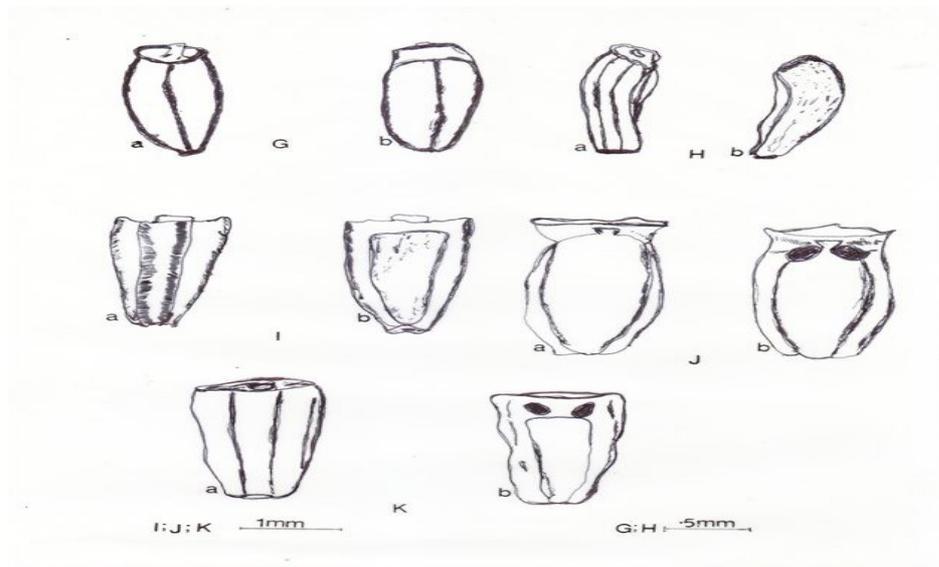
- 1a. Cypsela with two (2) resin glands towards the apex of the abaxial side; abaxial side and furrows of adaxial side cross- rugose..... 2
- 1b. Cypsela not as above..... 3
- 2a. Carpopodium narrower than the base of cypsela; carpopodial cells arranged in 2-3 rows; corona less conspicuous..... *Tripleurospermum inodorum*
- 2b. Carpopodium as wide as the base of the cypsela; carpopodial cells arranged in 3-4 rows; corona more conspicuous.... *Tripleurospermum maritimum*
- 3a. Cypsela distinctly curved..... *Matricaria recutita*
- 3b. Cypsela straight or slightly curved..... 4
- 4a. Cypsela ellipsoid without any ribs and furrows or with inconspicuously lobed; pericarp thin..... 5
- 4b. Cypsella ellipsoid, circular or triangular with distinct ribs and furrows; pericarp thick to moderately thick..... 6
- 5a. Cypsela without having any ribs or furrows. Corona absent; carpopodium narrower than the base of the cypsela..... *Artemisia vallesiaca*
- 5b. Cypsela with inconspicuously lobes; corona distinct; carpopodium as wide as the base of the cypsela..... *Chamaemelum nobile*
- 6a. Cypsela with 10 ribs and furrows. Ten (10) sclerenchymatous bundles found in pericarp..... *Leucanthemum vulgare*
- 6b. Cypsela not as above..... 7
- 7a. Cypsela more or less triangular to tetragonal in cross section..... 8
- 7b. Cypsela more or less pentagonal with 5-9 lobes and furrows..... 10
- 8a. Cypsela with distinct wide corona; mucilage vesicle present at the tip of each lobe; cotyledon exists parallel to the cypselar axis..... *Lonas annua*
- 8b. Cypsela without corona; mucilage vesciles absent; cotyledon exists right angle to cypselar axis..... 9
- 9a. Cypsela 2.4 – 2.5 mm long; cypsela with 3 distinct lobes... *Achillea atrata*
- 9b. Cypsela 1.8 – 2.0 mm long; cypsela with 2 distinct lateral lobes.....
.....*Achillea ptarmica*
- 10a. Cypsela oblanceolate; constricted towards base; diameter of carpopodium as wide as the base; mucilage vesciles absent on cypselar surface.....
.....*Tanacetum parthenium*
- 10b. Cypsela oblong to narrow oblong; constricted towards base and apex; diameter of carpopodium narrower than the base; mucilage vesciles found on cypselar surface.....
.....*Matricaria matricaroides*

ACKNOWLEDGEMENTS

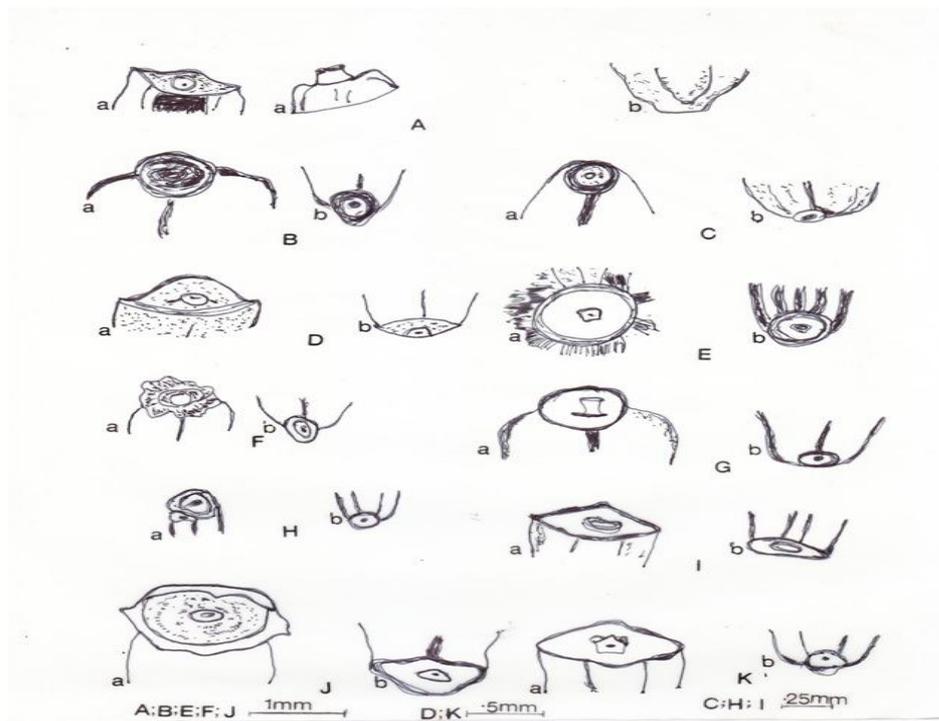
Thanks are also due to the **DST-PURSE fund** of the **University of Kalyani**, Kalyani -741 235, Nadia, West Bengal for endowing financial support.

We are thankful to Dr. PeterENZ, Curator, Botanischer Garten der Universität Zurich, Zurich, Switzerland (Z) ; Dr. [Henry Väre](#), Senior Curator of Phanerogams and Algae, Botanical Museum, Finnish Museum of Natural History, University of Helsinki, Finland (H).

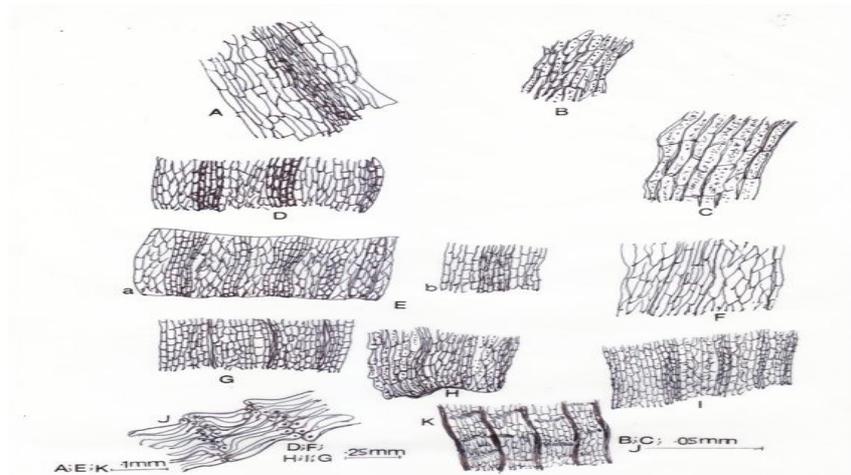




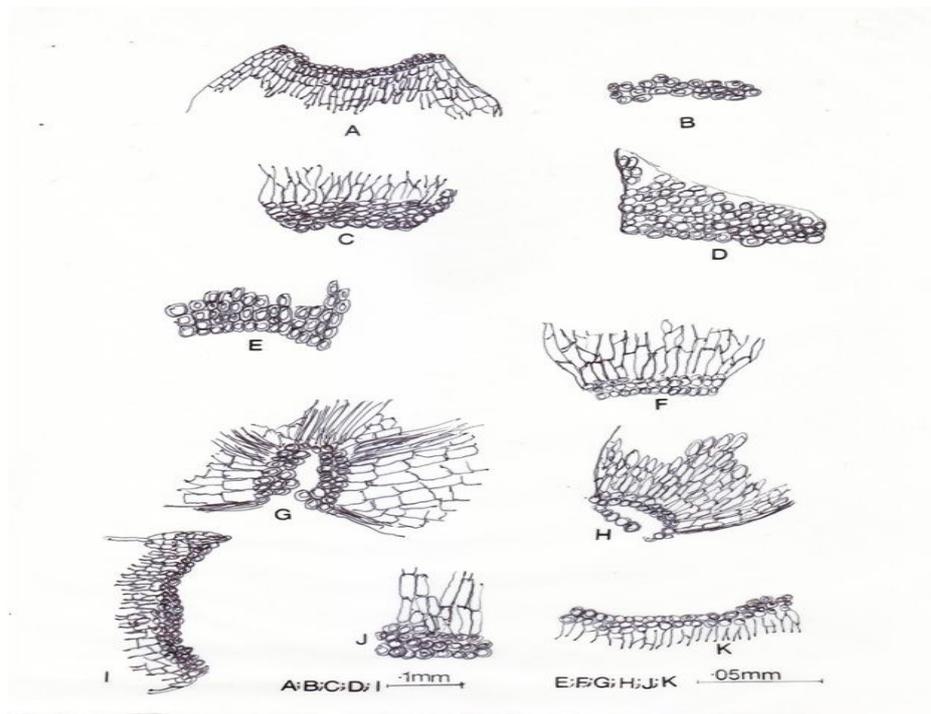
II. Figures : G - K Morphology of cypselas (a-Abaxial, b-Adaxial)
G - *Matricaria matricaroides* (Less.) Porter
H - *Matricaria recutita* L.
I - *Tanacetum parthenium* (L.) Sch. Bip
J - *Tripleurospermum inodorum* Schultz. Bip
K - *Tripleurospermum maritimum* (L.) Koch.



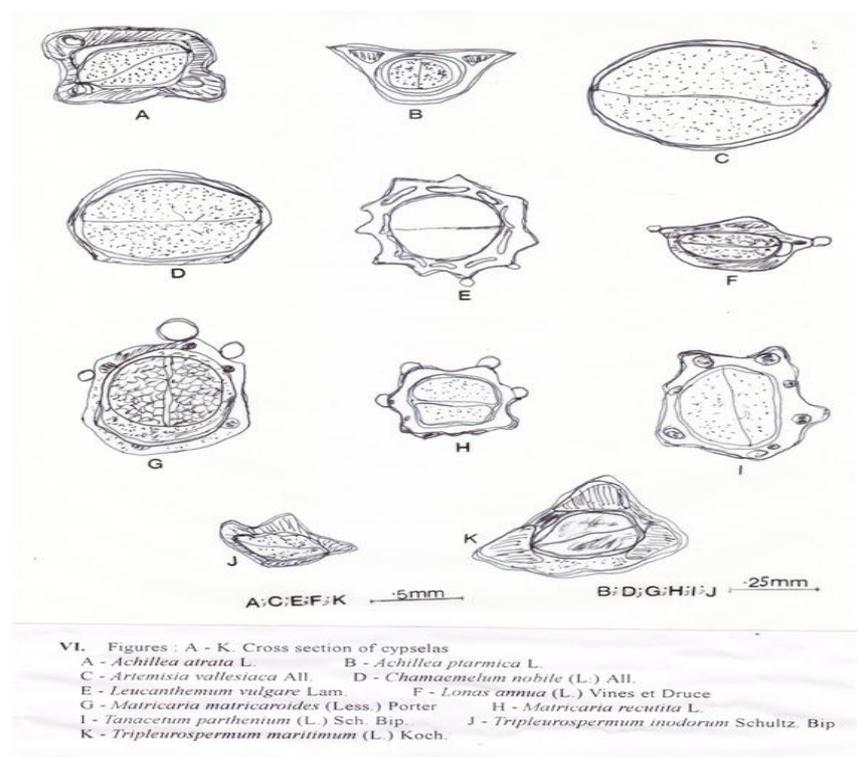
III. Figures : A - K. Apical and Basal part of Cypselas (a - Apical part of cypselas, b - Basal part of cypselas)
A - *Achillea atrata* L. B - *Achillea ptarmica* L.
C - *Artemisia vallesiaca* All. D - *Chamaemelum nobile* (L.) All.
E - *Leucanthemum vulgare* Lam. F - *Lonas annua* (L.) Vines et Druce
G - *Matricaria matricaroides* (Less.) Porter H - *Matricaria recutita* L.
I - *Tanacetum parthenium* (L.) Sch. Bip. J - *Tripleurospermum inodorum* Schultz. Bip
K - *Tripleurospermum maritimum* (L.) Koch.



IV. Figures : A - K, Surface of cypselas
 A - *Achillea atrata* L. B - *Achillea ptarmica* L.
 C - *Artemisia vallesiaca* All. D - *Chamaemelum nobile* (L.) All.
 E - *Leucanthemum vulgare* Lam. F - *Lonas annua* (L.) Vines et Druce
 G - *Matricaria matricaroides* (Less.) Porter H - *Matricaria recutita* L.
 I - *Tanacetum parthenium* (L.) Sch. Bip. J - *Tripleurospermum inodorum* Schultz. Bip
 K - *Tripleurospermum maritimum* (L.) Koch.



V. Figures : A - K, Carpapodial cells of cypselas
 A - *Achillea atrata* L. B - *Achillea ptarmica* L.
 C - *Artemisia vallesiaca* All. D - *Chamaemelum nobile* (L.) All.
 E - *Leucanthemum vulgare* Lam. F - *Lonas annua* (L.) Vines et Druce
 G - *Matricaria matricaroides* (Less.) Porter H - *Matricaria recutita* L.
 I - *Tanacetum parthenium* (L.) Sch. Bip. J - *Tripleurospermum inodorum* Schultz. Bip
 K - *Tripleurospermum maritimum* (L.) Koch.



REFERENCES

1. Briquet, J. 1916. Etudes carpologiques sur les genres de Composees *Anthemis*, *Ormenis* et *Santolina*. *Ann. Conser J. Jard. Bot. Geneve* 18-19 : 257 – 313.
2. Giroux, M. 1933. Note sur la position systematique *Chysanthemum cinerarifolium* (Rev.) vis. suivie de quelques remarque sur lev characters carpologiques des *Tanacetum*. *Bull. Soc. Hist. Nat. Atf. Nord.* 24 : 54 – 62.
3. Haque, M. Z. and M. B. E. Godward, 1984. New records of the carpopodium in Compositae and its taxonomic use. *Bot. Jour. Linnean Soc.* 89 (4) : 321 – 340.
4. Hegi, G. 1918. *Illustrierte Flora von Mitteleuropa*. *Wien. Munchen* 6 (1) : 535 – 544.
5. Hegi, G. 1929. *Illustrierte Flora von Mitteleuropa*. *Wien. Munchen* 6 (2) : 549 – 674.
6. Heywood, V. H. and C. J. Humphries, 1977. Anthemideae-systematic review. In : V. H. Heywood *et al.* (eds.). *The Biology and Chemistry of the Compositae*, Vol. 1, Academic Press, London.
7. Holmgren, P. K., W. Keu Ken and E. K. Schofield, 1981. *Index Herbariorum*, Part I. The Herbaria of the world. Edition 7 (Hague : Regnum vegetable, 106).

8. Horvatic, S. 1963. Genus *Leucanthemum* in Flora Jugoslaviae. *Acta. Bot. Croat. Zagreb.* **22** : 203-219.
9. Kallersjo, Mari, 1985. Fruit structure and generic delimitation of *Athanasia* (Asteraceae – Anthemideae) and related South African genera. *Nord. J. Bot.* **5** (6) : 527 – 542.
10. Kallersjo, Mari, 1990. Morphology, taxonomy and cladistics of Southern African Anthemideae (Compositae). Doctoral dissert. Dept. of Bot. Univ. of Stockholm.
11. Kubitzki, K. (Ed.). 2007. *The Families and Genera of Vascular Plants*. Volume VIII, Flowering Plants, Eudicots : Asterales (Eds.), Kaderiet J. W. and Jeffrey, C., Springer, Berlin.
12. Kynclova, M. 1970. Comparative morphology of achenes of the tribe Anthemideae Cas. (Asteraceae) and its taxonomic significance. *Preslia* **42** : 33 – 53.
13. Mukherjee, S. K. & A. K. Sarkar, 1992. Cypselar morphology and anatomy in some members of the family Compositae – tribe Anthemideae. In : R. D. Banerjee, S. P. Sen, K. R. Sammaddar, U. Sen, A. K. Sarkar and A. K. Biswas (Eds.). *Proceedings of the National Symposium of Plant Sciences in the nineties*. Department of Botany, Kalyani University, Kalyani, India, 3 – 464.
14. Roth, I. 1977. *Handbuch der pflanzenanatomic Spezieller Teil* Band X, Berlin : Gebruder, Borntraeger.
15. Weberling, F. and H. Reese, 1988. On the growth form and fruit anatomy of *Soliva* Ruiz and Pav. and *Isoetopsis* Turcz. (Compositae). *Beitr. Biol. Pflanz.* **63** : 289 – 312.