

马来西亚番荔枝科紫玉盘属 (*Uvaria* Linn.)、杯冠木属 (*Cyathostemma* Griff.) 和 *Ellipeia* Hook. f. et Thomson 叶的比较解剖学

Khatijah Haji HUSSIN, Noraishah Abu SAMAH, Kamarudin MAT-SALLEH

(*School of Environmental and Resource Science Studies, Faculty of Science and Technology,*

Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia)

摘要: 对紫玉盘属 8 种, 杯冠木属 3 种和 *Ellipeia* 属 1 种进行了叶的比较研究, 以调查不同种之间解剖学的不同点, 这对种的鉴别和了解它们的分类学意义可能是有用的。有意义的解剖学特征是: 末端石细胞, 表皮细胞的晶簇, 毛状体, 在中脉和叶柄的薄壁组织内的短石细胞以及中脉和叶柄横切面的形状。有某些特征仅出现在某些种中, 这对种的鉴别是有用的。结果亦显示这三个属的联系十分紧密。

关键词: 紫玉盘属; 杯冠木属; *Ellipeia*; 马来西亚; 叶比较解剖学

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COMPARATIVE LEAF ANATOMY OF *UVARIA* LINN., *CYATHOSTEMMA* GRIFF. AND *ELLIPEIA* HOOK. F. ET THOMSON (ANNONACEAE) FROM MALAYSIA

Khatijah Haji HUSSIN, Noraishah Abu SAMAH, Kamarudin MAT-SALLEH

(*School of Environmental and Resource Science Studies, Faculty of Science and Technology,*

Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia)

Abstract: A comparative study was undertaken on the leaves of eight *Uvaria*, three *Cyathostemma* and one *Ellipeia* species in order to investigate interspecific anatomical differences which could be useful in species identification and their taxonomic significance. Anatomical characters that are of significance are terminal sclereids, druses in epidermal cells, trichomes, brachysclereids in parenchymatous tissues of midribs and petioles, and the shape of midribs and petioles in transverse sections. Certain features are present in certain species only and are thus useful for species identification. The results also show that the three genera are quite closely related.

Key words: *Uvaria* Linn.; *Cyathostemma* Griff.; *Ellipeia* Hook. f. et Thomson; Malaysia; Comparative leaf anatomy

Uvaria Linn. is the second largest genus in the family Annonaceae consisting of 175 species distributed in Africa, Madagascar and the Indo-Malayan region especially in lowland rain forests^[1,2]. In Peninsular Malaysia there are 11 species of *Uvaria*, all of which are woody climbers. The genus *Cyathostemma* was published in 1854 by Griffith to accommodate woody climbers of uvarioid Annonaceae "with globose flowers". Unlike *Uvaria*, the flowers of *Cyathostemma* are not truly imbricate except at the tips of the petals while in bud stage. The petals also never fully expand. Their flowers are dense greyish, while those of *Uvaria* are always showy with strong colours. There are 14 species of *Cyathostemma* currently recognized distributed from Myanmar-China to New Guinea.

The affinity of *Cyathostemma* to *Uvaria* and morphological resemblance especially the leaves and the similarity in habit make it difficult to distinguish members of *Cyathostemma* from *Uvaria* especially sterile specimens. Some of the species were even described commonly as of *Uvaria*. One of such species is *Cyathostemma micranthum* (A. DC.) Sinclair which is common in the Malay Peninsula. The species was first published as *Guatteria micrantha* by A. De Candolle in 1832 but it was later transferred to *Uvaria micrantha*, by J. D. Hooker and Thomson in 1855, accepted by later botanists in their flora such as Kurz's Forest Flora of British Burma^[3], King's Compendium Annonaceae of the British India^[4], Ridley's Flora of the Malay Peninsula^[5] and Craib's Flora of Siam^[6]. It was only Sinclair^[1] who later in his revision recognized the peculiarity of its flowers that he decided to transfer the species to *Cyathostemma*.

Ellipeia is a small satellite asiatic genus related to *Uvaria* but differing from the latter by having a single ventral ovule and with the inner petals being much shorter than the outer petals. Several species of *Uvaria* was originally described as species of *Ellipeia* (such as *Ellipeia leptopoda* which is now known as *Uvaria leptopoda*) but was later transferred to *Uvaria* by Sinclair^[1] since they do not possess characteristics of the genus as typified in the original species of *E. cuneifolia*.

The objective of this study is to investigate anatomical interspecific variations in the genera *Uvaria*, *Cyathostemma* and *Ellipeia* which could help in the identification of the species.

1 Materials and methods

12 species of 3 genera in Annonaceae were studied in this paper and are listed in Table 1. Specimens used in this study were collected in the field [voucher specimens deposited in Universiti Kebangsaan Malaysia Herbarium (UKMB)], as well as from herbarium specimens. Specimens were fixed in AA (ethanol and acetic acid), sectioned on the sliding microtome and stained in safranin and alcian green. Herbarium specimens were boiled gently before fixation. Sections were made from the middle parts of the petioles and midribs. Epidermal peels were prepared by treatment with Jeffrey's fluid (10% nitric acid and 10% chrome acid, 1:1) and stained in safranin or alcian green. Leaf clearings

were prepared by treating the specimens with 1% basic fuchsin in 10% KOH at 60 °C. The cleared specimen were washed in 50% alcohol then transferred to 70% alcohol and acidified with a few drops of HCl. All slides were mounted in Euparal or Canada Balsam after dehydration. Observations of trichomes were made from transverse sections of leaves complemented with either leaf clearings or epidermal peels as well as stereoscopic observations of herbarium specimens. Images were captured using a video camera (JVC) attached to a Leitz Diaplan microscope and linked to a computer with SIS Docu image analysis software. Multiple images from large sections were joined using iPhotoDeluxe software.

Table 1 List of *Cyathostemma*, *Ellipeia* and *Uvaria* species studied

Species	Voucher specimens	Collecting site
<i>C. argenteum</i> (Blume) J. Sinclair	Shafii UKMB 27365	Kedah
<i>C. excelsum</i> (Hook. f. et Thomson) J. Sinclair	Zainuddin & Zulkifli AZ 5369	Selangor
<i>C. micranthum</i> (A. DC.) J. Sinclair	Mat Salleh KMS 36	Kedah
	Zainuddin AZ 2870	Pahang
	Latiff & Razali PUS 64	Selangor
	Kassim & Zainuddin UKMB 1266	Selangor
<i>E. cuneifolia</i> Hook. f. et Thomson	Asiah AS 26	Kelantan
	Zainuddin et al. AZ 2191	Kelantan
	Zainuddin & Hamid AZ 3181	Kelantan
<i>U. cordata</i> (Dunal) Alston	Razali RJ 689	Johor
	Mat Salleh & Rahim KMS 122	Johor
	Zainuddin AZ 2032	Kedah
<i>U. grandiflora</i> Roxb. ex Hornem	Latiff et al. ALM 3644	Kedah
	Zainuddin AZ 4387	Kedah
	Mat Salleh et al. KMS 01	Negri Sembilan
<i>U. hirsuta</i> Jack	Kassim & Zainuddin UKMB 3996	Selangor
	Kassim & Rahim UKMB 3994	Selangor
<i>U. javana</i> Dunal.	Nazre MN 01	Selangor
<i>U. leptopoda</i> (King) R. E. Fr.	Latiff et al. ALM 3733	Kelantan
	Latiff et al. ALM 3807	Kelantan
<i>U. littoralis</i> (Blume) Blume	Kassim UKMB 12656	Sabah
	Zainuddin UKMB 10530	Sabah
	Ruzita UKMB 19867	Sabah
<i>U. lobbiana</i> Hook. f. et Thomson	Van Balgooy 2554	Pahang
	Razali RJ 225	Pahang
<i>U. rufa</i> Blume	Latiff et al. ALM 1290	Kedah
	Zainuddin & Md. Shah AZ 4453	Kedah
	Zainuddin AZ 5146	Kedah

2 Results

Leaf surface EPIDERMAL CELLS: abaxial and adaxial cells with straight, wavy to sinuous walls, extending into projections (Plate I: A, Table 2). STOMATA: paracytic (Plate I: A). TRICHOMES: non-glandular hairs present on both surfaces of all species except *U. littoralis*. In *Ellipeia cuneifolia* only armed trichomes present; in *U. leptopoda* and *U. lobbiana* simple trichomes only; in the rest simple, armed and/or stellate (Table 3).

Table 2 Anatomical characters of *Cyathostemma*, *Ellipeia* and *Uvaria* species (Annonaceae): epidermis of lamina

Species	Anticlinal walls of epidermal cells (surface view)		Epidermal cells (TS)	
	Adaxial	Abaxial	Adaxial	Abaxial
<i>Cyathostemma argenteum</i>	Straight to wavy	Wavy	As high as wide to twice as wide as high	As high as wide to twice as wide as high
<i>C. excelsum</i>	Sinuuous	Wavy to sinuous	As high as wide to three times as wide as high	As high as wide to three times as wide as high
<i>C. micranthum</i>	Wavy with projections	Wavy with projections	As high as wide to twice as wide as high	As high as wide to twice as wide as high
<i>Ellipeia cuneifolia</i>	Wavy with projections	Wavy with projections	As high as wide to one and a half as wide as high	As high as wide to twice as wide as high
<i>Uvaria cordata</i>	Straight with projections	Wavy with projections	Twice as wide as high to four times as wide as high	Twice as wide as high to three times as wide as high
<i>U. grandiflora</i>	Straight with projections	Straight to wavy with projections	As high as wide	As high as wide to three times as wide as high
<i>U. hirsuta</i>	Straight with projections	Wavy with projections	As high as wide to twice as wide as high	Twice as wide as high to four times as wide as high
<i>U. javana</i>	Wavy	Wavy to sinuous	As high as wide to twice as wide as high	Twice as high as wide
<i>U. leptopoda</i>	Straight with slight projections	Wavy to sinuous	As high as wide to twice as wide as high	Twice as wide as high to four times as wide as high; outer wall conical
<i>U. littoralis</i>	Straight with projections	Straight to wavy with projections	As high as wide to twice as wide as high	Twice as wide as high to four times as wide as high
<i>U. lobbiana</i>	Straight with projections	Straight with projections	As high as wide to twice as wide as high	Twice as wide as high to four times as wide as high
<i>U. rufa</i>	Wavy	Wavy	Twice as wide as high to three times as wide as high	As high as wide to twice as wide as high

Lamina TS EPIDERMAL CELLS: adaxial cells of most species are as high as wide to twice as wide as high, other exceptions are shown in Table 2. Abaxial cells range from as high as wide to four times as wide as high (Table 2). In *U. leptopoda* the outer walls of the abaxial cells are conical in shape (Plate I: B). HYPODERMIS: present adaxially only in *C. argenteum*, *U. cordata* and *U. littoralis*. CHLORENCHYMA: palisade cells in one layer except in *U. leptopoda* and *E. cuneifolia* which vary from one to two. In all species this layer occupies less than half of leaf thickness. Spongy parenchyma ranges from 3–6 cell layers in thickness. VASCULAR BUNDLES: lamina bundles collateral, surrounded by complete or incomplete fibrous sheaths in all species except in *U. leptopoda* and *U. lobbiana* where sheath cells are parenchymatous. In all species the sheaths extend as girders to both epidermis especially in the large and medium size bundles. VEIN ENDINGS: enlarged tracheids absent. TERMINAL SCLEREIDS: abundant in all species except in *U. leptopoda* where they are absent. In *U. lobbiana* they are short and few while in *U. grandiflora* they are rare. CRYSTALS: druses commonly present in adaxial epidermis of 7 of the 12 species studied, but absent in *C. excelsum*, *C. micranthum* and *U. javana*. They

Table 3 Anatomical characters of *Cyathostemma*, *Ellipeia* and *Uvaria* species (Annonaceae): lamina

Species	Terminal sclereids	Hypo-dermis	Palisade number	Spongy thickness (no. of cell layers)	Trichomes	Druses	Bundle sheaths
<i>Cyathostemma argenteum</i>	+	+	1	3	Simple, unicellular; 2-4 armed & stellate (unicellular arms)	Adaxial epidermis, small acicular in palisade	Fibrous
<i>C. excelsum</i>	+	-	1	4-5	Simple, uniseriate; stellate (uniseriate arms)	—	Fibrous
<i>C. micranthum</i>	+	-	1	3	Simple, uniseriate; 2-5 armed, (uniseriate arms)	—	Fibrous
<i>Ellipeia cuneifolia</i>	+	-	1.5	3-4	3-armed, (bicellular arms)	Adaxial epidermis	Fibres in large bundles
<i>Uvaria cordata</i>	+	+	1	3	Short simple, bicellular; 2-armed	Hypodermis	Fibrous
<i>U. grandiflora</i>	Rare	-	1	3-4	Simple, unicellular-bicellular; armed (bicellular arms)	Adaxial epidermis	Fibrous
<i>U. hirsuta</i>	+	-	1	3-4	Simple, unicellular; stellate, (unicellular arms)	Adaxial epidermis	Fibrous
<i>U. javana</i>	+	-	1	3	Simple, slender (bicellular); 2-3 armed, stellate (bicellular arms)	—	Fibrous
<i>U. leptopoda</i>	-	-	1-2	3-4	Simple, 2-3 celled	Adaxial epidermis	Parenchyma
<i>U. littoralis</i>	+	+	1	5	—	Adaxial epidermis	Fibrous
<i>U. lobbiana</i>	Short, few	-	1	4	Short, simple, bicellular	Adaxial epidermis	Parenchyma
<i>U. rufa</i>	+	-	1	5-6	Simple, unicellular; armed, stellate, (unicellular & bicellular arms)	Adaxial epidermis	Fibrous

are present in the hypodermis of *U. cordata* and only in the adaxial hypodermis of *U. hirsuta*. In *Cyathostemma argenteum* small acicular crystals present in palisade cells apart from druses in epidermis. SECRETORY CELLS: globular, thin-wall in all species, some species (*U. rufa* and *U. lobbiana*) with yellowish contents.

Midrib TS OUTLINE: abaxial surfaces vary from U-shaped (*C. argenteum*, *U. cordata*, *U. grandiflora* and *C. excelsum*), rounded (*U. leptopoda*, *U. rufa*) to V shaped (*U. littoralis*, *U. hirsuta*, *C. micranthum*, *E. cuneifolia*, *U. javana* and *U. lobbiana*); adaxial surfaces vary from nearly straight (*U. littoralis* and *U. grandiflora*), slightly concave (*U. cordata*, *C. micranthum*, *C. excelsum*, *E. cuneifolia*, *U. lobbiana* and *U. rufa*) to slightly humped (*U. leptopoda*, *U. javana*, *U. hirsuta* and *C. argenteum*) (Plate I: C-G, Plate II). TRICHOMES: simple unicellular or uniseriate trichomes are present in all *Uvaria* species except *U. cordata*. They are also absent in *C. excelsum*, *C. micranthum* and *E. cuneifolia*. Stellate trichomes are present in seven species and armed trichomes occur in eight species of the three genera (Table 4). COLLENCHYMA: not seen in any species. SCLERENCHYMA: in *U. littoralis* fibres present below abaxial and adaxial epidermis in continuous layer, 2-3 cell layers thick (Plate II: E). VASCULAR TISSUE: open type in continuous or interrupted strands arranged in U-V shape except in *U. leptopoda* which is of the close type. Phloem interrupted. Wing and adaxial bundles present in *U. leptopoda*. BUNDLE SHEATH: fibres completely surrounding

vascular tissue except *U. leptopoda* where fibre sheath is discontinuous. CRYSTALS: druses present in parenchyma cells of ground tissue in most species, but absent in *C. excelsum*, *C. micranthum*, *U. hirsuta* and *U. javana*. SCLEREIDS: brachysclereids abundant in ground tissue of all species. SECRETORY CELLS: not seen.

Table 4 Anatomical characters of *Cyathostemma*, *Ellipeia* and *Uvaria* species (Annonaceae): midrib and petiole

Species	Midrib		Petiole		
	Trichomes	Crystals	Epidermis	Cortex (no. of cell layers)	Crystals
<i>Cyathostemma argenteum</i>	Simple, unicellular; armed, stellate (unicellular arms)	Druses in parenchyma	Twice as wide as high to twice as high as wide	18-20	Druses in parenchyma
<i>C. excelsum</i>	Stellate (uniseriate arms)	—	As high as wide to twice as wide as high	18-21	Druses, few solitary in parenchyma
<i>C. micranthum</i>	—	—	As high as wide to twice as high as wide	9-15	—
<i>Ellipeia cuneifolia</i>	Armed, stellate (unicellular arms)	Druses, few in parenchyma	As high as wide to twice as high as wide	18-21	Druses in parenchyma
<i>Uvaria cordata</i>	Short, 2-armed (bicellular arms)	Druses in parenchyma	As high as wide to twice as high as wide	16-20	Druses in parenchyma
<i>U. grandiflora</i>	Simple, 2-armed, stellate (bicellular arms)	Druses in parenchyma	Twice as high as wide to three times as high as wide	16-21	Druses in parenchyma
<i>U. hirsuta</i>	Simple, unicellular; stellate (unicellular arms)	—	Twice as high as wide	13-15	Druses, few solitary in parenchyma
<i>U. javana</i>	Simple, armed, stellate (bicellular arms, stellate arms long and slender)	—	As high as wide to twice as wide as high	15-20	Druses, few solitary in parenchyma
<i>U. leptopoda</i>	Simple, unicellular	Druses in parenchyma	Twice as high as wide to twice as wide as high	13-22	Druses in parenchyma
<i>U. littoralis</i>	Short, simple (uniseriate); 2-3 armed (unicellular arms)	Druses in parenchyma	Twice as high as wide to twice as wide as high	14-20	Druses, few solitary in parenchyma
<i>U. lobbiana</i>	Simple, unicellular; armed (unicellular arms)	Druses in parenchyma	Twice as high as wide to as high as wide	15-25	—
<i>U. rufa</i>	Simple, uniseriate to bicellular; armed, stellate (1-2 celled arms)	Druses in parenchyma	Twice as high as wide	11-15	Druses in parenchyma

Petiole TS OUTLINE: circular (*E. cuneifolia*, *U. javana*, *U. rufa*, *U. hirsuta*, *C. argenteum*, and *C. excelsum*), sub-circular (*U. grandiflora*, *U. littoralis*, *U. cordata*), almond shaped (*U. leptopoda* and *U. micranthum*) to cordate (*U. lobbiana*) (grooved adaxially). In *U. leptopoda* and *C. micranthum* abaxial surface V shaped. In *C. micranthum*, *U. grandiflora* and *U. leptopoda* adaxial surfaces nearly straight (Plates III and IV). EPIDERMIS: as high as wide to three times as high as wide. In *U. leptopoda* epidermal cells range to twice as wide as high. In *U. lobbiana* outer wall papillose. TRICHOMES: simple unicellular or uniseriate trichomes are present in all species except in *E. cuneifolia* which has short stellate trichomes only. Armed and stellate trichomes with unicellular to uniseriate arms are present in all species except in *U. leptopoda* which has simple trichomes only. CORTEX: parenchyma in 9-25 cell layers. Brachysclereids abundant in all species. VASCULAR TISSUES: open

type, separate bundles, arranged in an arc or in V to U-shapes (Plates III and IV). BUNDLE SHEATHS: absent in all species. CRYSTALS: druses present in parenchyma of all species except *C. micranthum* and *U. lobbiana*; solitary crystals also present in *C. excelsum*, *U. javana*, *U. hirsuta* and *U. littoralis*. SECRETORY CELLS in cortex below epidermis present in *U. leptopoda*, *U. lobbiana*, *U. grandiflora*, *U. hirsuta*, *U. cordata* and *C. micranthum*. These cells are rare in *Ellipeia cuneifolia* and not seen in the rest of the species.

3 Discussion

3.1 Significant anatomical features

Results of the study show that several characters present in all the species which may be characteristic of the three genera. The paracytic type of stomata is common in all species studied and is typical of the family^[7-10]. Brachysclereids are present in the ground tissue of the midribs and petioles in all specimens and have been reported to be present in the petioles of many species in the family^[10] such as *Monodora myristica*, *Uvaria virens*^[9] and *Goniothalamus* species^[11]. The midribs of all species possess the open type of vascular tissue except *U. leptopoda* which is of the close type. In the petiole the vascular tissue consists of widely spaced bundles laid in an arc or in V to U-shapes, the number of strands depending on where the section is made. This is contrary to Metcalfe and Chalk^[9] who reported that *Uvaria* petiole has numerous strands arranged in a circle. All species studied do not possess sclerenchymatous sheaths around the vascular tissue of the petiole, and this could be a common character for the genus or family.

According to Jovet-Ast^[12] species of the three genera have stellate trichomes and that simple trichomes are present in other genera of the family. However in our study stellate trichomes on lamina are absent in *Cyathostemma micranthum*, *E. cuneifolia*, *U. grandiflora*, *U. cordata*, *U. leptopoda*, *U. littoralis* and *U. lobbiana*, whereas in the *Uvaria* species mentioned above, simple (2 species), simple and armed trichomes (3 species) are present instead. However, this difference may result from the difference in terminology used since we define stellate trichomes as having more than five arms in contrast to Jovet-Ast who considered four-armed stellate as well. The presence of trichomes on *Cyathostemma micranthum* midrib is in contrast to Jovet-Ast^[12] who reported that the leaves are glabrous.

Druses are present in epidermal cells of all but three species (*C. excelsum*, *C. micranthum*, and *U. javana*), although according to Jovet-Ast^[12] they are present in all the three genera.

3.2 Interspecific variation

Adaxial hypodermis is present only in *C. argenteum*, *U. cordata* and *U. littoralis*. In *Annona* the adaxial hypodermis has been reported to be characteristic of a section of the genus^[13]. Projections from the anticlinal walls of the epidermal cells as seen in many of the species studied have been reported for *Goniothalamus andersonii*^[11]. According to Roth^[8] cell

wall undulation is fairly constant and is considered to be of taxonomic value. In this study these projections are found to be absent in *C. excelsum*, *C. argenteum*, *U. javana*, *U. leptopoda* and *U. rufa*.

Oil and/or mucilage cells are present in *Annona* species, the oil cells being smaller and having thicker cell walls than mucilage cells. Their frequencies, in combination with other characters, were reported to be useful for species identification and possibly for elucidation of the relationships among species^[13]. *C. micranthum* can be distinguished by the large secretory cells in the lamina which are most likely to be mucilage cells. Smaller ones are also present in petioles. In *C. excelsum* and *C. argenteum* lamina they are smaller and are probably oil cells. In these two species oil or mucilage cells are not present in the midrib or petioles.

In the lamina, druses are present in adaxial epidermal cells of eight species, and in hypodermal cells of *U. cordata*. They are absent in 3 species (Table 3). The presence of crystals in epidermal cells have been found to occur in many genera of the Annonaceae^[7,9]. Their form, size and distribution are of considerable taxonomic value^[10]. According to Jovet-Ast^[12] the three genera are very closely related due to the presence of stellate trichomes and druses in epidermal cells. Together with *Anomianthus* and *Rauwenhoffia* he reported that they form a homogenous group of genera and are very distantly related to other genera of the family. Druses are also present in parenchyma cells either in petioles or midribs except *C. micranthum* and *U. lobbiana* in which they are completely absent in petioles and in 4 species they do not occur in midribs (Table 4).

Foliar sclereids have been reported to be present in Annonaceae leaves^[14] and has been recorded by Rao and Das in representatives of 14 genera^[10]. Terminal sclereids are observed in all three species of *Cyathostemma*, *Ellipeia cuneifolia* and seven *Uvaria* species except *U. leptopoda*. Their presence has been reported for *Annona*, *Anaxagorea*, *Asteranthe*, *Guatteria*, *Uvaria*, etc.^[9] and is characteristic for one sectional group of *Annona* species^[13]. In *Goniothalamus*, the presence of terminal sclereids distinguishes *G. macrophyllus* from *G. andersonii*, *G. malayanus* and *G. velutinus*^[11].

Plate I: C–G and Plates II–IV display variations in the shape and vascular tissue arrangement of the midribs and petioles in TS which, when combined with other characters mentioned above, indicate the usefulness of anatomical characters for species identification. With more species studied it may be possible to construct a dichotomous key for identification. Certain characters can be used as diagnostic characters such as the presence of fibres below the epidermis in the midrib of *U. littoralis* and the shape of the petiole of *U. lobbiana*. In *U. leptopoda* it is possible to use a group of characters such as the shape of the midrib and petiole, closed type of midrib bundle, presence of adaxial and wing bundles, conically-

shaped abaxial epidermal cells, and the absence of terminal sclereids, to distinguish it from the rest species. Morphologically it is easily distinguishable from the rest of the species by having long carpel stalks, tuberculate and slightly spherical carpels. The leaves also differ from other species by having tomentose lower leaf surface while glabrous on the upper surface.

No clear distinction however, could be seen between the three genera and no grouping of characters were found to subdivide the genus *Uvaria*. This is agreeable to Jovet-Ast^[12] who reported that *Ellipeia*, *Cyathostemma* and *Uvaria* are very close and that *Uvaria* does not have any distinct characters different from the other two.

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Explanation of Plates

Plate I

A. Surface view of abaxial epidermis of *Uvaria cordata* showing paracytic stomata and wavy anticlinal epidermal walls extending into projections (arrowhead). B. Transverse section (TS) of *U. leptopoda* lamina showing conical outer abaxial

epidermal walls (arrowhead). C-G, TS of midribs of Annonaceae species. C. *Cyathostemma argenteum*; D. *C. excelsum*; E. *C. micranthum*; F. *Ellipeia cuneifolia*; G. *U. cordata*. Scales for A & B=100 μm , C-G=500 μm .

Plate II

TS of midribs of Annonaceae species. A. *U. grandiflora*; B. *U. hirsuta*; C. *U. javana*; D. *U. leptopoda*; E. *U. littoralis*; F. *U. lobbiana*; G. *U. rufa*. Scales=500 μm .

Plate III

TS of petioles of Annonaceae species. A. *Cyathostemma argenteum*; B. *C. excelsum*; C. *C. micranthum*; D. *Ellipeia cuneifolia*; E. *U. cordata*. Scales=500 μm .

Plate IV

TS of petioles of Annonaceae species. A. *U. grandiflora*; B. *U. hirsuta*; C. *U. javana*; D. *U. leptopoda*, E. *U. littoralis*; F. *U. lobbiana*; G. *U. rufa*. Scales=500 μm .