Taxonomic Investigation Of Sub- Family Caesalpiniaceae Of Hojai Sub Division With Special Reference To Pollen Morphology.

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Abstract:
Taxonomical and palynological study were carried out from February to July, 2017. A total of 10 species belonging to 7 genera were recorded in the Hojai sub division, out of which 5 species were perennial trees, 3 were large shrub and 2 were shrub. Their leaves were found to be unipinnate and peripinnately compound with pulvinous leaf bases. Inflorescence were found in either raceme or panicle type. Among the 10 taxa, six have yellow flowers and flowering time was at summer. Stamens were found to be heterodynamous.I n *Cassia fistula* Linn., all the10 stamens were fertile, while in others, out of the 10 stamens each, 7 were fertile and rest 3 were sterile. The fruits were represented by pod (legume). Pollen grains in most of the taxa were found to be trizonocolpate and colpi never meet each other at either pole. The shape of the grains was prolate to sub-prolate while in *Delonix regia* it is oblate to spheroidal and in *Saracaasoca* it is spheroidal. The Largest pollen grains were observed in *Bauhinia tomentosa* L.with a length of 3.8µm and smallest grains in *Cassia javanica*Linn. and *C. fistula* Linn. with a length of 1.06µm. The pollen grains of all the recorded species were found to bear thin exine. *Senna occidentalis* Linn. had the thinnest exine with 0.098µm. and hence may be considered as highly evolved among all the 10 species under study. The taxonomic enumeration of all the taxa were done with proper description, analytical diagrams, and photographs. The palynomorphological study revealed that the pollen grains of the taxa were from non- colpate to trizonocolporate to penta- colpate. Most of them Oblate, Sub- oblate, Prolate, Sub- prolate and spheroidal in shape.
Key words: *Pollen grain, Hojai, Pod,Taxa, Exine.*

INTRODUCTION:

Taxonomy is a branch of science that deals with the identification, nomenclature, and classification of living organisms regarding their origin, affinities, phylogeny, etc. In plant systematics the plants are arranged into related groups based on data coming from various disciplines of botany like morphology, anatomy, embryology, cytology, palynology, molecular analysis, etc. The data taken from palynological evidences for systematic Botany is called Palynotaxonomy. The male gametophytes i.e., the pollen grains are structurally and functionally adapted for their efficient transfer to the receptive stigma and these characters are of value to systematic botany in deducing the palynology and taxonomy of the group. Bentham &Hooker divided the family Leguminosae (Fabaceae) into three sub- families- Papilionaceae, Caesalpiniaceae and Mimosaceae. Primitive and closest to the Rosaceae family, the Caesalpiniaceae appears to have descended from the rosaceous stock. Caesalpiniaceae or Caesalpinoideae comprises about 180 genera which are cosmopolitan in distribution. In India it is represented by 85 species and 23 genera.Caesalpinoid legumes are found mostly in three geographic regions: South America, Tropical Afric a, and South East Asia.Numerous prominent genera, like Poinciana, Bauhinia, and Cassia, are found acros s the tropics. The members of Caesalpinoideae are characterized by trees (Tamarindus) and shrubs (*Caesalpinia parkinsonia, C. pulcherrima*); rarely herbs (*Senna tora*), or prickly climbers (*Caesalpinia sepiaria*) and tall trees (*Cassia javanica*).Leaves are usually alternate, pinnate or bipinnately compound; rarely simple (*Bauhinia*); stipules sometimes modify into spines (*Parkinsonia*). Inflorescence usually raceme, or spikes, rarely corymb; or solitary flowers. Flower bisexual, zygomorphic; pentamerous, hypogynous or perigynous; rarely unisexual (*Gleditsia*). Calyx usually with 5 sepals, free or basally

connate, imbricate or valvate; odd sepal anterior; sepals are petaloid in *Saraca indica*. Corolla with 5 petals, polypetalous, ascending imbricate aestivation; the petals are unequal- sized. Androecium with usually 10 free stamens, arranged in 2 alternate whorls of 5 each (diplostemonous), often a few stamens reduced to staminodes; filaments often unequal; anthers dithecous; introrse and dehisce by apical pores. Carpel 1, superior, unilocular ovary, with two alternating rows of anatropous or campylotropous ovules on marginal placentation; style single. Fruit legume, sometimes indehiscent; often winged. Seeds are exalbuminous.

Caesalpinioideae is important source of several ornamentals, drugs, dyes, and timber. Due to presence of beautiful and colourful flowers many plants are planted as avenue tree, landscape gardening and garden plants.*Bauhinia acuminate* (swetakanchan); *B. corymbosa* (white flower); *B. galpini* (scarlet flower); *B. Monandra*(hedge kachnar); *B. tomentosa* (yellow- flowered); *B. variegata* (variegated- flowered kachnar), *Caesalpinia pulcherrima* (Orange or yellow); *Senna alata*; *Cassia fistula*; *Delonix regia* (Gulmohar or Royal Poinciana); and *Saraca indica* (Ashok tree) are few of them.

A lot of them are also medicinally useful. Notable among them are: *Senna alata*leaves and *S. occidentalis* seeds and leaves are used for skin infections; *S. sophera*leaf decoction is helpful for acute bronchitis: *Cassia acutifolia*and*c. Fistula* leaves and fruits are used as purgatives.Arya (2011) studied phenolic content and antioxidant activities of leaf extract of *C. occidentalis*. Bhadaurea and Singh (2011) studied flavanoid activity of *Cassia siamea*. Evaluation of in vitro cytotoxity of *C. occidentalis* against human cancer cell was done by Bhagat et el (2010).Heartwood (Haematoxylon campechianum) is the source of haematoxylin the most well

known nuclear stain.Commercially valuable tannin is extracted from the bark and seeds of several plants, i ncluding *Bauhinia variegata, B. purpurea, B. racemosa, B. vahlii*, and *C. digyna*.,*C.copaifera pubiflora*an d *B.*racemosa are sources of gum.Wood from the heart of Caesalpinia sepiaria is used to make red dye, wh ich is then used to make red ink.

Numerous taxonomy studies on *Caesalpinia* have been conducted from time to time by various researcher s.In

Plants of the coast of Coromandel (1798 & 1819), ScottishBotanist William Roxburgh exquisitely portray ed a few unique legumes, such as *Dalbergia rubiginosa* Roxb. and *Hardwicki*

abinata Roxb.Numerous south Indian legumes were described by Wight & Arnott in 1834. The most significant taxonomical works on Leguminosae had done by the workers like Ansari (1985), Manilal (1988), Subramanian (1995), Ramachandran and Nair (1988), Mohanan & Sivadasan (2002), Kumar *et.al.* (2005) etc are few to mention.

Fritzsche (1832) was the first to characterise *Cassia* L.'s tricolpate pollen grain. In their discussion on pollen grains of Leguminosae pollen grains. Nair and Sharma listed the genus *Cassia* which belongs to the Cassieae tribe. Kim and Song (1998) studied the pollen morphology of seven taxa of three genera of the sub-family in Korea with the help of LM & SEM. They recognised four major pollen types of the sub-family. Banks et.el (2003) proposed the systematic position of the tribe Cassieae of Caesalpinioideae based on pollenmorphology. Pollen morphological characteristics of 36 taxa of the Mimosoideae representing 30 species 4 sub-species and 2 varieties were investigated with the aid of LM & SEM by Tantawy *et. al*. (2005). They used several palynological features to build an identification key for the species under study. Morphological analyses of the pollen of Cajanus

cajan (L.) Millsp. cultivars and their hybrids, three

colporate pollen grains with areolate exine and varied areolae

sizes were detected in the hybrids Srivastava's (1978). By characterising 92 species of the subfamily Papilionoideae belonging to 36 genera under 8 tribes, Tewari & Nair (1979) have made a substa ntial addition to the pollen studies of Indian Papilionoideae. L. Borah (2014) conducted research on the micromorphological

traits of six distinct *Cassia* species in Guwahati.

Although a fair amount of published data on pollen morphology of Indian Leguminosae are available, there is a dearth of palynotaxonomical data on legumes from Assam, particularly in Hojai sub division.

Aim and objectives

The members of sub family Caesalpiniaceae are diverse in Assam and flowers mostly from march to August of the year. Some of them are found abundantly in Hojai sub division. Studies on the taxonomic description of the sub- family Caesalpiniaceae in relation to Palynology of Hojai sub division, Assam is almost nil. So, to know the floral composition and pollen morphology of the members of the sub family found in Hojai, the present study has been adopted with the following objectives:

1. To carry out preliminary survey of Caesalpiniaceae occurring in Hojai sub division, Nagaon of Assam to know its diversity.
2. To describe the taxa with their recent up-to-date nomenclature to have a correct taxonomical data.
3. To study the pollen morphology of the members of the sub- family Caesalpiniaceae to see any palynomorph variation occurred with the change of habitat and climate in the study area.

Study Site:

Assam is the gateway of North Eastern part of India. The study area Hojai sub division of Nagaon district is located on a global position between latitude of 26°01/ N to 26°05/ Nand longitude of 92°45/ E to 92°48/ E. at a mean altitude 85 meters above sea level. Hojai is pre-eminently an agricultural belt and in recent times it has attracted attention for it's famous Agarwood processing and Agar product export to the Gulf countries. It is situated in the flood plains of river Kopili, Yamuna and Jogi which comprises 7 reserve forests and a hill named Doboka hill with rich floral diversity. Hojai sub division is a rain-shed area and enjoys hot and humid subtropical climate. It also comprises numerous large wetlands that formed from the changing tract of river Kopili in due course of tectonic depression and seismic activities (Saikia,M 2008).The soil of the study site is clay loam type. High anthropogenic activities lead to the loss of biodiversity and climate change in this area. (Disaster management plan under Hojai sub division, 2017-2018).

MATERIALS AND METHOD

Survey, Collection and Preparation of Voucher Specimen:

Frequent field survey has been carried out to collect plant specimens of the sub- family Caesalpiniaceae from different localities within the study area during flowering and fruiting at regular interval within the study period i.e., March to August, 2017. Efforts were made to study the specimens in their natural habitat by recording salient features on the field notebook.Voucher specimens were prepared following standard herbarium techniques of Jain and Rao's (1977).

Identification and Nomenclature:

Voucher specimens were identified in consultation withthe Gauhati University Herbarium (Botany department) and with microfilms of herbarium specimens stored on online databases of various herbaria. Up to date nomenclature and confirmation of the specimens were done by consulting with the online database of 'The Plant list' for Angiospermic plants (flowering plants) version 1.1 (www.theplantlist.org). Taxonomic Enumerationand results were drawn with the help of analytical drawings and photographs. For ease identification, dichotomous keys, were prepared based on their morphological characters.

Study of Pollen Morphology:

Pollen slides were prepared by acetolysis method as described by Erdtman (1960) with slight modification of Nair (1970). Observations of pollen data such as, polar axis, equatorial diameter, P/E ratio, exine thickness, aperture types and colpus length were made with Nikon Lab phot microscope (400X). At least 5 pollen grains were examined for each taxon. Terminology of pollen grains were adopted from Erdtman and Nair (1970).

RESULT:

The taxonomical and palynological study of Caesalpiniaceae have been carried out from March to August, 2018 where a total of 10 species belonging to 7 genera were recorded and studied. The photographs of habit (Plate No.1) and analytical drawings are presented in Plate No.2.

Taxonomic enumeration:

Caesalpiniaceae Lindl. (nom. alt. Leguminosae Juss.).

Mostly trees or shrubs, sometimes climbers, rarely herbs.Leaves usually paripinnate or bipinnate. Flowers irregular or i.e., medianly zygomorphic, usually bisexual, sub- perigynous in racemes or paniculate inflorescence. Sepals 5, occasionally 2, usually united, sometimes free, imbricate. Petals 5, free, imbricate; the odd 5th petal posterior, smallest and posterior and innermost. Stamens usually 10 or less by abortion, free or rarely united at base. Ovary superior, sometimes stalk or united by the stipe to the calyx tube. Pod indehiscent or dehiscent, often septate but not breaking into 1- seeded joints. Seeds various, albuminous or exalbuminous. It has been reported that the distribution of tricolporate pollen grains with reticulate, psilate, striate and rarely regulate ornamentation is found in Caesalpiniaceae.

Floral formula: Br % ⚥ K_5 C_5 A_{10} or 7+ 3std, G_1

Key to the genera:

1a. Trees
- 2a. Leaflets many
  - 3a. Leaves 1- pinnate
    - 4a. Petals 5, pods without pulpy mesocarp _____*Cassia*
    - 4b. Petals 0, stamens 7-8 _____*Saraca*
  - 3b. Leaves bipinnate
    - 5a. Flowers in diffuse corymbose racemes _____*Delonix*
    - 5b. Flowers in large compound racemes, Style with broad peltate stigma _____*Peltophorum*

1b. Shrubs
- 6a. No. of Leaflets- 2 _____*Bauhinia*

1c. Herbs
- 7a. Leaves paripinnate
  - 8a. Petals 5, flowers yellow _____*Senna*
  - 8b. stamens very long, 70–90 mm, bright red___*Caesalpinia*

1. 
2. 
3. 
4. 
5. 
6. 

7.  8.  9.  10. 

Plate no. 1- External morphology of – I. *Bauhinia tomentosa* Linn. 2. *Caesalpinia pulcherrima* (L.) Swartz. 3. *Cassia fistula* Lam. 4 *Cassia javanica*Linn. 5. *Delonix regia* Raf. 6. *Peltophorumpterocarpum*(D.C.). 7. *Saracaasoca*Linn. 8. *Senna alata*Linn. 9.*Sennahirsuta*Linn. 10. *Senna occidentalis* Linn.

Pictures of the analytical diagrams of the recorded species:

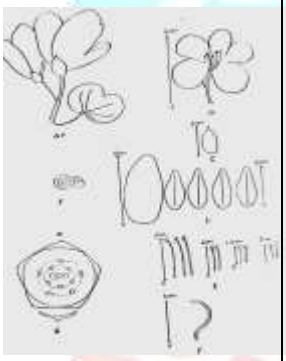
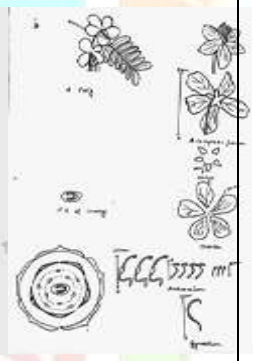
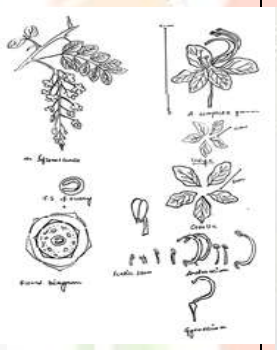
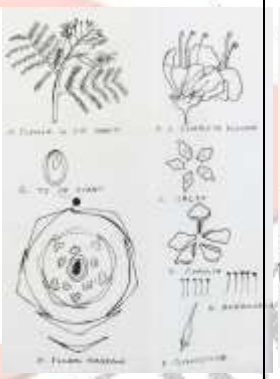
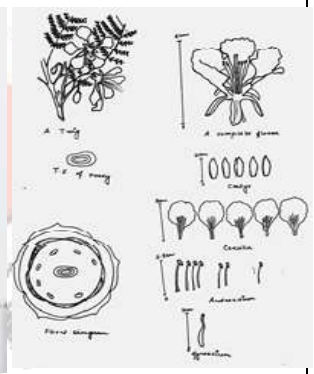
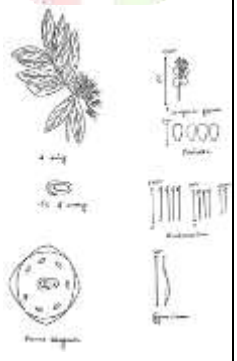
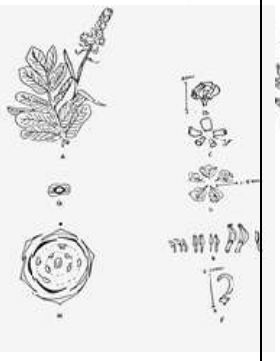
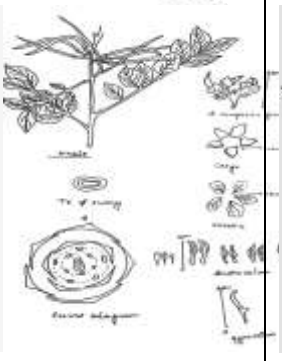
1. 	2. 	3. 	4. 	5. 
6. 	7. 	8. 	9. 	10. 

Plate no. 2: Analytical drawing of- 1. *B.tomentosa*2. *C.fistula* 3. *C. javanica*4. *C. pulcherrima* 5. *D. regia* 6. *P. pterocarpum* 7. *S. asoca* 8. *S. alata* 9. *S. hirsuta* 10. *S. occidentalis*A. Habit of the plant, B. A complete flower, C. Calyx, D. Corolla, E. Androecium, F. Gynoecium

***1. Bauhinia tomentosa* L.**

Bauhinia tomentosa Linn**.,** Sp. PI. 1: 375. 1753; N. L.Burm., FI. Ind. 94. 1768; Lam., Encycl. 1(2): 390. 1785; Baker in Hook. Fl. Brit. India 2: 275.1878.

Habit: Shrubs, erect, up to 4 m tall.Young branches puberulent. Stipules linear.

Leaves: petiolate1; 3-5 cm, slender; leaf blade suborbicular, 3-7 x 4- 8 cm,abaxially tomentose, adaxially glabrous, base cordate, 7-9- veined, apex bifid, lobes rounded at apex.

Inflorescence: lateral raceme, 1-3 flowered; pedicel short; bracts and bracteoles linear, 2cm.

Corolla: Petals 5, light yellowish, subequal, broadly obovate, 5x 4 cm, subsessile.

Androecium: Fertile stamens 10, unequal; filaments 1cm, puberulent at base.

Gynoecium: Carpel 1; ovary stalked, tomentose; styles slender, glabrous; stigma peltate, small.

Fruit: Legume flat, linear, 7-15 x 1.2- 1.5 cm.

Occurrence- cultivated**.**

Flowering period- March to June. Vern.Name-Kanchan, Kachnar(Hindi)

2.*Cassia fistula* L.

*Cassia fistula*L., Sp. PI. 377. 1753; Hook, f., FBI. 2:261.1878; Kanjilal*et. al.*, FA 2:128; Rao et. Rabha, BBSI. 8:299.1966; Jain *et.* Hajra, BBSI 17:82.1975; Deb, FTS. 1:118.1981; Chowdhury *et. al.* Ass. Fl. 215.2005.

Habit: Medium sized deciduous *tree,* bark smooth, grey.

Leaves: leaf rachis 15-40 cm long; leaflets 4-8 pairs, (sub)-opposite, oblong-elliptic to broadly ovate, acute or subacuminate, basecunneate orrounded, shining above, subpubescent beneath.

Inflorescence: Racemes 15-40 cm long. **Flowers**: yellow, 4-6 cm across.

Stamens:10, fertile 7, anthers dithecous, dorsifixed, introrse.

Gynoecium: Monocarpellary, ovary superior, marginal placentation, stigma curved.

Flowering period- April- August

Grown in dry deciduous forests and planted for its beautiful flower and shade.

Occurrence: Common **Vern**. **Name-** Sonaru.

3. *Cassia javanica* Wall.

*Cassia javanica*Wall. Cat. n. 5307. 1849; Randhawa, M.S. Flowering trees. 121.1983; Chowdhury *et. al.*, *Ass*. FI. 215.2005.

Habit: A medium sized beautiful deciduous *tree,* branches horizontal and drooping.

Leaves: *L*eaflets 10-12 pairs, elliptic-oblong to oblong lanceolate, pointed at apex, leathery, glossy, 20- 30 cm long.

Inflorescence: Raceme, terminal on leafy shoots or lateral on short branches, up to 16 cm long.

Flowers: Arise as clusters on short stems from the scars of old leaves, erect, showing a line of pink, erect blossoms arranged on horizontal branches.

Calyx: Sepals 1cm. **Corolla:** Petals 2 cm.

Androecium: Stamens 10, 3 longer ones with filaments 1.5 cm long, 4 shorter with filaments of 1 cm long and 3 reduced with filaments of 1 cm long and minute anthers.

Gynoecium: Monocarpellary, ovary superior, style curved.

Flowering period: May-June **Ver. Name-**Radhachura (As.)

Cultivated as ornamental tree for its beautiful flowers.

4. *Caesalpinia pulcherrima* (L.) Swartz., Obs. Bot. Ind. Occ.: 166 (1791); Willd., Sp. Pl. 2: 531 (1799); Prain, Beng. Pl. 1: 449 (1903); Brandis, Ind. Trees: 247 (1906). Poinciana pulcherrima L., Sp. Pl.: 380 (1753); Baker in Hook, f., Fl. Brit. Ind. 2: 255 (1878).

Habit- Prickly shrub up to 3 m tall;

Leaves- bipinnate, leaflets up to 2 cm long; pinnae 5-8(-10) pairs; leaflets 6-10 pairs, elliptic to obovate, 1-2.5 cm

Flowers- with red petals having yellow margins, becoming deep red; stamens bright red, up to 6 cm long; pod flat, up to 10 cm long. Flowers in elongate terminal racemes, pedicels 7.5-10.0 cm

Calyx- sepals unequal, orange-red, enclosing the others in bud, 1-1.4 cm, glabrous.

Corolla- Petals 5, free, 4 sub-equal, distinctly clawed, 5th petals with long clawed and smaller lamina, orbicular. Androecium- Stamens 10, free; filament up to 7.5 cm long, very much long exserted; anthers versatile.

Gynoecium- Ovary seated on short gynophore, glabrous, compressed; style 5.0-5.5 cm long; stigma ciliate.

Fruit- Pod oblong, compressed 5.0-8.5 × 1.5-2.0 cm, purple to dark brown, dehiscent.
Seeds 8-10 per pod, brown or black.
Flowering and Fruiting: February - April and September - November.
Ver. names: Krisnachura (As); English names: Barbados Pride, Red Bird of Paradise

5. *Delonix regia* Raf.

Delonix regia (Bojer) Raf., FI. Tell. 2:92.1836; Blatter *et.al.*Beautiful Indian Trees (ed. 2) 52. 1954; Matthew, FI. Tam. Car. 1:512. 1983; Chowdhury *et.al.*Ass. FI. 215. 2005. *Poinciana regia* Bojer ex Hook, in Curtis, Bot. Mag. T. 2884. 1829; Hook, f., FBI 2:260.1878; Kanjilal*et.al.*FA 2:137.1938.

Habit- A soft wooded deciduous tree with spreading crown.
Leaves:large, feathery, bipinnate of 11-18 pairs.
Flowers: gorgeous scarlet and orange; **Calyx:** Sepals 5, 2 cm each. **Corolla:** s3cm or more long, orbicular with a long claw.
Androecium: Stamens 7, 4 large, 2.5 cm, and rest 3 of 2 cm each.
Gynoecium: Monocarpellary, ovary superior, 3 cm long.
Fruit: 30-60 cm long pod, flat, woody.
Flowering period: March- June **Vern. name:**Krishnachura (As.)
Cultivated for its beautiful flower and canopy; also grow wild.

***6. Peltophorumpterocarpum* (DC.) K. Heyne**

***Peltophorumpterocarpum*(DC.) Backer ex K. Heyne,** *Inga pterocarp*a DC, Prodr. 2:441 (1825). *Caesalpinia ferruginea*Decne., Descr. Herb. Tim. 134 (1834). *Peltophorumferrugimeum* (Decne.) Benth., Fl. Austral. 2: 279 (1864); Bak.f., Leg. Trop. Afr. 3: 612 (1930). *Caesalpinia ferruginea*. P. *africanum*var. *speciosum* Burtt Davy in Kew Bull. 1921: 50(1921).

Habit: Deciduous tree usually reaching a height of 15 m. Bark smooth, grey; crown dense, spreading.
Leaves: large, 30-60 cm long, with 8-10 pairs of pinnae each bearing.
Flowers: Orange-yellow, each about 3.5 cm in diameter, fragrant, particularly at night; inflorescence brown-tomentose, panicles terminal with rust-coloured buds. Calyx- sepals 5, 1.5 cm in length. Corolla- Petals 5, 3cm long. Androecium- Stamens 10, 5 large (2.5 cm long) and less large (2 cm in length). Gynoecium- Style erect, 2cm long. Fruits 1-4 seeded pods, flat, thin, winged, 5-10 cm long, dark red when ripe, then turning black.
Flowering period: April - June **Vern. name:** Copper pod

7. *Saracaasoca* (Roxb.), De. Wilde

***Saracaasoca*(Roxb.) De. Wilde.** *Saracaasoca* (Roxb.) de Wilde, Blumea 15: 393. 1968; Manilal & Sivar., Fl. Calicut 94. 1982; Mohanan, Fl. Quilon Dist. 164. 1984; Ramach. & V.J. Nair, Fl. Cannanore Dist. 167. 1988; Antony, Syst. Stud. Fl. Kottayam Dist. 147. 1989; Vajr., Fl. Palghat Dist. 184. 1990; Sanjappa, Legumes Ind. 35. 1992; M. Mohanan &Henry, Fl. Thiruvanthapuram 170. 1994; Subram., Fl. Thenmala Div. 119. 1995; Sasidh. & Sivar., Fl. Pl. Thrissur For. 166. 1996; Ravikumar &Ved, Illustr. Field Guide 100 Red Listed Med. Pl. 334. 2000; Anil Kumar *et.al.* Fl. Pathanamthitta 200. 2005; Sunil & Sivadasan, Fl. Alappuzha Dist. 260. 2009; Ratheesh Narayanan, Fl. Stud. Wayanad Dist. 327. 2009. *Jonesiaasoca*Roxb., Asiat. Res. 4: 365. 1799. *Saraca indica*sensuBedd., Fl. Sylv. t. 57. 1870; Hook. f., Fl. Brit. India 2: 271. 1878, non-L. 1769; Gamble, Fl. Pres. Madras 409(289). 1919.

Habit- A tree 6-9 meters high; branches glabrous. Stems erect or ascending, more than 2 meters tall, solid,glabrous, or sparingly glabrate.
Leaves-15-25 cm long; rachis glabrous, corky at the base; petioles very short; stipules intrapetiolar, completely united, 10- 13 by 6mm. scarious, ovate, oblong, obtuse, parallelnerved.
Leaflets 4-6 pairs, 10-20 by 3-5.7 cm., oblong-lanceolate, obtuse, or acute, quite glabrous, base rounded or cuneate, slightly oblique.
Flowers are actinomorphic or somewhat irregular fragrant, numerous, in dense axillary corymbs 7.5- 10 cm. across; peduncles stout; ovate, subacute; bracteoles2, appearing like a calyx, 2 cm. long, spathulate-oblong subacute
Androecium- Stamens7 or 8, much exerted; filaments filiform, thrice if the calyx segments; **Gynoecium-** Ovarypubescent, especially on the sutures; **Style** curved into a ring.
Fruit- Podsblack, 10-25 by 4.5-5 cm.
Flowering period: March- June
Vern. name: Krishnachura (As.)

8. *Senna alata* L.

Senna alataL., Sp. PL 378. 1753; Wight & Am., Prodr. fl. Ind. orient. 287. 1834; Hook. *f*, FBI 2:264. 1878; Kanjilal*et.al.*FA 2: 133.1938; Deb, FTS.1:117. 1981; Chowdhury *et.al.*Ass. Fl. 215. 2005.
Habit- Shrubs **Stem**- erect, branched, solid, cylindrical, bark green.
Leaves- compound, peripinnate, leaflets 5-12 pairs, 7 x 4 cm, oblong, upper most obovate stipules 0.6 cm long, triangular – deltoid, auriculate, acuminate, persistent, pubescent, rachis without any glands.
Inflorescence- raceme, 20-60 cm long like a yellow candle, puberulous. **Calyx** – sepals 5, polysepalous, unequal, 1 cm, obovate, membranous, imbricate, light green. **Corolla** – Petals 5, polypetalous, unequal, 2 cm, obovate – orbicular to spathulate, imbricate flowering at summer, yellow.
Androecium – stamens 10, unequal, 7 fertile (2 long + 2cm, 1 medium + 1 cm, 4 short + 0.5 cm), 3 sterile 0.25 cm, anther bilobed, basifixed, large anthers falcate, filaments short in comparison to anthers, anthers dehiscing by apical pores and longitudinal rims.
Gynoecium- Ovary around 2.5 cm, sickle shaped, superior, one chambered, placentation marginal ovules many, style short, stigma terminal.
Fruit- A winged pod (legume), longitudinally winged along the middle of each valve, ±16 cm long, straight, transversely septate,
Flowering period- March- May. **Ver. Name-** Candle Bush or Ringworm Bush

9. *Senna hirsuta*L.

***Senna hirsuta*L.**, Sp. PI. 378. 1753; Hook, f., FBI 2:263. 1878; Kanjilal*et.al.*, FA. 2:131.1938; Choudhury *et. al.*, Ass. FI. 215. 2005.
Habit- A much branched under shrub, about 120 cm in height, all parts hirsute with dense spreading hairs, stem deeply ribbed.
Leaves- spiral, paripinnate, petiolate, pulvinous; leaflets subsessile to shortly petiolate, 1.5-5.7x0.8-2.1 cm across, ovate to broad lanceolate, bade obtuse, apex acuminate, densely pubescent on both surfaces, entire pinnately veined, lateral nerves opposite to alternate up to 8-9 on either half, oblique, open. Rachisup to 11 cm long, densely pubescent, striate.
Flowers-in groups of 1-4 deeply yellow on short peduncles, crowded at the ends of shoots.
Calyx - persistent, 5 sepals.
Corolla- 5 petals, yellow.
Androecium- 7 fertile stamens 2 cm long, 3 staminodes.
Gynoecium- Ovary 1.7 cm long, many ovules, hairless style.
Fruit- Pods6-12, 3 cm across, slender flattened, grooved, densely villous.
Flowering period- March- May. **Ver. Name-** Hairy Senna, Sickle pod

10.*Senna occidentalis* L.

Senna occidentalis L., Sp. PI. 377.1753; Wight & Am., Prodr. fl. Ind. orient. 290. 1834; Hook. *f*, FBI 2:262. 1878; Prain, Bengal Plants. 1: 437.1903; Kanjilal*et. al*, FA. 2:129. 1938; Matthew, FI. Tam. Car, 1:505. 1983; Chowdhury *et.al.*Ass. FI. 215.2005.
Habit- A soft wooded sub-shrub.
Leaves-15-20 cm long, channelled with a gland at base; stipules small, caduceus; leaflets 4-5 pairs, opposite, oblong lanceolate, glabrous, base round, margin entire, apex obtuse or acute; petiole 4cm, with a sessile globose gland at its base; rachis glandular.
Flowers- axillary or terminal racemes or corymbose raceme; 2 cm across.
Calyx-lobes 5, ovate, obtuse.
Corolla-Petals 5, yellow, oblong-obovate, clawed.
Androecium-Stamens10; upper 3 staminodes, with filaments and empty anthers; antheriferous 7; lower 3 large, 2 medium, 2 short.
Gynoecium- Ovarysubsessile, pubescent; ovules many.
Fruit-Podcompressed, slightly falcate, flat, obtuse at apices, with transverse depressions between the seeds. Seeds20-30, pale brown, longitudinal.
Flowering period: March- June **Ver. name:** BorMedeluwa / Hat-thenga (As.)

Key to the species for *Cassia sp.*

1a. Flowers yellow; Inflorescence, drooping racemes……*Cassia fistula*
1b. Flowers pink; Inflorescence arranged in horizontal racemes ……*C. javanica*

Key to species for *Senna sp.*

1a Plants hirsute throughout..... *Senna hirsuta*

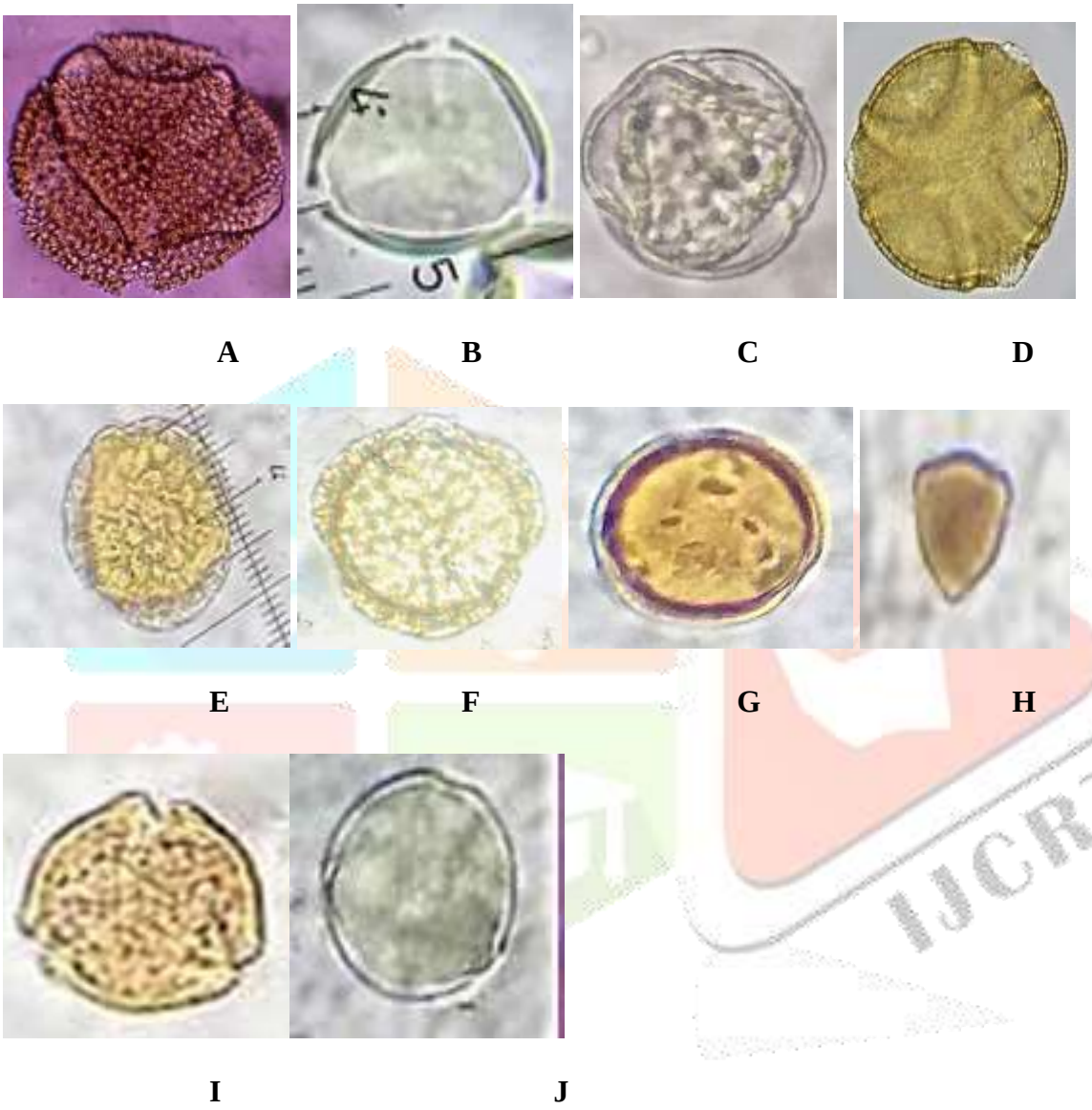
1b. Plants not hirsute:

2a. Undershrub. Leaflets more than 3 pairs, oblong to lanceolate:

3a. Leaflets 4-5 pairs, oblong-lanceolate, sharply acuminate; foetid..... *S. occidentalis*

4a. Leaf rachis without glands.

Valves of pod with projecting wings..... *S. alata*



A **B** **C** **D**

E **F** **G** **H**

I **J**

Plate no. 3- Pollen morphology (Equatorial view) of – I. *Bauhinia tomentosa* Linn. II. *Caesalpinia pulcherrima* (L.) Swartz. III. *Cassia fistula* Lam. IV. *Cassia javanica*Linn. V. *Delonix regia* Raf. VI. *Peltophorumpterocarpum*(D.C.). VII. *Saracaasoca*Linn. VIII. *Senna alata*Linn. IX.*Senna hirsuta*Linn. X. *Senna occidentalis* Linn.

Table 1: Quantitative Palynomorphological Features of 10 species Caesalpiniaceae

Species	*Bauhinia tomentosa*	*Cassia fistula*	*Cassia javanica*	*Caesalpinia pulcherrima*	*Delonix regia*	*Peltophorumpterocarpum*	*Saracaasoca*	*Sennaalata*	*Sennahirsuta*	*Sennaoccidentalis*
Equatorial diameter (µm)	38.1	10.6	10.6	63.2	21.3	19.5	16.3	12	15.2	13
Polar diameter (µm)	39.1	11.6	10.8	66.1	25.4	16.6	15.6	10.6	14.6	11.6
P/E (µ)	1.02	1.09	1.018	1.04	1.192	0.85	0.957	0.88	0.96	0.892
Pollen unit	Monad	Monad	Monad	Monad	Monad	Monad	Monad	Monad	Monad	Monad
Polarity	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar	Isopolar
Shape	Prolate	Prolate	Sub-prolate	Prolate spheroidal	Prolate spheroidal	Sub-prolate	Oblate	Prolate	Prolate	Sub-prolate, circular
Aperture	Penta-colpate	Tri-colporate	Tri-zono-colporate	Tri-colporate	Tri-zono-colporate	Tri-colporate	Non-colporate	Tri-zono-colporate	Tri-zon-ocolporate	Tri-colporate
No. of colpi	5	3	3	3	3	3	0	3	3	3
Exine thickness (µm)	0.294	0.099	0.102	1.23	0.311	0.294	0.196	0.102	0.187	0.098
Exine sculpture	Rugulate	Psilate	Reticulate	Reticulate	Reticulate heterobrocate	Reticulate	Rugulate	Scabrate Psilate	Perforate	Psilate

Taxonomic key based on pollen micromorphology

1. Pollen in Monads _____**2**
2a. Pollen grains oblate spheroidal or
Sub- prolate _____ **3**
2b. Pollen grains prolate, spheroidal _____**4**
3a. Pollen grains oblate spheroidal, exine
Regulate _____*Saracaasoca*
3b. Pollen grains sub- prolate,
exine reticulate _____*Delonix regia*
3c. Pollen grains sub- prolate,
exine reticulate, aperture tri- zono-colporate_____*Peltophorumpterocarpum*
4a. Pollen grain penta-colporate _____*Bauhinia tomentosa*
Pollen grain tri-colporate _____*Cassia fistula*
Exine sculpture is psilate
Aperture Tri-colporate_____ *Cassia fistula*
Aperture Tri-zono- colporate_____*Senna occidentalis*

Palynological studies

Observations on structural features of pollen grains of Caesalpinoideae: Study of structural features of the pollen grains of 7 genera of Caesalpinoideae viz. *Bauhinia tomentosa, Caesalpinia pulcherrima, Delonix regia, Peltophorumpterocarpum, Saraca indica, Cassia Linn. (C. fistula, C. javanica*Linn.) and *Senna Linn.*(*S. alata, S. hirsuta and S. occidentalis Linn.)* were investigated were presented in **Table 1.**

***Bauhinia tomentosa* L.** [Plate No.-3 A]

Pollen grains 5- colpate, sub-oblate to spheroidal, semi- tectate, amb circular, average equatorial diameter- 38.1 µm and average polar diameter- 3.91µm.Colpi,Colpous membrane smooth. Exine- 0.1µm thick.

***Cassia fistula* Linn.** [Plate No.-3B]

Pollen grains 3-zono-colporate, prolate to sub-prolate in shape, slightly pointed at both the ends, furrows angulaperturate. Average equatorial diameter 10.6 µm, average polar diameter was found to be 11.6 µm. Colpi did not meet each other at either pole, margin of the colpi smooth. Exine sculpture mesocolpial. Exine ± 0.1µm thick. Ratio of diameter at polar and equatorial view was calculated as 1.09.

***Cassia javanica*L.** [Plate No.3 C]

Pollen grains 3-zono-colporate, pollen sub-prolate, isopolar, radially symmetric, average equatorial diameter was found to be 10.6 µm and that in polar view was found to be 10.8 µm; oralolongate, exine 0.2 µmthick, ornamentation reticulate.

***Caesalpinia pulcherrima* (L.) Swartz.** [Plate No.-3D]

Pollen grains 3- colporate, sub- oblate in shape, slightly pointed at both the ends. Average equatorial diameter 63.2 µm, average polar diameter was found to be 66.1 µm. Colpi did not meet each other at either pole, margin of the colpi smooth. Exine sculpture Reticulate. Exine 0.332µm thick. Ratio of diameter at polar and equatorial view was calculated as 0.95.

***Delonix regia* Raf.** [Plate No.-3E]

Pollen grains 3-zono-colporate, oblate to spheroidal. Average length in equatorial view is 21.3µm in diameter and in polar view it was 20.4 µm in diameter, isopolar, radially symmetry, amb circular, colpi long,oralalongate, exine 0.3 µm thick,exine ornamentation reticulate hererobrocate, mashes smaller near the aperture regions and larger inner side.

***Peltophorumpterocarpum*(DC.)** [Plate No.-3 F]

Pollen grains 3-zono-colporate, sub-prolate, iso-polar, radially symmetric, ambcircular, average equatorial diameter was 19.5 µm and average polar diameter was 16.6 µm. Oralolongate, exine 0.3 µmthick. Exine ornamentation reticulate.

***Saracaasoca*(Roxb.) Willd.** [Plate No.-3 G]

Pollen grains 3-zono-colporate, oblate, iso-polar, radially symmetric amb circular, inaperturate,average length in the equatorial region was found to be16.3µm and that in the polar region was 15.6 µm. The ration of P/E was 0.975, exine 0.2µm ornamentation rugulate.

***Senna alata*Linn.** [Plate No.-3 I]

Pollen grains 3-zono-colporate, prolate to sub-prolate in shape,graduallyblunt at both the ends. Furrows angulaperturate, some are found to be syncolpate on one pole, average equatorial diameter calculated was 12µm(approx.). Average polar diameter wasfound to be 10.6µm. Ratio was found to be 0.89. Colpi did not meet each other at either pole.Margin of thecolpi is not equally continuous. Exine sculpture was observed as scabrate, thickness of the exine0.1 µm.

***Senna hirsuta*Linn.** [Plate No.- 3 J]

Pollen grains 3-zono-colporate, prolate to spheroidal in shape, one end found to be suddenly bluntand the other end slightly pointed, furrows angulaperturate. Average in in equatorial diameter was found to be 15.2 µm and average polar diameter was found to be 14.6µm. Ratio of the diameter was found to be 0.96. Colpi did not meet each other at either pole. Marginof the colpi smooth. Exine sculpture perforate, thickness of the exine 0.1 µm.

***Senna occidentalis* Linn.** [Plate No.- 2:I]

Pollen grains 3-zono-colporate, sub-prolate, suddenly blunt at both the ends. Furrows angulaperturate and syncolpate. In equatorial view the average length of the pollen grain was found to be13 µmin diameter, whereas the diameter at polar view was 15.2 µm. Ratio of the diameter was found to be 1.16. Colpi did not meet each other at either pole Exine sculpture psilate, thickness of the exine 0.1µm.

DISCUSSION AND CONCLUSION:

The 10 species of present investigation were *Bauhinia tomentosa* Linn.,*Caesalpinia pulcherrima* (L.) Swartz., *Cassia fistula* Lam.,*Cassia javanica*Linn., *Delonix regia* Raf., *Peltophorumpterocarpum*(D.C.), *Saracaasoca*Linn. *Senna alata*Linn., *Senna hirsute* Linn., *Senna occidentalis* Linn., and *Senna hirsuta*Linn., under the sub-family Caesalpinioideae of family Fabaceae. They were distributed all over the Hojai sub- division. Out of which *Delonix regia* Raf., *Cassia fistula* Linn. *Cassia javanica*Linn., *Saraca asoca*Linn. And *Peltophorum pterocarpum*Linn. were perennial and tree. Among the other five species *Bauhinia tomentosa* Linn. *Caesalpinia pulcherrima* (L.) Swartz. and *Senna alata*Linn. are large shrubs, while *Senna occidentalis* Linn., *Senna hirsute* Linn. were shrub. In all the eleven species the type of leaf was found to be unipinnate and peripinnately compound with pulvinous leaf bases. But the number of leaflets varies from species to species and their shape and size also different. Flowers were found in either raceme or panicle type of inflorescence in all the investigated species where 1-3 flowers were found at the axils of the leaf without any definite type of inflorescence. Among the 10 taxa, seven of the taxa have yellow flowers and flowering time were from May to August..

Stamens were found to be heterodynamous and in *Cassia fistula* Linn., all the 10 stamens were fertile, while in other five species out of the 10 stamens each, 7 were fertile and rest 3 were sterile. Except shape and size, gynoecium characters were almost same in all the studied taxa. Though the type of fruit in all the species were represented by pod (legume), still some of their features were different.

Present day knowledge on classical taxonomy is greatly enhanced by the detail studies on micromorphology such as pollen grains morphology. Thus, the palynomorphological studies immensely helpful in solving many intricate taxonomic problems involving proper identification and speciation of many plants. (Bahadur *et.al.*,1990, Solomon 1983; Tidke*et.al.*2012, Devi 2003). Palynology played a significant role in angiosperm systematic. Pollen features have been used as an additional tool for elucidating taxonomic status of Caryophyllidae. Although the pollen morphology provides an important aid in distinguishing different species, the present investigation did not reveal much distinct pollen morphological differences among the 10 species of Caesalpiniaceae. Pollen grains in most of the taxa were found to be tri-zono-colpate and colpi never meet each other at either pole (except *Bauhinia tomentosa* L. having 5 colpa and *Saracaasoca*L. with no colpa). The shape of the grains was observed as prolate to sub-prolate in *Cassia fistula* Linn., *Cassia javanica*Linn., *Senna alata*Linn. And *Peltophorumpterocarpum*(D.C); while in *Senna hirsuta*, it was sub-prolate to spheroidal. On the other hand, in *Senna occidentalis* Linn. the shape was found to be only sub- prolate and in *Delonix regia*. it is oblate to spheroidal while in *Saraca asoca* Linn. it is spheroidal. Pollen grains showed some differences in their size. The largest size of pollen grains was observed in *Delonix regia* (1.192µ) and smallest grains in *P.pterocarpum* (0.85µ). The exine sculpture in most of the species were reticulate. The pollen grains of

the taxa were found to be from non- colpate to tri-zono-colporate to penta- colpate.Most of them were Oblate, Sub- oblate, Prolate, Sub- prolate and spheroidal in shape. Wodehouse (1936) considered that thinner the exine, highly evolved is the grain. In the present study it was found that all the pollen grains bear thin exine. Out of all, *Senna occidentalis* Linn. had the thinnest exine with 0.098µm. Hence, *Senna occidentalis* Linn. may be considered as highly evolved among all the 10 species under study.

The outcome of this investigation revealed that no such striking variation have seen in the pollen morphology in the prevailing climatic condition of this area. Yet the study will help in the future researchers to solve taxonomic problems of the Caesalpiniaceae related to genus considered here.

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