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Abstract

The taxonomic descriptions and pollen morphology of 4 species belonging to 4 genera of family Euphorbiaceae were described in the present paper. The studied materials were collected throughout Mandalay Region. The plants were identified and their pollen have been examined under microscope. In the present study 4 species have been described together with the taxonomic descriptions and colour photograph of inflorescence. Pollen morphology and pollen keys to the species were also constructed. In *Ricinus communis*, the outline of a pollen grain seen in polar view (amb) is rounded triangular and in equatorial view it was observed that suboblate. The remaining 3 species are spheroidal. The exine sculpture of 4 species were pilate, distinctly reticulate and croton pattern. The number of apertures possessed by the pollen grains of 4 species were tricolporate, polyporate and inaperturate. The studied pollen grains are observed in 2 sizes, medium (25-50 μ) and large (above 50 μ).

Introduction

The Euphorbiaceae is a large family of flowering plants, including some 300 genera and over 5000 species of dicotyledonous herbs, shrubs and trees (Heywood 1978). The family is taxonomically characterised by the presence of watery juice, latex or milky sap, the unisexual flowers, the superior ovary, and trilobular with axile placentation, the collateral and pendulous ovules. According to the Heywood 2007, the Euphorbiaceae is a large, diverse family with unisexual flowers, superior syncarpous ovaries, and 1 ovule per locule.

The family contains many species of both economic and decorative importance species. *Manihot esculenta* having thick tuberous roots rich in starch, and which yield cassava or tapioca is an important food plant of the

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tropics. Castor oil is obtained from the oily endospermic seeds of *Ricinus communis*. In Myanmar, Biodiesel is produced from seeds of *Jatropha curcas* and it is popular nowadays. It is also used as powerful purgative. The bark, roots and leaves of *Croton persimilis* are used in reducing chronic enlargement of liver and they are applied externally to sprains, bruises, and rheumatic swellings.

Pollen is one plant material best resistant to various kinds of treatment. It remains unchanged in structure and sculpture for millions of years, when fossilized in the soil. Pollen mother cells (microsporocytes) are differentiated from sporogenous cells in the young male organ. These cells are poorly attached to each other by plasma connections.

During growth, the pollen mother cells become spherical and then separate from each other; these cells undergo meiosis to produce tetrads, which in the haploid phase are called microspores. The members of the tetrad become separated from one another by a callose wall which is continuous with that such surrounding the entire tetrad. The surface features of the mature grain are clearly related to the original orientation of the microspore within the tetrad. Within each microspore, peripheral elements of the endoplasmic reticulum are fixed which polymerize sporopollenin to form the sexine matrix on its surface – when this happens, the callose disappears. Later, the sexine thickens without changing its structure. Each microspore in turn differentiates into a pollen grain (Iwanami *et al.* 1988).

Pollen grains represent the gametophytic generation. A large number of genes, some unique to the pollen and others common to the sporophytic generation are expressed during its development as well as during the post germination phase. Studies on the expression of these genes are important for the application of pollen selection, for recombinant DNA technology, and for the induction of pollen embryos. In addition to these areas of pollen biology, which have direct relevance to its function, other areas that are equally important include pollen in relation to taxonomy and phylogeny (Erdtman 1966), fossil palynology (Faegri & Iversen 1989), aeropalynology and pollen allergy (Stanley & Linskens 1974, Knox 1979, Singh *et al.* 1991, Mohapatra & Knox 1996), and the use of pollen to analyze the effects of ecotoxin chemicals (Kappler & Kristen 1987, Wolters & Martens 1987, Strube *et al.* 1991 & Pfahler 1992).

These all information and knowledge push to study the taxonomy and pollen morphology of family Euphorbiaceae. This research works are going to be carried out to identify, describe and record the taxonomic characters and pollen morphology of 4 economic importance species of family Euphorbiaceae.

Materials and methods

The plants are collected from Mandalay Region. The collected plants are photographs in flower, then identified and pressed for further studies. Plant identification was followed to Hooker (1885), Backer (1965), Dassanayake (1997). For pollen study the collected flowers were immediately fixed in glass vial containing glacial acetic acid. Each of the specimen was labeled and stored in a dry and cool place. Pollen samples were acetolysed according to Erdtman (1960). A prepared slide was examined to ascertain the shape, size, aperture and exine sculpture of the pollen. Photographs were taken with Sony digital camera directly from the eyepiece of microscope. Measurements were based on 20 grains per sample; values of polar axis length (P) and equatorial diameter (E) were measured and recorded. Pollen aperture was observed directly. Terminology used followed to that of Erdtman (1952 & 1969), Hoen (1999) and Paldat (2005).

Results

The taxonomic descriptions and pollen morphology of 4 species belonging to 4 genera of the Euphorbiaceae have been described .

Pollen key to the species

- | | |
|------------------------|------------------------------|
| 1. Inaperturate..... | 2 |
| 1. Aperturate..... | 3 |
| 2. Pilate..... | <i>Jatropha curcas</i> (2) |
| 2. Croton pattern..... | <i>Croton persimilis</i> (1) |

3. Distinctly reticulate, grains less than 50 μ in diameter..... *Ricinus communis* (4)
3. Croton pattern, grains more than 100 μ in diameter..... *Manihot esculenta* (3)

Taxonomic description and pollen morphology

1. *Croton persimilis* Muell. Arg. emend. philcox (hic); Muell. Arg. Linnaea 34: 116. 1865.(Figure 1.A,B,C)

Myanmar name : That yin gyi

English name : Unknown

Flowering period : December to March

Perennial, deciduous and monoecious tree; up to 9 m high; young branches terete, densely lepidote, with distinct leaf-scars. Leaves simple, alternate, stipulates, petiolate; stipules caducous; petioles 3 - 7 cm long, terete, lepidote; blades elliptic-oblong, ovate-lanceolate or elliptic, 7.5 - 26.5 cm by 6.0 - 11.5 cm, lepidote on both surfaces when young, glabrous in age, with two yellowish glands on either side of the leaf base, penninerved with 9 to 16 pairs of lateral veins, obtuse at the base, serrate along the margin, acute at the apex. Inflorescences axillary or terminal racemes, elongate, up to 25.0 cm long, androgynous, the staminate flowers at the upper portion and the pistillate flowers at the lower portion. Staminate flowers 1 cm across at anthesis; bracts deciduous; pedicels about 5 mm long, lepidote. Sepals 5, ovate, greenish yellow, glabrous on both surfaces, valvate in bud. Petals 5, obovate, greenish yellow, glabrous without, pubescent within, valvate in bud. Disk glands 5, orange, alternate with the petals; stamens 10 to 12, exserted on the hairy receptacles; filaments 4 mm long, filiform, yellowish green, glabrous; anthers 1.5 mm long and wide, ditheous, introrse, yellow, basifixed, longitudinally dehiscent. Pistillate flowers 5.5 - 7.0 mm across at anthesis; bracts ovate, caducous; pedicels about 1.5 mm long, lepidote, persistent. Sepals 5, ovate, pale green,

lepidote without, pubescent within, valvate in bud. Petals 5, greenish yellow, valvate in bud. Disk glands 5, depressed, yellow. Ovary superior, globoid, about 2 mm long and wide, lepidote, trilocular with one ovule in each locule on the axile placenta; styles 3, basally connate; stigmas 3, each bifid, glabrous. Capsules globoid, distinctly 3-lobed, lepidote, with persistent sepals, dehiscent into three 2-valved cocci, each coccus 1-seeded. Seeds oblongoid, whitish brown, smooth with small caruncle.

Pollen morphology of this species are inaperturate, spheroidal, large, 55-67 μ in diameter; exine 5-6 μ thick; sexine 3-4 μ thick, sexine thicker than nexine; sculpturing croton pattern, the lower part of the mureoid ridges separated by rounded foveoloid areas, the upper part of well defined regular pegs or warts situated on top of the ridges; each foveoloid area encircled by 5-7 triangular pegs, each peg about 3 μ in diameter, situated between 3 foveoloid areas.

Location: Pyin Oo Lwin Township

2. *Jatropha curcas* L. Sp. Pl. 2: 1006. 1753. (Figure 1.D,E,F)

Myanmar names : Siyo kyetsu, Tinbaw kyetsu

English names : Physic nut, Punging nut

Flowering period : May to August

Perennial, monoecious shrubs, up to 3 m high, stem terete, soft-wooded; branches watery-juicy (slightly milky juicy) and spreading. Leaves simple, alternate, stipulate, petiolate; stipules caducous; petioles 4.5 - 13.5 cm long, as long as the blades, glabrous, swollen at the base; blades broadly ovate or suborbicular, 3- to 5-lobed, 4.5 - 13.5 cm by 5 - 14 cm, glabrous on both surfaces, palmately 5-nerved, cordate at the base, entire along the margin, acute or acuminate at the apex. Inflorescences axillary corymbose, with a pistillate flower at the centre and staminate flowers on much branched peduncles; bracts at the base of secondary peduncles 4- 9 mm long, bracts at the base of tertiary peduncles 1 - 5 mm long, tomentose; bracteoles minute, caducous. Staminate flowers 6 - 8 mm in diameter; pedicels 2.0 - 2.5 mm long, pubescent. Calyx 5-lobed, the lobes ovate-oblong, greenish yellow, ciliate at the margin, glabrous, imbricate in bud. Petals 5, obovate-oblong, greenish yellow, erect with a recurved apex, twisted in bud. Disk glands 5, yellow, free or slightly connate in a ring.

Stamens 10 in 2 whorls, exerted, the outer stamens slightly shorter than the inner ones and free; the filaments 3 mm long, filiform, yellowish green, glabrous; inner stamens connate at the base, the androphore 4 mm long; anthers 1.5 mm by 1 mm, ditheous, extrorse, yellow, basifixed, longitudinally dehiscent. Pistillate flowers about 1 cm in diameter; pedicels 2 - 5 mm long, densely tomentose. Sepals 5, ovate-oblong, greenish yellow, pubescent on both sides, persistent, imbricate in bud. Petals 5, obovate-oblong, pale-yellow, glabrous without, pubescent within, erect with a recurved apex, twisted in bud. Disk glands 5, yellow, free or slightly connate in a ring. Ovary superior, globoid, about 2 mm long and wide, glabrous, trilocular with one ovule in each locule on the axile placenta; styles 3, connate at the base, glabrous; stigmas 3, each bifid, shortly 2-lobed, sagittate. Capsules ovoid or subgloboid, glabrous, slightly 3-lobed, with persistent calyx, dehiscent into three 2-valved cocci, each coccus 1-seeded. Seeds ovoid-oblongoid, black, glabrous, carunculate.

Pollen morphology of this species are inaperturate, spheroidal, large, 53-67 μ in diameter; exine 5-6 μ thick; sexine 3-4 μ thick, sexine thicker than nexine; sculpturing pilate; the pila 3.0-4.5 μ in diameter, about 4.5 μ in length, pila head 3.0-4.5 μ in diameter.

Location: Mahar aung myae Township

3. *Manihot esculenta* Cantz. Inst 1: 167. 1766. (Figure 2.A,B,C)

Myanmar name : Palaw pinan

English names : Cassava, Tapioca

Flowering period : October to March

Perennial, monoecious shrubs, up to 5 m high, with latex; branches erect or spreading, glabrous, with leaves towards the upper portions and with prominent leaf-scars at the lower portions. Leaves palmately compound, alternate, stipulate, petiolate; stipules 2- to 3-lobed, deciduous; petioles 4.0 - 11.5 cm long, usually longer than the blades, glabrous; blades palmately divided; lobes 3 to 5, obovate-lanceolate, 4.0 - 10.5 cm by 1.0 - 2.5 cm, glabrous on both surfaces, palminerved with 3 to 5 costae, rounded at the base, entire along the margin, acuminate at the apex. Inflorescences axillary racemes, 1 to 5 female flowers at the basal portions with long pedicelled and male flowers at the upper portions with short

pedicelled. Staminate flowers 1.2 - 1.6 cm in diameter; bracts 2 mm long, deciduous; pedicels 0.5 - 1.0 cm long, glabrous. Calyx 5-partite, campanulate, the lobes triangular, yellowish red, imbricate in bud. Disk glands with 5 double lobes, orange, nectariferous. Stamens 10 in 2 whorls of 5 each, alternately short and long, inserted; filaments 4 - 7 mm long, filiform, white, free, glabrous; anthers 2 mm by 1 mm, ditheous, oblongoid, yellow, basifixed, longitudinally dehiscent. Pistillate flowers about 3 cm in diameter; bracts 3 mm long, deciduous; pedicels 1 - 2 cm long, glabrous, longer in fruit. Calyx deeply 5-partite, the lobes lanceolate, yellowish red, imbricate in bud. Disk glands 10-lobed, orange. Ovary superior, subgloboid, 3 mm in diameter, glabrous, with 6 red ridges, trilocular with one ovule in each locule on the axile placenta; styles 3, connate at the base, glabrous, surmounted by 3-lobed stigmas. Capsules globoid, glabrous with 6 narrow longitudinal wings, dehiscent into three 2-valved cocci, each coccus 1-seeded. Seeds ellipsoid, grey with dark blotches,

Pollen morphology of this species are polyporate, pantoporate, spheroidal, large, about 130-160 μ in diameter; pori circular, 50-20 μ in diameter; exine about 8 μ thick; sexine about 5 μ thick, sexine thicker than nexine; sculpturing croton pattern, 5-7 triangular pegs, each peg about 7 μ in diameter.

Location: Patheingyi Township

4. *Ricinus communis* L. Sp. Pl. 1007. 1753. (Figure 2.D,E,F)

Myanmar names : Kyet su

English name : Castor oil plant

Flowering period : Almost throughout the year

Perennial, monoecious, tree like shrubs, up to 4.5 m high; stems and branchlets erect, hollow, with prominent leaf-scars. Leaves simple, alternate, stipulate, petiolate; stipules caducous; petioles 9.5 – 25.0 cm long, hollow, glabrous; blades peltate, palmately lobed or partite, 8 - 19 cm by 5 - 14 cm, glabrous on both surfaces, palminerved with 5 to 8 costae; lobes 5 to 8, lanceolate, glandular-serrate along the margin, acuminate at the apex.

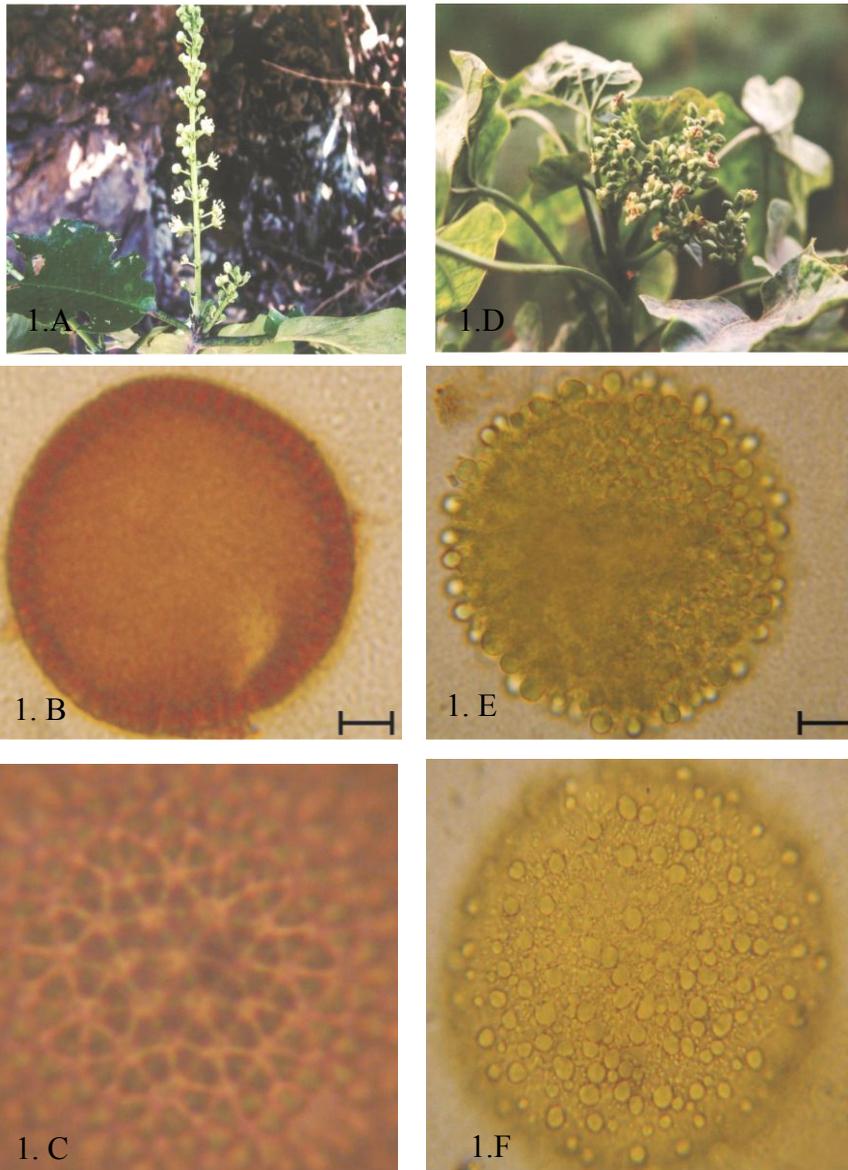


Figure 1. A. Inflorescence, B. Polar view, C. Surface pattern of *Croton persimilis*; D. Inflorescence, E. Polar view, F. Surface pattern of *Jatropha curcas*

Scale bar = 10 μ

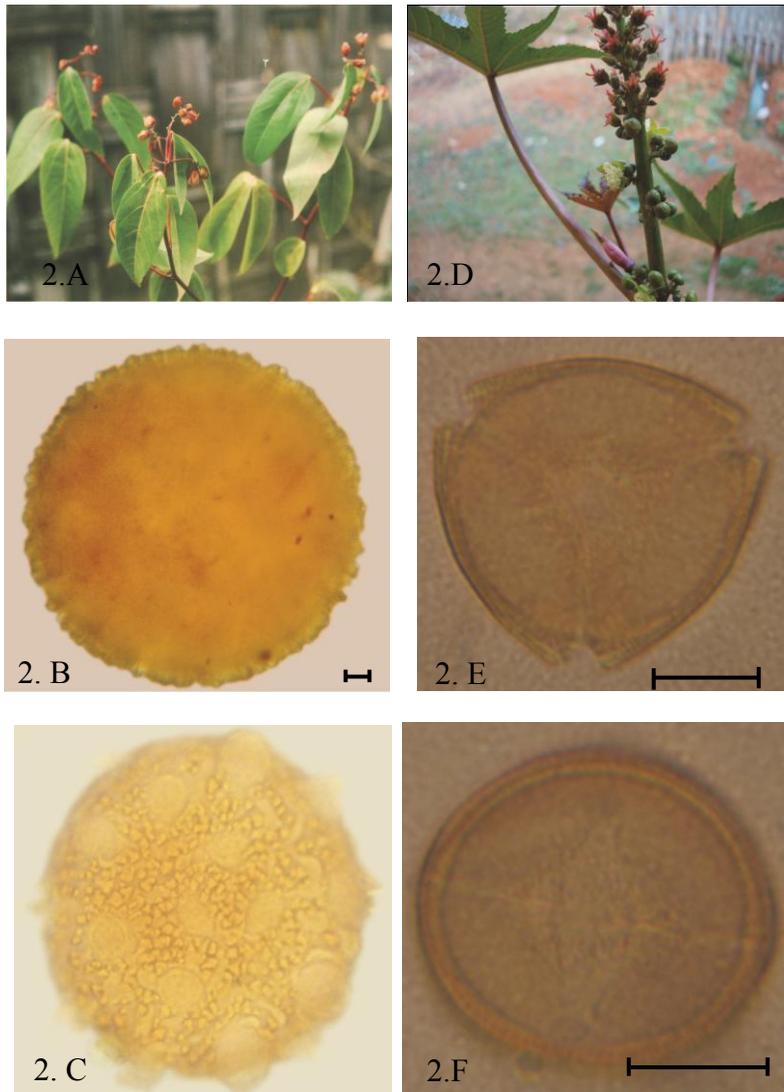


Figure 2. A. Inflorescence, B. Polar view, C. Surface pattern of *Manihot esculenta*; D. Inflorescence, E. Polar view, F. Equatorial view of *Ricinus communis*

Scale bar = 10 μ

Inflorescences terminal or leaf-opposed racemes, pistillate flowers at the terminal portions and staminate flowers at the lower portions. Staminate flowers 1.3 - 1.7 cm in diameter, apetalous; bracts 3 mm by 2 mm, ovate, glabrous, caducous; pedicels 5 - 10 mm long, glabrous. Calyx deeply 5-partite, the lobes 6 - 10 mm by 3 - 5 mm, ovate-lanceolate, greenish yellow, glabrous, valvate in bud. Stamens numerous, exerted, monadelphous, in a dense fascicle; filaments filiform, 0.5 - 1.0 mm long, unequal in length, white, glabrous; anthers 0.5 mm long and wide, ditheous, yellow, basifixed, longitudinally dehiscent. Pistillate flowers 1.0 - 1.5 cm in diameter at anthesis, apetalous; bracts minute, caducous; pedicels 1.5 - 2.0 mm long, glabrous. Calyx deeply 5-partite, the lobes lanceolate, greenish yellow, glabrous, valvate in bud, caducous. Ovary superior, globoid, 2.0 - 3.5 mm in diameter, covered with fleshy soft green spines, trilocular with one ovule in each locule on the axile placenta; styles 3, connate at the base; stigmas 3, each bifid, densely papillose inside. Capsules globoid or subgloboid, 3-lobed, usually spiny, dehiscent into three 2-valved cocci, each coccus 1-seeded. Seeds ovoid, pale brown and mottled, with a large caruncle.

Pollen morphology of this species are tricolporate, suboblate, medium, 21-25 x 25-31 μ in length and breadth; amb rounded triangular; colpi longicolate, about 20 x 2 μ in length and breadth; pori elongate, about 4 x 13 μ in length and breadth; exine about 1.5 μ thick; sexine about 0.7 μ thick, sexine as thick as nexine; sculpturing obscurely reticulate.

Location: Pyin Oo Lwin Township

Discussion and Conclusion

In the present study, taxonomy and pollen morphology of 4 species belonging to 4 genera of the Euphorbiaceae were examined.

In taxonomic study, the flowers of all members are very small. All species are monoecious and perennial. *Croton persimilis* is characterized by the presence of two yellowish glands on either side of the leafbase, and axillary or terminal raceme with the staminate flowers at the upper portions and the pistillate flowers at the lower portions. The distinctive characters of *Jatropha curcas* are swollen bases of petioles, corymbose cymes with a solitary pistillate flower at the centre and staminate flowers on much-branched peduncles. Milky latex are present in all parts of *Manihot*

esculenta. The outstanding characters of this species are prominent leaf-scars on the older branches, 6-ridged ovary, three styles surmounted by 3-lobed stigmas, and 6 narrow longitudinal wings of capsules. The outstanding characters of *Ricinus communis* are hollow stems and petioles, terminal or leaf-opposed racemes, variously connate fascicles of stamens and presence of fleshy soft green spines on the capsules.

It is very difficult to set up an identification due to the presence of smaller flowers, which consisting of incomplete floral parts. Therefore more easily identification system is required and others only character such as pollen morphology must be essential to identify.

The classification of pollen has been based on the basis of the type, numbers and position of the aperture, shape and sculpturing the grains. In this paper the inaperturate is found in 2 species (*Croton persimilis*, *Jatropha curcas*) and the remaining are aperturate type. *Manihot esculenta* is polyporate and *Ricinus communis* is tricolporate. Depending on the position of apertures, *Manihot esculenta* is pantoporate and the latter is zonoporate. In the present research, it was observed that the shape of the pollen are spheroidal (*Croton persimilis*, *Jatropha curcas*, *Manihot esculenta*) and suboblate (*Ricinus communis*). Sizes ranging from medium to large. Longicolpate found in *Ricinus communis* and the shape of pori was lalongate. The ornamentation of exine were observed in 3 types. Croton pattern were found in 2 species (*Croton persimilis*, *Manihot esculenta*), pilate found in *Jatropha curcas* and distinctly reticulate in *Ricinus communis*. Exine thickness also ranged from 1.5- 8.0 μ , thickness of sexine as thick as or thicker than nexine.

All of these data give to draw the conclusion that pollen morphology is one of the keys for identification of plants and will give a great help for the study of taxa.

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