POLLEN MORPHOLOGY OF SOME SPECIES OF BIGNONIACEAE IN LASHIO AREA

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Abstract

The pollen grains of 15 species from 14 genera of Bignoniaceae in Lashio area were investigated by using light microscope. The species studies were included in genera *Campis*, *Dolichandrone*, *Haplophragma*, *Jacaranda*, *Mansoa*, *Mayodendron*, *Millingtonia*, *Oroxylum*, *Podranea*, *Pyrostegia*, *Radermachera*, *Spathodea*, *Tabebuia* and *Tecoma*. Pollens collected from mature flowers were analyzed by acetolysis method of Erdtman 1960. The pollen grains of the species studied were monads with radially symmetrical; apolar or isopolar; tricolpate in 7 species, tetracolpate in only one species, tricolporoidate with ill-defined endoaperture in 4 species, tricolporate with lolongate endoaperture in 2 species and polycolpate in only one species; the apertures position showed zonocolpate in most species but pantocolpate in *Mansoa alliacea*; mostly subprolate to prolate except from those of *Tecoma stans* and *Radermachera yunnanensis*; circular, rounded triangular to triangular amb; exine sculpture psilate in one species, microreticulate in 3 species and reticulate in 11 species; homo- or heterobronchate lumen, with simpli or duplibaculate muri. The resulting pollen morphological diversity may offer some taxonomic potential and interrelationships among the studied species.

Keywords: Pollen, Morphology, Bignoniaceae, Species, Lashio.

Introduction

The study area, Lashio, is situated in Northern Shan State of Myanmar. It lies between 22º 39' 53" and 23º 04' 27" N latitude and 97º 30' 10" and 97º 47' 40" E longitude. Generally, the elevation of this part is roundly 855m above sea level. The total area of Lashio is 4832 sqkm. It is divided into 12 quarters. It is bounded by Kawonlon and Hopan townships on the east, Nanmatau Township on the west, Tantyann and Mairal townships on the south and Theini township on the North. Lashio area is rich in the variety of flora due to its tropical mountainous climate. The natural vegetation is evergreen and dry deciduous forest in the study area.

Bignoniaceae Juss. is one of the dicotyledonous families of flowering plant. Lohmann (2004) stated that the Bignoniaceae composed of 120 genera and about 800 species in worldwide distribution; of these, *Tabebuia*, *Jacaranda*, *Arrabidaea*, *Anemopaegma* and *Adenocalymma* are the largest and comprise almost half of the species in the family. The rest genera are small and monotypic. Hundley & Chit Ko Ko (1987) recorded 39 species in 21 genera and Kress *et al.* (2003) listed that 40 species and 22 genera of Bignoniaceae were distributed in Myanmar.

The study of pollen and spores is called palynology. The term palynology was first coined by Hyde and Willian (1945). In 1952, Erdtman has worked on the publication of the pollen morphology and plant taxonomy included 327 families of monocot and dicot. Pollen characters are very distinctive, easily recognizable and identifiable to the family, genus or even species level. Furthermore, sporopollinin included in pollen is very durable and does not decay. Therefore, pollen remains as durable natural marker in environment (Ugbabe *et al.*, 2007). Therefore, pollen morphology has great significance in the taxonomy of angiosperms. Nowadays an attempt has been made to classify the plants by using the pollen characters.

The pollen morphology of the Bignoniaceae was studied by many authors: Erdtman (1952), Bove (1993), Ugbabe *et al*. (2007, 2013), Saensouk & Saensouk (2011) and Souza *et al.* (2019). Erdtman (1952) recorded about 25 species and 20 genera of Bignoniaceae. According to Kress *et al.* (2003), about half of total species of Bignoniaceae were distributed in Lashio area. The pollen

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morphology of Bignoniaceae from Lashio had not been recorded by other authors. Therefore, the present study attempts to describe the pollen morphology of Bignoniaceae from the Lashio area.

The aim of this study was to record the characters of the pollen of Bignoniaceae in Lashio area. The objectives were to identify the species of Bignoniaceae and to provide palynological information which may contribute to the understanding and identification of the family Bignoniaceae.

Materials and Methods

The plant materials of the fifteen species of Bignoniaceae were obtained from collection of Lashio area, Northern Shan State, from December 2018 to November, 2019. Polliniferous samples were harvested from the anther of fresh flower specimens. The collected materials were preserved in a glass vial with glacial acetic acid. The pollen grains were prepared for light microscopy by acetolysis method described by Erdtman (1960). The pollen morphology was characterized by using the following parameter.

Qualitative characters: dispersal unit, symmetry, type and position of aperture, shape of endoaperture, pollen shape in equatorial and polar view and exine ornamentation including muri and lumen in reticulate sculpture. Quantitative characters: number of apertures, length and width of aperture, size of pollen grain, measurement of polar axis and equatorial diameter, length and width of muri and exine thickness.

The shape of pollen grains was determined by the polar axis/equatorial diameter ratio in accordance with the classification proposed by Erdtman (1952). A measurement of equatorial diameter and polar axis of ten pollen samples were taken by using ocular stage division and the measuring unit converted into milimicron (μm). The pollen size was categorized on the basis of classification by Erdtman (1952). The length and width of colpi, pore, muri and exine thickness were also measured. Microphotographs of the prepared sample were made with camera Cannon A 3500 IS under 40x and using 10x eye piece.

The pollen morphology was presented alphabetic order of scientific name. Myanmar name and English name were also checked by Hundley and Chit Ko Ko (1987) and Kress *et al*. (2003). The primitive and advanced character states were defined by method of Luo *et al.* (2015). Morphology of the collected specimens were identified with the help of literatures and flora like Flora of Java (Backer, 1965), Flora of Ceylon (Dassanyake, 1981) and Flora of China (Wu & Raven, 1998). The descriptive terms of perisynclopate, colporoidate and microreticulate were followed by Bove (1993). The terminologies were used in accordance with Erdtman (1952), Paldat (2005) and Hesse (2009).

Results

In the present study, pollen morphology of 15 species belonging to 14 genera of Bignoniaceae had been investigated. The collected species were presented in Table 1 and Figure 1. The results of the pollen grain morphological studies are represented in Table 2, 3 and Figure 2. The palynological descriptions were arranged according to the following pollen characters: dispersal unit, polarity, shape and size of pollen, type of aperture and exine sculpture. The resulting pollen characters may serve as taxonomic markers to distinguish the taxa of Bignoniaceae.

Polarity, dispersal unit, size and shape

In the present study, isopolar pollen grains were found in most of the species and the apolar grain was found in *Mansoa alliacea*. In the current study the dispersal unit of all studied species is

monads. The size of pollen grain was measured in equatorial view including equatorial diameter and polar axis. The size of pollen grains varies between 23.5 - 95.0µm polar axis and 17.5 - 75.0 µm equatorial diameter. The largest one was observed in *Spathodea campanulata* and the smallest one was found in *Campis grandiflora*.

The shape of pollen grain can sometime be useful in identification of species. It may vary within one genus and one family. The shape is defined by the ratio between the length of polar axis and the equatorial diameter. In this research, the pollen grains are mostly subprolate to prolate. The subprolate shape was found in *Millingtonia hortensis, Podranea ricasoliana, Pyrostegia venusta* and *Spathodea campanulata,* and prolate in *Campis grandiflora*, *Dolichandrone spathacea*, *Jacaranda mimosifolia*, *Mayodendron igneum*, *Tabebuia aurea* and *Tecoma capensis*. However other shape like suboblate and spheroidal are also occurred. AMB is circular in most species but triangular in *Jacaranda mimosifolia* and *Tecoma capensis*, rounded triangular in *Campis grandiflora, Dolichedrone spathacea* and *Tabebuia aurea*.

Number and type of apertures

Tricolpate in most species but polycolpate in *Manosa alliacea*. The apertures found in *Manosa alliacea* were distributed around the pollen grain so it is called pantocolpate. Zonocolpate, the aperture equally distributed along the equatorial plane were observed in the remaining 14 species. According to an aperture type, five types can be found including tricolpate, tetracolpate, polycolpate, tricolporoidate and tricolporate. The aperture joined toward the pore (syncolpate) were observed in *Haplophragma adenophyllum* and *Jacaranda mimosifolia*, parasyncolpate (aperture join at the pole remaining triangular space) in *Millintonia hortensis* and *Tecoma stans* and perisyncolpate in *Manosa alliacea*. The colpi were longicolpate in all studied species. *Jacaranda mimosifolia* featured the colpus constricted in psilate. In this study, 11 species possess reticulate sculpture, 3 species in microreticulate and only one species in psilate. The muri are simplibaculate in most species but duplibaculate in *Pyrostegia venusta*. The lumen is homobranchate in *Haplophragma adenophylla* and *Millintonia hortensis*, and heterobronchate in the rest species. The muri are smaller than the polar region in *Oroxylum indicum*. Sexine thickness is the same as nexine thickness in 11 species, thinner in 2 species and thicker in 2 species.

Table 1 List of collected species

No	Scientific name	Local name	Common name	Flowering period	Uses
1	*Campis grandiflora* (Thunb.) K. Schum.	Egayit Nwe	Chinese Trumpet Vine	May to Aug	Ornamental
2	*Dolichandrone spathacea* (L.f.) Seem.	Thakut	Mangrove Trumpet Tree	March to June	Flower vegetable
3	*Haplophragma adenophyllum* (Wall.) P. Dop	Kyaung Sha	Katsagon	Oct to Dec	Flower vegetable
4	*Jacaranda mimosifolia* D. Don	Seinban Apya	Blue Jacaranda	June to Aug	Ornamental
5	*Mansoa alliacea* (Lam.) A.H.Gentry.	Thahtay Warda	Garlic Vine	June to Oct	Ornamental
6	*Mayodendron igneum* Kurz	Egayit	Orange Tree Jasmine	Oct to Dec	Ornamental
7	*Millingtonia hortensis* L. f.	Egayit	Tree Jasmine	Nov to Dec	Medicinal
8	*Oroxylum indicum* (L.) Benth. ex Kurz	Kyaung Sha	Indian Trumpet Flower	Oct to Dec	Flower & fruit vegetable

No	Scientific name	Local name	Common name	Flowering period	Uses
9	*Podranea ricasoliana* (Tanf.) Sprague	Egayit	Pink Trumpet Vine	Oct to Jan	Ornamental
10	*Pyrostegia venusta* Miers	Thaw Ka Nwe	Flame Vine	Jan to March	Ornamental
11	*Radermachera yunnanensis* C.Y.Wu	Yae Mhwe Pan	Kunming Tree Jasmine	May to Aug	Ornamental
12	*Spathodea campanulata* P.Beauv.	Ar Fri Ka Kyu Lit	African Tulip Tree	October to December	Ornamental
13	*Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S.Moore	Ta Bay Bu Ah	Tree of Gold	Feb to April	Ornamental
14	*Tecoma capensis* (Thunb.) Lindl.	Egayit	Cape Honeysuckle	Jan to March	Ornamental
15	*Tecoma stans* (L.) Juss. ex Kunth	Sein Ta Kyu	Yellow Trumpet Bush	Sep to Dec	Ornamental

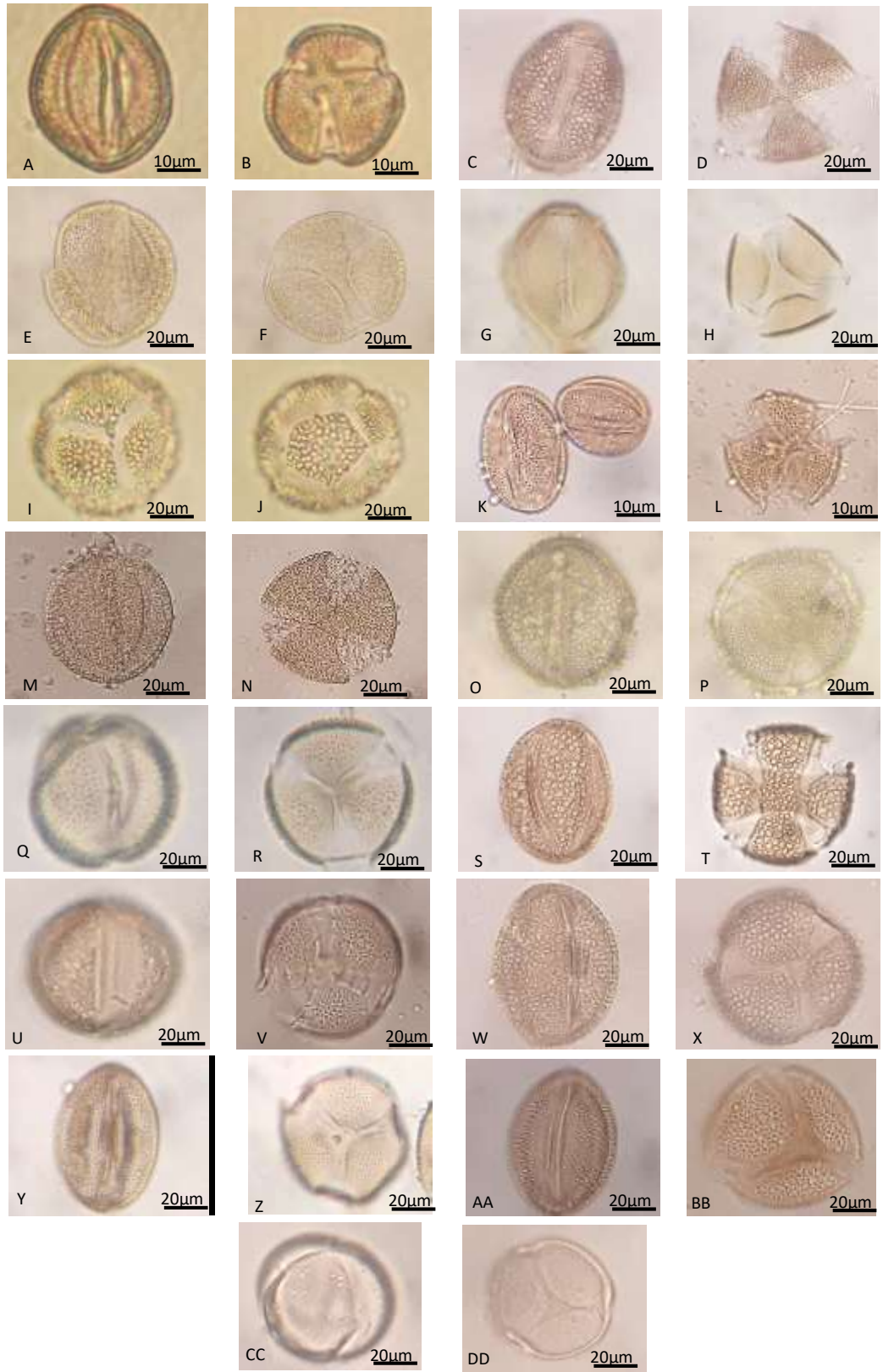
Figure 1 Flowering branches of collected species **A**. *Campis grandiflora* (Thunb.) K.Schum. **B**. *Dolichandrone spathacea* (L.f.) Seem.**C**. *Haplophragma adenophyllum* (Wall.) P. Dop **D**. *Jacaranda mimosifolia* D.Don **E**. *Mansoa alliacea* (Lam.) A.H.Gentry. **F**. *Mayodendron igneum* Kurz**G**. *Millingtonia hortensis* L. f. **H**. *Oroxylum indicum* (L.) Benth. ex Kurz **I**. *Podranea ricasoliana* (Tanf.) Sprague **J**. *Pyrostegia venusta* Miers **K**. *Radermachera yunnanensis* C.Y.Wu **L**. *Spathodea campanulata* P.Beauv. **M**. *Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore **N**.*Tecoma capensis* (Thunb.) Lindl. **O**.*Tecoma stans* (L.) Juss. ex Kunth

Table 2 Qualitative pollen characters of investigated taxa

No	Scientific Name	Aperture type	Aperture position	Shape class	AMB	Exine sculpture
1.	*Campis grandiflora*	colporoidate	zonocolpate	prolate	rounded triangular	reticulate
2.	*Dolichandrone spathacea*	colpate	zonocolpate	prolate	rounded triangular	reticulate
3.	*Haplophragma adenophyllum*	syncolpate	zonocolpate	prolate spheroidal	circular	microreticulate
4.	*Jacaranda mimosifolia*	colpate	zonocolpate	prolate	triangular	psilate
5.	*Mansoa alliacea*	perisyncolpate	pantocolpate	spheroidal	circular	reticulate
6.	*Mayodendron igneum*	colpate	zonocolpate	prolate	circular	reticulate
7.	*Millingtonia hortensis*	parasyncolpate	zonocolpate	subprolate	circular	microreticulate
8.	*Oroxylum indicum*	colpate	zonocolpate	Prolate spheroidal	circular	reticulate
9.	*Podranea ricasoliana*	colporoidate	zonocolpate	subprolate	circular	reticulate
10.	*Pyrostegia venusta*	colpate	zonocolpate	subprolate	circular	reticulate
11.	*Radermachera yunnanensis*	colpate	zonocolpate	suboblate	circular	reticulate
12.	*Spathodea campanulata*	colporoidate	zonocolpate	subprolate	rounded triangular	reticulate
13.	*Tabebuia aurea*	colporoidate	zonocolpate	prolate	rounded triangular	reticulate
14.	*Tecoma capensis*	syncolpate	zonocolpate	prolate	triangular	reticulate
15.	*Tecoma stans*	parasyncolpate	zonocolpate	suboblate	circular	microreticulate

Table 3 Quantitative pollen characters of investigated taxa

No	Scientific Name	Aperture number	Polar axis(µm)	Equatorial diameter (µm)	P/E ratio	Colpi length(µm)	Colpi width(µm)	Exine thickness (µm)
1.	*Campis grandiflora*	3	23.5 - 25.0	17.5 - 20.0	1.34	15.0 - 17.5	3.75 - 5.00	2.50 - 3.75
2.	*Dolichandrone spathacea*	3	60.0 - 62.5	42.5 - 45.5	1.42	42.5 - 45.5	5.0 - 7.5	2.50-3.75
3.	*Haplophragma adenophyllum*	3	55.0 - 57.5	50.5 - 52.5	1.10	-	7.5 - 10.0	1.25-2.50
4.	*Jacaranda mimosifolia*	3	57.5 - 60.0	42.5 - 45.0	1.34	-	-	1.25-2.50
5.	*Mansoa alliacea*	15	42.5 - 47.5	-	1.00	12.5-17.5	2.5 - 7.5	3.75 - 5.00
6.	*Mayodendron igneum*	3	40.0 - 45.0	25.0 - 30.0	1.60	35.0 – 37.5	5.0 - 6.5	1.25 - 2.5
7.	*Millingtonia hortensis*	3	45.0 - 47.5	40.0 - 42.5	1.30	-	2.50 - 3.75	1.25 - 2.5
8.	*Oroxylum indicum*	3	72.5 - 75.0	67.5 - 70.0	1.07	67.5 - 70.0	5.0 - 10.0	2.5-3.75
9.	*Podranea ricasoliana*	3	40.0 - 42.5	32.5 - 37.5	1.23	32.5 - 37.5	5.00 - 6.25	1.25 - 2.50
10.	*Pyrostegia venusta*	3 - 4	70.0 - 72.5	67.5 - 70.0	1.27	65.0 - 62.5	5.0 - 7.5	2.5-3.75
11.	*Radermachera yunnanensis*	3	27.5 - 30.0	30.0 - 32.5	0.91	27.5 - 30.0	3.75 - 5.00	1.25 - 2.50
12.	*Spathodea campanulata*	3	90.0 - 95.0	70.0 - 75.0	1.28	70.0 – 75.0	7.50 - 8.75	2.5-5.0
13.	*Tabebuia aurea*	3	47.5 - 50.0	32.5 - 35.0	1.48	45.0 - 47.5	2.50 - 3.25	1.25-2.0
14.	*Tecoma capensis*	3	42.5 - 47.5	30.0 - 35.5	1.41	-	5.00 - 6.25	1.25-2.50
15.	*Tecoma stans*	3	32.5 - 35.0	37.5 - 40.0	0.87	-	5.0 - 7.5	1.25-2.50



Figurer 2 Equatorial view and Polar view of pollen for each species **A.,B**. *Campis grandiflora* (Thunb.) K.Schum. **C.,D**. *Dolichandrone spathacea* (L.f.) Seem. **E.,F**. *Haplophragma adenophyllum*(Wall.) P. Dop **G.,H**. *Jacaranda mimosifolia* D.Don **I.,J**. *Mansoa alliacea* (Lam.) A.H.Gentry. **K.,L**. *Mayodendron igneum* Kurz **M.,N**. *Millingtonia hortensis* L. f. **O.,P**. *Oroxylum indicum* (L.) Benth. ex Kurz **Q.,R**. *Podranea ricasoliana* (Tanf.) Sprague **S.,T**. *Pyrostegia venusta* Miers **U.,V**. *Radermachera yunnanensis* C.Y.Wu **W.,X**. *Spathodea campanulata* P.Beauv. **Y.,Z**. *Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore **AA., BB**. *Tecoma capensis*(Thunb.) Lindl. **CC.,DD**. *Tecoma stans* (L.) Juss. ex Kunth

Discussion and Conclusion

The current study was done by analyzing the pollen morphology of some species of Bignoniaceae which are known for their ornamental and medicinal uses. In this study, *Mayodendron igneum* and *Millingtonia hortensis* were cultivated as ornamental and medicinal purposes; *Dolichandrome spathacea*, *Haplophragma adenophyllum* and *Oroxylum indicum* as medicinal plants for their floral and fruit vegetable and the rest species as ornamental plant for their large and showy attractive flowers.

Nowadays, the pollen characters are considered together with morphological feature of the plants. Therefore, they become useful complementary tool in solving the problem of taxonomy and phylogeny. The present study has shown the differences and similarities in the pollen morphology of some species of Bignoniaceae.

Generally, in Bignoniaceae, the pollens are monads, radially symmetrical, isopolar and apolar, tricolpate, tetracolpate, tricolporate, tricolporoidate and polycolpate and psilate, microreticulate to reticulate. This result is in line with the work of Erdtman (1952), Gentry (1980), Bove (1993), Saensouk & Saensouk (2011) and Ugbabe *et al.* (2007, 2013). The pollens of the species analyzed in this study are tricolpate, oblate shape and reticulate sculpture which is typical of the family studied. This confirms that the species investigated are members of Bignoniaceae. Gentry (1980) assumed that the tricolpate and reticulate pollen is ancestral status.

Tsymbalyuk (2014) reported that the pollen of the genus *Campis* was tri – tetracolpate and reticulate sculpture while the present study reveals tricloporoidate and reticulate sculpture in *Campis grandiflora.* It was noted that the pollen morphology of *Dolichandrome spathacea* was not reported by any authors in family Bignoniaceae. The current study described them as tricolpate, prolate and reticulate sculpture. According to Saensouk & Saensouk (2011), the pollen of *Haplophragma adenophylla* is tricolpate and prolate; in the present study, it is tricolpate, syncolpate and prolate spheroidal. In the studies carried out by Bove (1993), the pollen of *Jacaranda* was examined as tricolporoidate, oblate spheroidal to prolate and psilate sculpture. The results presented by this author were different from the trisyncolpate aperture type of the current study.

The perisyncolpate aperture type and reticulate sculpture found in *Mansoa alliacea* by Bove (1993) was the same one found by the present study. The pollen of *Mayodendron igneum* was tricolpate and prolate. This finding is in accordance with those of Saensouk & Saensouk (2011). They also described the pollen of *Millintonia hortensis* as tricolpate, prolate and microreticulate. The current study coincides with the results found by these authors. The pollen of *Oroxylum indicum* is tricolpate, prolate spheroidal and reticulate. This finding is agreement with those of Ugbabe *et al.* (2007).

The pollen of *Podranea ricasoliana* was studied by Trigo (1991). The results of those are confirmed to the present study of tricolporoidate pollen with reticulate sculpture. The current study described the aperture of *Pyrostegia venusta* as tri - tetracolpate and exine sculpture as reticulate. These characters are confirmed to the results of Bove (1993). The pollen characters of *Ridermachera yunnanensis* corroborate those of Wei *et al.* (2001) in relation to the pollen characters being tricolpate. Ugbabe *et al.* (2013) found the pollen of *Spathodoea campanulata* to be tricolporate and subprolate; in the current result, it is tricolporoidate and prolate.

Bove (1993) analyzed that the pollen of *Tabebuia* was tircolporoidate, prolate and reticulate; Ugbabe *et al.* (2007) described it as tricolporate and prolate-spheroidal; the results of this study were confirmed to those of the first author. The pollen of *Tecoma capensis* was described as having tricolpate and prolate by Saensouk & Saensouk (2011) similar to the pollen grain

described in this paper. The tricolporate aperture type found in *Tecoma stans* by Ugbabe *et al.* (2007, 2013). The results of the present research were similar to the findings of this author.

In the study of pollen morphology, it was categorized on the basis of dispersal unit, polarity, symmetry, shape, size, aperture types and exine sculpture. However, from an evolutionary point of view, aperture type and exine sculpture are the most important pollen character. The pollen of Bignoniaceae shows both primitive and advance characters. These characters were defined by the method of character states used by Luo *et al.* (2015).

The dispersal unit of studied species was monad which was considered by Luo *et al*. (2015) as primitive character while Dajoz 1991 as advances one. The apolar as in *Mansoa alliacea* was primitive whereas isopolar of the rest species was advanced. The symmetry of pollen was radial in this paper. According to Luo *et al.* (2015), bilateral symmetry proceed into radial symmetry.

The shape of pollen was examined under equatorial orientation. It was mostly prolate in present species. Luo *et al.* (2015) defined that the prolate was advanced, spheroidal as in *Mansoa alliacea* was intermediate and suboblate as in *Tecoma stans* and *Radermachera yunnanensis* was primitive. In the present investigation, the pollen grain size was classified based on polar axis by method of Erdtman (1952). In this paper, 5 species of medium and 10 species of large size were recorded. Luo *et al.* (2015) analyzed that the medium size pollen was more primitive than small one.

Luo *et al.* (2015) stated that the porate derived from colpate but syncolpate were the most advance one. In an evolutionary point of view, the morphology of angiosperm pollen has an increasing number of apertures; the more apertures a pollen grain has, the more quickly its germinate (Dajoz, 1991). In the present study the number of aperture were mostly three in number but many in *Mansoa alliacea*. Luo *et al.* (2015) classified inaperturate as primitive, three apertures as mediate and more than three as advanced condition.

According to Luo *et al.* (2015), zonocolpate like *Campis grandiflora* was more primitive than pantocolpate as in *Mansoa alliacea*. Exine sculpture was mostly reticulate pattern but rarely observed psilate in *Jacaranda mimosifolia*. Luo *et al.* (2015) analyzed psilate evolved into reticulate. According to the above results, the presence of primitive status namely aperture type, number, position, and the advance character namely polarity, symmetry, shape and sculpture indicates the Bignoniaceae lie intermediate evolutionary trends.

In angiosperms, the most important pollen characters at the higher taxonomic levels involve the number, position and structure of aperture, exine sculpture and in some cases size and shape (Bose, 2012). From a palynological perspective, the family Bignoniaceae is known as heterogenous or eurypalynous. The results show that the size, shape and exine sculpture have little diagnostic value, while the number, position and type of the aperture have higher taxonomic value. It can be concluded that the pollens of the species investigated was found to have taxonomic value and also supports the identification of species. These resulting pollen morphological characters may offer some taxonomic tools and interrelationships among the species studied.

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