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# Pollinial Morphology on Ten Species of Orchidaceae Found in Southern Shan State

Htet Htet Khaing<sup>1</sup> & Nwè Nwè Yi<sup>2</sup>

## Abstract

Pollinial morphology of Orchidaceae were studied from Southern Shan State. The specimens of 10 species belonging to 10 genera were collected from Southern Shan State during 2016-2017. In the present study, two pollinia were found in five species, four pollinia in two species and eight pollinia in three species. The smallest pollinarium (4.8 - 5.4 × 4.8 - 5.4 mm) was found in *Eria stricta* Lindl. and the largest pollinarium (33.6 - 36.0 × 50.4 - 54.0 mm) was observed in *Thunia alba* (Lindl.) Rchb. f. Pollinial morphology of 10 species was recorded in their number, shape, size, colour and attachment of caudicle or stipe and viscidium to the pollinia. The pollinial morphology provides the knowledge for identification and future systematic research work of family Orchidaceae.

**Key words:** Orchidaceae, Pollinia, Caudicle, Stipe, Viscidium

## Introduction

Palynology (Gr.palynos, dust) is the study of spores and pollen grains. The features of spores and pollen grains can often be used to identify a particular plant taxon (Simpson 2006). The pollen grains are usually bound together by threads of a clear, sticky substance (viscin) in masses called pollinia (Dodson 2015).

The pollinarium is defined as pollinia, a pollen mass and accessory organs such as a caudicle, a stipe, and a viscidium. In Orchidaceae, this feature is an informative source both in taxonomy and phylogenetics (Freudenstein and Ramussen 1999 as cited in Hidayat *et al.* 2006).

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The ancestral number of pollinia per pollinarium is eight and that from there, were independent reductions to six, four or two pollinia (Dressler 1993 as cited in Damon and Nieto 2012).

Taxonomic study of family Orchidaceae had been studied on various regions of Myanmar. However, pollinial morphology of Orchidaceae is left to be studied and recorded. Therefore, pollinial morphology of Orchidaceae were selected and studied.

The present study aimed to investigate the morphological differences in pollinia of Orchidaceae, to knowledge regarding the development and variation in number and structure of pollinia in the family Orchidaceae and to provide the valuable pollinial information in plant classification and identification of Orchidaceae from Northern and Southern Shan State from the palynological point of view.

### **Materials and Methods**

The Orchidaceous plants were collected from Southern Shan State during 2016-2017. All the collected species were recorded by digital images. Precise locations of the specimen collections were made by using Global Positioning System (GPS) Map Navigator.

Identification of specimens were carried out by referring to the key and description stated by Hooker (1894), Schweinurth (1960), Backer and Brick (1968), Holttum (1964), Dassanayake (1981) and Seidenfaden (1992). Myanmar names of the collected species were referred to Hundley and Chit KoKo (1961), and Kress *et al.* (2003).

For pollinarium preparation, the methods described by Chase (1987) as cited in Hidayat *et al.* (2006) were used with several modifications.

According to Erdtman 1960, the specimen were put into a test-tube, then crushed with a glass rod. Acetolysis solution was mixed using a measuring cylinder: 9 parts of glacial acetic acid was added, then 1 part of concentrated sulphuric acid was added. The acid was dropped gently down the side of the tube. Acetolysis mixture (1 CC) was poured into the test-tube containing the pollen sample and stirred with a glass rod. The test-tube was heated in a water-bath to 70° – 80° C for 10 – 20 minutes.

The test-tube was allowed to cool, and the sample diluted with distilled water and centrifuged for 20 – 30 minutes at 3000 rpm. This was repeated twice decanting the water each time. Glycerine was added to the residue, then transferred on a glass slide then covered with a coverslip. The mounted slide was examined under the light microscope. Measurements were also recorded for length and breadth of pollinia and pollen tetrad.

## Results

### List of the collected plants

Pollinial morphology of 10 species belonging to 10 genera of Orchidaceae was studied. The lists of collected species are arranged by alphabetically as shown in Table 1.

Family	No.	Scientific Name	Myanmar Name
Orchidaceae	1	<i>Coelogyne lactea</i> Rchb. f.	Ngwe hnin phyu myokywe
	2	<i>Cymbidium lowianum</i> (Rchb. f.) Rchb. f.	Pan thet she kya
	3	<i>Eria stricta</i> Lindl.	Letset pan
	4	<i>Hemipilia cordifolia</i> Lindl.	Unknown
	5	<i>Hygrochilus parishii</i> (Rchb. f.) Pfitzer	Taung Karamet
	6	<i>Papilionanthe teres</i> (Roxb.) Schltr.	Yo set gyi
	7	<i>Phaius tankervilleae</i> var. <i>pulchra</i> (King & Pantl.) Karthik.	Zayti thithkwa
	8	<i>Robiquetia pachyphylla</i> (Rchb. f.) Garay	Unknown
	9	<i>Thunia alba</i> (Lindl.) Rchb. f.	Kyauk thikhwa phyu
	10	<i>Vanda bensoni</i> Bateman	Moe thuzar

**1. *Coelogyne lactea* Rchb. f., Gard. Chron. 1: 692.1885. (Figure 1 A)**

Myanmar name	:	Ngwe hnin phyu myo kywe
Common name	:	Unknown
Flowering period	:	From March to May

**Outstanding characters**

Sympodial epiphytes; roots clinging, cylindrical, white, glabrous; pseudobulbs one-jointed, fusiform, coriaceous, ridge green, glabrous. Leaves alternate and distichous, oblong-lanceolate, the tips acute, coriaceous, leafy at anthesis, 7–8 veined, green, glabrous. Inflorescences basal racemes, erect, one on each pseudobulbs, 2- to 3- flowered. Flowers reddish brown streak with yellow 2 spot lip, 4.5 – 5.5 cm in diameter; dorsal sepals ovate-lanceolate, the tips acute pure white, glabrous; lateral sepals oblong-lanceolate, the tips acute, coriaceous, pure white, glabrous; lateral petals linear-lanceolate, the tips acute, coriaceous pure white, glabrous; lip distinctly 3-lobed, sidelobes oblong-ovate, inrolled, reddish brown streak with white, glabrous, midlobes ovate-lanceolate, 3-yellowish calli, 2-yellow spot, glabrous; spur not distinct; column long flat, yellow ridges base and white; anthercaps ovoid, white; pollinia 4. Ovary trigonous, pale green, glabrous.

**Specimens examined** : Taunggyi Township; 20° 47' 0.08" N and 97° 02' 0.12" E; 7 March, 2015; Htet Htet Khaing, collection no. 27.

**Pollinial morphology (Figure 1 B, C)**

Pollinarium 13.8 – 15.6 × 15.6 – 16.8 mm in length and breadth; pollinia number 4; pollinial sac 10.5 – 11.0 × 6.5 – 7.5 mm in length and breadth, gibbous in shape, saffron, attachment of pollinium apical; caudicle not prominent; stipe absent; viscidium 4.6 – 5.2 × 9.5 – 10.8 mm in length and breadth, strap in shape, saffron; pollen tetrad tetragonal in shape, 17.5 – 30.0 × 21 – 35 μm in length and breadth; individual grain 5 – 11 × 5 – 15 μm in length and breadth; exine 2 – 3 μm thick, sexine as thick as nexine.

2. *Cymbidium lowianum* (Rchb.f.) Rchb.f., Gard. Chron., n.s. 11: 332, f. 56. 1879. (Figure 1 D)

*Cymbidium giganteum* var. *lowianum* Rchb.f., Gard. Chron., n.s. 7: 685. 1877.

Myanmar name	:	Pan thet she kya
Common name	:	Low's Cymbidium
Flowering period	:	From February to April

**Outstanding characters**

Sympodial epiphytic or lithophytic; roots clinging, cylindrical, white, glabrous; pseudobulbs bilaterally flattened, many-jointed, narrowly ellipsoid, dark green, glabrous. Leaves alternate and distichous, elliptic, the tips acuminate, coriaceous, persistent, deep green. Inflorescences solitary, basal racemes, drooping, many-flowered. Flowers yellowish green, 9.0 – 10.0 cm in diameter; dorsal sepals oblong-lanceolate, the tips acuminate, greenish yellow, glabrous; lateral sepals lanceolate, the tips acuminate, greenish yellow, glabrous; lateral petals oblong-lanceolate, erect, the tips acute, greenish yellow, glabrous; lip ovate lanceolate, attached to the base of the column, distinctly 3-lobed; sidelobes ovate, the tips subacute, pubescent; midlobes lanceolate, the tips acute, coriaceous, reddish, pubescent; spur absent; column 30 mm long, yellow; anthercaps sub globose, white, glabrous; pollinia 2. Ovary oblongoid, glabrous.

**Specimens examined:** Taunggyi Township; 20° 47' 0.08" N and 97° 02' 0.12" E; 6 March, 2016; Htet Htet Khaing, collection no. 42.

**Pollinial morphology (Figure 1 E, F)**

Pollinarium 19.2 – 24.0 × 30 – 36 mm in length and breadth; pollinia number 2; pollinial sac 6.4 – 8.0 × 15 – 18 mm in length and breadth, bell in shape, fulvous, attachment of pollinium ventral; caudicle not prominent; stipe single, 2.4 – 4.8 × 3.6 – 4.8 mm in length and breadth, rectangular in shape, white; viscidium 10.8 – 12.0 × 26.3 – 31.5 mm in length and breadth, strap in shape, white; pollen tetrad rhomboidal in shape, 33 – 39 × 35 – 70 μm in length and breadth; individual grain 10 – 19 × 10 – 23 μm in length and breadth; exine 2.5 – 5.0 μm thick, sexine thicker than nexine.

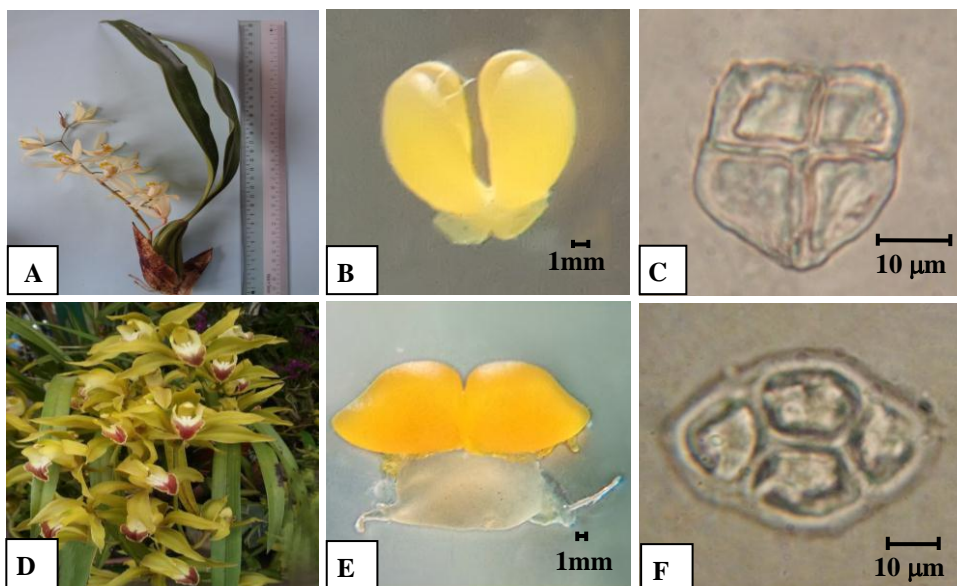


Figure 1. A. Inflorescences of *Coelogyne lactea* Rchb. f.  
 B. Pollinarium of *C. lactea* Rchb. f.  
 C. Tetragonal tetrad pollen of *C. lactea* Rchb. f.  
 D. Inflorescences of *Cymbidium lowianum* (Rchb. f.) Rchb. f.  
 E. Pollinarium of *C. lowianum* (Rchb. f.) Rchb. f.  
 F. Rhomboidal tetrad pollen of *C. lowianum* (Rchb. f.) Rchb. f.

### 3. *Eria stricta* Lindl., Coll. Bot. Ad pl. 41B. 1826. (Figure 2A)

Myanmar name	: Letset pan
Common name	: The Rigid Eria
Flowering period	: From January to February

#### Outstanding characters

Sympodial epiphytes; roots clinging, cylindrical, brownish white, glabrous; pseudobulbs clustered, cylindrical, slightly dilated toward apex, apex 2-leaved, yellowish green, glabrous. Leaves oblong-lanceolate, arising from the pseudobulbs, the tips acute, subcoriaceous, deep green. Inflorescences terminal, secund spike, solitary, erect, 30- to 50- flowered. Flowers white with purplish brown apex, 2.0 – 3.0 mm in diameter; dorsal

sepals triangular ovate, concave, the tips acute; lateral sepals triangular ovate, concave, the tips acute; lateral petals oblong, the tips acute, glabrous; lip obovate; sidelobes the tips subobtuse, purplish brown, glabrous; midlobes the tips obtuse, purplish brown, glabrous; spur obscure; column short and stout, white; anthercaps subglobose, white, glabrous; pollinia 8. Ovary fusiform, white, densely villous.

**Specimens examined:** Hopong Township; 20° 48' 18.28" N and 97° 10' 05.12" E; 7 February, 2016; Htet Htet Khaing, collection no. 56.

#### **Pollinial morphology (Figure 2B, C)**

Pollinarium 4.8 – 5.4 × 4.8 – 5.4 mm in length and breadth; pollinia number 8; pollinial sac 3.0 – 3.3 × 2.0 – 2.3 mm in length and breadth, obovate in shape, beige, attachment of pollinium apical; caudicle not prominent; stipe absent; viscidium 1.0 – 1.3 × 2.4 – 2.7 mm in length and breadth, quadrangular in shape, beige; pollen tetrad rhomboidal in shape, 20.0 – 22.5 × 30 – 40 µm in length and breadth; individual grain 6.5 – 15.0 × 10 – 15 µm in length and breadth; exine 1.5 – 2.0 µm thick, sexine thicker than nexine.

#### **4. *Hemipilia cordifolia* Lindl., Gen. Sp. Orchid. Pl. 296, 1835.**

##### **(Figure 2 D)**

Myanmar name	:	Unknown
Common name	:	The heart-shaped leaf Hemipilia
Flowering period	:	From June to August

#### **Outstanding characters**

Sympodial terrestrials; roots fibrous, cylindrical, white, glabrous; rhizomes tuberous, ovoid, white. Leaves one leafed, radical, suborbicular to cordate, coriaceous, the tips acute, green with pale purple spots, glabrous. Inflorescences terminal racemes, erect, 3- to 20- flowered. Flowers purplish red, 0.5 – 0.8 cm in diameter; dorsal sepals ovate, concave, the tips acute, pale pinkish purple, glabrous; lateral sepals falcately ovate, the tips subacute, pale pinkish purple, glabrous; lateral petals broadly ovate, the tips subacute, pale pinkish purple, glabrous; lip obscurely fimbriate; sidelobes rounded, the tips retuse, dark reddish purple, glabrous; midlobes



subcuneate, the tips retuse, dark reddish purple, glabrous; spur trumpet shaped, pinkish, glabrous; column very short, pinkish white; anthercaps oblongoid, pinkish purple, glabrous; pollinia 2. Ovary oblongoid, green, glabrous.

**Specimens examined:** Myin Ma Ti Taung; 20° 35' 23.38" N and 96° 35' 40.89" E; 9 June, 2017; Htet Htet Khaing, collection no. 67.

### Pollinial morphology (Figure 2 E, F)

Pollinarium 28.8 – 29.4 × 16.0 – 16.3 mm in length and breadth; pollinia number 2; pollinial sac 14.0 – 14.2 × 8.0 – 8.3 mm in length and breadth, obovate in shape, purple, attachment of pollinium apical; caudicle, 13.0 – 13.2 × 1.8 – 2.0 mm in length and breadth, strap in shape, tawny; stipe absent; viscidium 1.8 – 2.0 × 2.0 – 2.2 mm in length and breadth, irregular in shape, mauve; pollen tetrad rhomboidal in shape, 40 – 44 × 55 – 60 μm in length and breadth; individual grain 17.5 – 22.5 × 16.5 – 17.5 μm in length and breadth; exine 1.5 – 2.0 μm thick, sexine thicker than nexine.

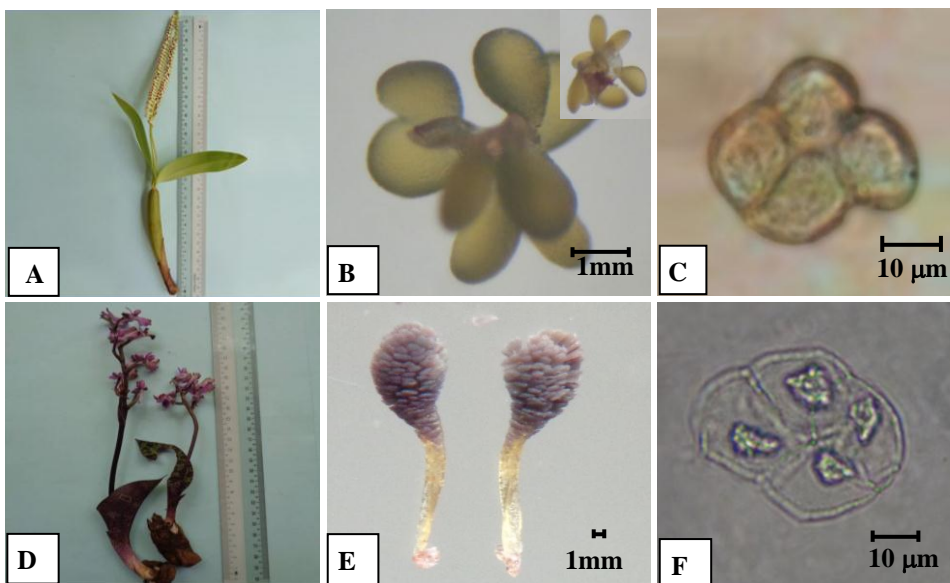


Figure 2. A. Inflorescences of *Eria stricta* Lindl.  
 B. Pollinarium of *E. stricta* Lindl.  
 C. Rhomboidal tetrad pollen of *E. stricta* Lindl.  
 D. Inflorescences of *Hemipilia cordifolia* Lindl.  
 E. Pollinarium of *H. cordifolia* Lindl.  
 F. Rhomboidal tetrad pollen of *H. cordifolia* Lindl.

5. *Hygrochilus parishii* (Rchb.f.) Pfitzer, Nat. Pflanzenfam. 1: 112. 1897. (Figure 3A)

*Vanda parishii* Rchb. f., Xenia Orchid. 2: 138. 1868.

Myanmar name	:	Taungkaramet
Common name	:	The Moist Lip Palenopsis
Flowering period	:	From June to July

**Outstanding Characters**

Monopodial epiphytes; roots long drooping and clinging greyish white, glabrous. Stems leafy, erect, cylindrical. Leaves alternate and distichous, broadly oblong, lightly undulate margins, tips bilobed, deeply emerginate, thickening, coriaceous, persistent glabrous. Inflorescences axillary racemes. Flowers mauve brown spots on yellow sepals and petal, fragrant, 4.0 – 4.5 cm in diameter; dorsal sepals orbicular, tips obtuse, thickening, coriaceous, fleshy mauve brown spots on yellow, glabrous; lateral sepals broadly ovate-oblong, tips apiculate, coriaceous, mauve brown spot on yellow, glabrous; lip half as long as the sepals, distinctly 3-lobed, sidelobes counted, midlobes small cuneately flabelliform, dark violet, glabrous; spur saccate; column short; anthercaps obovoid, white glabrous; pollinia 4. Ovary narrowly oblongoid, pale yellow, glabrous.

**Specimens examined:** Taunggyi Township; 20° 47' 0.08" N and 97° 02' 0.12" E; 20 June, 2015; Htet Htet Khaing, collection no. 39.

**Pollinial morphology (Figure 3B, C)**

Pollinarium 25.2 – 32.4 × 12.6 – 16.2 mm in length and breadth; pollinia number 4; pollinial sac 10.2 – 13.0 × 6.3 – 8.1 mm in length and breadth, orbicular in shape, fulvous, attachment of pollinium ventral; caudicle not prominent; stipe single, 18.9 – 24.3 × 6.0 – 7.8 mm in length and breadth, Y like in shape, white; viscidium 8.0 – 10.2 × 7.5 – 8.5 mm in length and breadth, quadrangular in shape, white; pollen tetrad rhomboidal in shape, 17.5 – 20.0 × 25 – 39 µm in length and breadth; individual grain 6 – 9 × 6.5 – 10.0 µm in length and breadth; exine 2.5 – 3.0 µm thick, sexine thicker than nexine.

**6. *Papilionanthe teres* (Roxb.) Schltr., Orchis 9:78. 1915. (Figure 3D)**

***Dendrobium teres* Roxb., Fl. Ind. (ed.1832) 3: 485. 1832.**

Myanmar name	:	Yo set gyi
Common name	:	The Terete Leaf Papilionanthe
Flowering period	:	From March to May

**Outstanding characters**

Monopodial giant epiphytes; roots long drooping and clinging, cylindrical, white, glabrous; stems leafy, erect, cylindrical, stout. Leaves alternate, oblong, suberect, terete, the tips subacute, coriaceous, green, glabrous. Inflorescences axillary racemes, more or less erect, 2- to 3-flowered loosely arranged. Flowers rose purple and yellow with red speckles and streak lets lip, 6.0 – 7.5 cm in diameter; dorsal sepals broadly abovate-orbicular, the tips obtuse, rose purple, glabrous; lateral sepals subrhomboid or obovate, the tips obtuse, rose purple, glabrous; lateral petals ovate-orbicular, twisted on the axis, the tips obtuse, rose purple, glabrous; lip united with the short column foot; sidelobes obtusely triangular the tips subobtuse, rose purple, glabrous; midlobes broadly cuneate quadrangular, the tips deeply bilobed and truncate, rose purple, glabrous; spur funnel shaped, the tips subacute, purple, glabrous; column long; anthercaps broadly ovoid with tailed, white, glabrous; pollinia 2. Ovary oblongoid with ridges, purple, glabrous.

**Specimens examined:** Kalaw Township; 20° 37' 5.99" N and 96° 34' 03.01", E; 15 May, 2016; Htet Htet Khaing, collection no.52.

**Pollinial morphology (Figure 3E, F)**

Pollinarium 36 – 42 × 30.0 – 34.8 mm in length and breadth; pollinia number 2; pollinial sac 15 – 20 × 14.5 – 17.4 mm in length and breadth, orbicular in shape, fulvous, attachment of pollinium ventral; caudicle not prominent; stipe single, 19 – 21 × 7.5 – 8.4 mm in length and breadth, cylindrical in shape, white; viscidium 19.5 – 22.0 × 28.0 – 32.5 mm in length and breadth, obtriangular in shape, white; pollen tetrad rhomboidal in shape, 27.5 – 35.0 × 35 – 45 μm in length and breadth; individual grain 9.0 – 12.5 × 10 – 15 μm in length and breadth; exine 1.0 – 1.5 μm thick, sexine thicker than nexine.

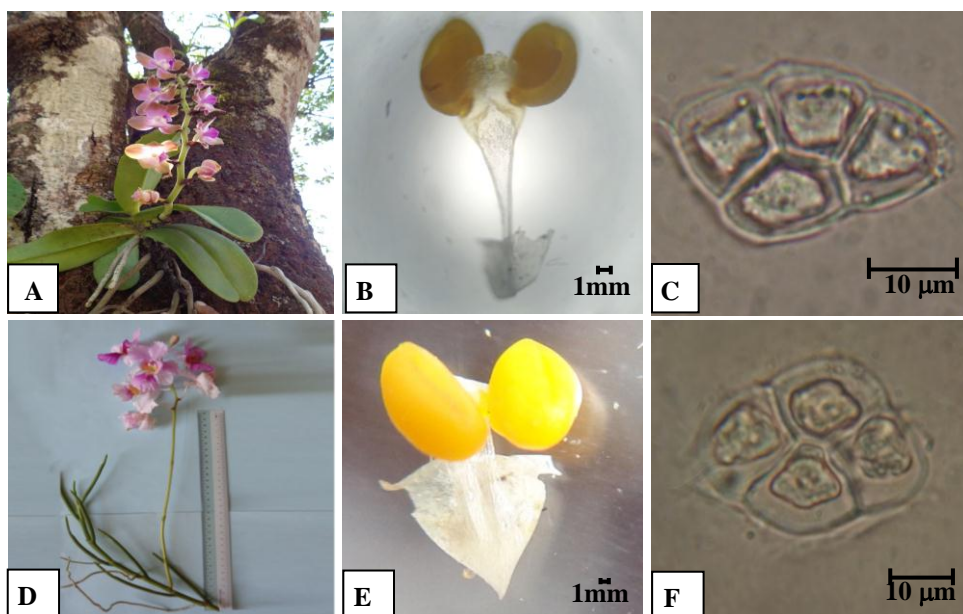


Figure 3. A. Inflorescences of *Hygrochilus parishii* (Rchb. f.) Pfitzer  
 B. Pollinarium of *H. parishii* (Rchb. f.) Pfitzer  
 C. Rhomboidal tetrad pollen of *H. parishii* (Rchb. f.) Pfitzer  
 D. Inflorescences of *Papilionanthe teres* (Roxb.) Schltr.  
 E. Pollinarium of *P. teres* (Roxb.) Schltr.  
 F. Rhomboidal tetrad pollen of *P. teres* (Roxb.) Schltr.

**7. *Phaius tankervilleae* var. *pulchra* (King & Pantl.) Karthik., Fl. Ind. Enum: Monocot. 163. 1989. (Figure 4A)**

***Phaius blumei* var. *pulchra* King & Pantl., Ann. Roy. Bot. Gard. (Calcutta) 8: 109. 1898.**

Myanmar name : Zayti thithkwa  
 Common name : Unknown  
 Flowering period : From February to April.

**Outstanding characters**

Sympodial terrestrials; roots fibrous, cylindrical, white; pseudobulbs subglobose, covered with leaf sheaths. Leaves alternate and distichous, elliptic-lanceolate, coriaceous, pale green, glabrous, entire along the margin, acute at the apex. Inflorescences lateral racemes, erect, solitary, 15- to 20- flowered. Flowers purplish yellow to pale orange yellow, 6.0 – 8.5 cm in diameter; dorsal sepals ovate-lanceolate, glabrous, the tips acuminate; lateral sepals falcately ovate-lanceolate, glabrous the

tips acute; lateral petals oblong-lanceolate to elliptic-lanceolate, glabrous, the tips acute; lip distinctly 3-lobed, andante to the base of the colum; sidelobes oblong, yellow with purplish streaks, the tips obtuse to truncate, midlobes orbicular, glabrous without, orange yellow with reddish purple; spur funnel shaped; column long, creamy white to pale yellow; anthercaps oblong, glabrous, white; pollinia 8. Ovary trigonous, pale yellowish green.

**Specimens examined:** Between Ma Kwe and Wet Pyu Ye Village; 20° 42' 56.38" N and 96° 30' 25.06" E; 7 March, 2015; Htet Htet Khaing, collection no. 21.

#### **Pollinial morphology (Figure 4B, C)**

Pollinarium 16.0 – 18.4 × 24.0 – 27.6 mm in length and breadth; pollinia number 8; pollinial sac 5.6 – 6.6 × 10.0 – 12.5 mm in length and breadth, elliptic in shape, fulvous, attachment of pollinium apical; caudicle not prominent; stipe absent; viscidium 7.5 – 8.8 × 7.0 – 8.5 mm in length and breadth, irregular in shape, fulvous; pollen tetrad rhomboidal in shape, 27.5 – 37.5 × 32.5 – 51.5 μm in length and breadth; individual grain 6.5 – 15.0 × 10.0 – 14.5 μm in length and breadth; exine 3 – 5 μm thick, sexine as thick as nexine.

#### **8. *Robiquetia pachyphylla* (Rchb.f.) Garay, Bot. Mus. Leaflet 23 (4): 197, 1972. (Figure 4D)**

*Aerides pachyphyllum* Rchb.f., Gard. Chron. 14:231. 1880.

Myanmar name	:	Unknown
Common name	:	The broad leafed Robiquetia
Flowering period	:	From April to June

#### **Outstanding characters**

Monopodial epiphytes; root wiry, cylindrical, twisted, branched with velamen, glabrous; stem short, stout, fleshy. Leaves alternate and distichous, articulate, stout, the tips bilobed, bright green, glabrous. Inflorescences axillary racemes, many-flowered. Flowers pale purple, 0.3 – 0.4 cm in diameter; dorsal sepals ovate-acute, the tips acute, slightly concave, purple, glabrous; lateral sepals ovate acute, the tips acute, spreading, purple, glabrous; lateral petals ovate acute, the tips acute, purple, glabrous; lip long, purple; sidelobes small and erect, the tips acute,

purple; midlobes projecting downward, the tips acute, deep purple; spur long, purple; column short; anthercaps purple; pollinia 2. Ovary oblongoid, glabrous.

**Specimens examined:** Between Ma Kwe and Wet Pyu Ye Village; 20° 42' 56.38" N and 96° 30' 25.06" E; 9 June, 2017; Htet Htet Khaing, collection no. 84.

**Pollinial morphology (Figure 4 E, F)**

Pollinarium 13.2 – 13.8 × 12.0 – 12.6 mm in length and breadth; pollinia number 2; pollinial sac 5.4 – 5.9 × 5.0 – 5.4 mm in length and breadth, orbicular in shape, cream, attachment of pollinium ventral; caudicle not prominent; stipe single, 8.5 – 9.5 × 2.0 – 2.1 mm in length and breadth, strap in shape, white; viscidium 6.6 – 6.9 × 4.0 – 4.2 mm in length and breadth, rectangular in shape, white; pollen tetrad rhomboidal in shape, 25 – 27 × 32.0 – 37.5 μm in length and breadth; individual grain 7.5 – 11.0 × 10.0 – 12.5 μm in length and breadth; exine 1.5– 2.0 μm thick, sexine thicker than nexine.

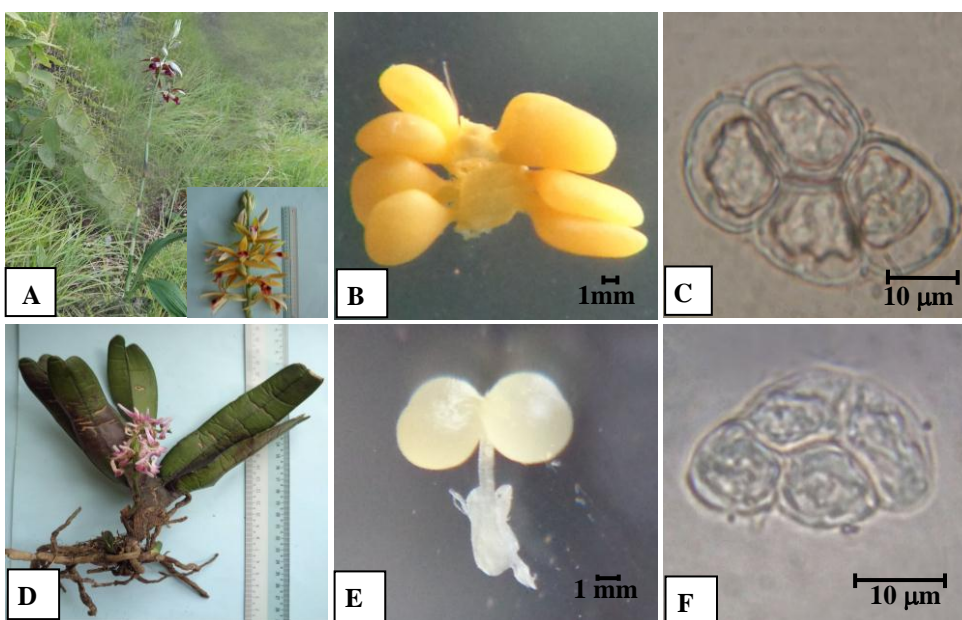


Figure 4. A. Inflorescences of *Phaius tankervilleae* var. *pulchra* (King & Pantl.) Karthik.  
 B. Pollinarium of *P. tankervilleae* var. *pulchra* (King & Pantl.) Karthik.  
 C. Rhomboidal tetrad pollen of *P. tankervilleae* var. *pulchra* (King & Pantl.) Karthik.  
 D. Inflorescences of *Robiquetia pachyphylla* (Rchb. f.) Garay  
 E. Pollinarium of *R. pachyphylla* (Rchb. f.) Garay  
 F. Rhomboidal tetrad pollen of *R. pachyphylla* (Rchb. f.) Garay

**9. *Thunia alba* (Lindl.) Rchb. f., Bot. Zeitung (Berlin) 10:764.1852.**

**(Figure 5 A)**

***Phaius albus* Lindl., Pl. Asiat. Rar.2:, Pl. 198. 1831.**

- Myanmar name : Kyauk thikhwa phyu  
 Common name : Unknown  
 Flowering period : From January to April.

**Outstanding characters**

Sympodial epiphytes or lithophytes; roots clinging, fibrous cylindrical, brownish white, glabrous. Leaves alternate and distichous, ovate-lanceolate, the tips acuminate, green, glabrous. Inflorescences terminal racemes, solitary 2- to 5- flowered. Flowers white with yellow and reddish brown streak, 5.0 – 6.0 cm is diameter; dorsal sepals oblong-lanceolate, slightly concave the tips acute, white, glabrous; lateral sepals oblong-lanceolate, the tips acuminate, white, glabrous; lateral petals elliptic-lanceolate to linear-lanceolate, the tips acuminate, white, glabrous lip distinctly 3-lobed, sidelobes oblong, white with reddish brown streak, glabrous; midlobes broadly obovate-orbicular, white with reddish brown streak, pubescent within and glabrous without; spur white, the tips emarginated, glabrous; column long, white; anthercaps subglobose, white, glabrous; pollinia 8. Ovary oblongoid, pale green, glabrous.

**Specimens examined:** Kalaw Township; 20° 37' 5.99" N and 96° 34' 03.01", E; 30 April, 2016; Htet Htet Khaing, collection no. 58.

**Pollinial morphology (Figure 5B, C)**

Pollinarium 33.6 – 36.0 × 50.4 – 54.0 mm in length and breadth; pollinia number 8; pollinial sac 29.4 – 31.5 × 13.0 – 13.7 mm in length and breadth, obovate in shape, ochereous, attachment of pollinium apical; caudicle not prominent; stipe absent; viscidium 7.4 – 7.9 × 12.8 – 13.5 mm in length and breadth, irregular in shape, white; pollen tetrad

rhomboidal in shape,  $27.5 - 35.0 \times 35.0 - 42.5$   $\mu\text{m}$  in length and breadth; individual grain  $12.5 - 20.0 \times 12.5 - 21.0$   $\mu\text{m}$  in length and breadth; exine  $1.5 - 2.0$   $\mu\text{m}$  thick, sexine thicker than nexine

**10. *Vanda bensoni* Bateman, Bot., Mag. 92:, Pl. 5611. 1866.**

**(Figure 5 D)**

Myanmar name : Moe thuzar  
 Common name : Unknown  
 Flowering period : From March to June

**Outstanding characters**

Monopodial epiphytes; stems erect, stout. Leaves alternate and distichous, blades oblong, recurved, coriaceous, attenuate at the base, entire along the margin, 2-lobed or obliquely truncate and toothed at the apex, glabrous. Inflorescences axillary racemes, 4-to 10-flowered. Flowers dull yellow with brown tessellation within and pale pinkish purple without, 6 – 10 cm in diameter, fragrant; dorsal sepals obovate, light lavender, 5-veined, coriaceous, glabrous; lateral sepals broadly obovate, coriaceous, light lavender, 7-veined, glabrous; lip nearly as long as the sepals, blue; sidelobes triangular, coriaceous, pale pinkish purple, glabrous; midlobes of lip with 3- obtuse ridges; spur conical, curved; column short, pale blue, stout; anthercaps minute, ovoid; pollinia 2; stipes round, white. Ovary triangular, pale green, glabrous.

**Specimens examined:** Between Ma Kwe and Wet Pyu Ye Village;  $20^{\circ} 42' 56.38''$  N and  $96^{\circ} 30' 25.06''$  E; 7 June, 2014; Htet Htet Khaing and Ah Nge Htwe, collection no. 3.



### Pollinial morphology (Figure 5 E, F)

Pollinarium 30 – 36 × 18 – 24 mm in length and breadth; pollinia number 2; pollinial sac 11.4 – 12.5 × 9 – 12 mm in length and breadth, orbicular in shape, tawny, attachment of pollinium ventral; caudicle not prominent; stipe single, 16 – 22 × 11.0 – 12.6 mm in length and breadth, triangular in shape, white; viscidium 13.5 – 18.0 × 17 – 23 mm in length and breadth, quadrangular in shape, white; pollen tetrad rhomboidal in shape, 20 – 33 × 20 – 43  $\mu\text{m}$  in length and breadth; individual grain 5.0 – 14.5 × 5 – 17  $\mu\text{m}$  in length and breadth; exine 2.5– 5.0  $\mu\text{m}$  thick, sexine

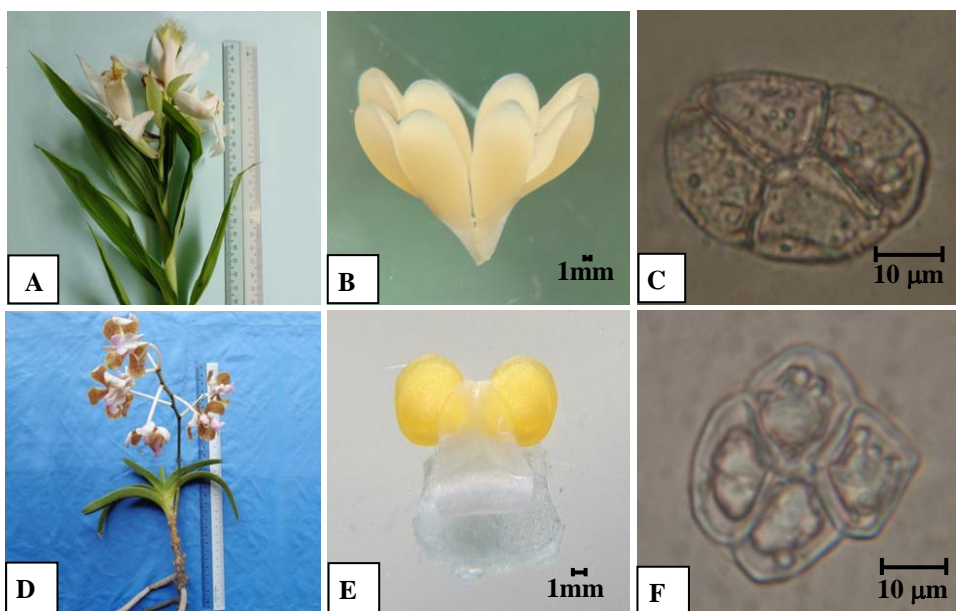


Figure 5. A. Inflorescences of *Thunia alba* (Lindl.) Rchb. f.  
 B. Pollinarium of *T. alba* (Lindl.) Rchb. f.  
 C. Rhomboidal tetrad pollen of *T. alba* (Lindl.) Rchb. f.  
 D. Inflorescences of *Vanda bensoni* Bateman  
 E. Pollinarium of *V. bensoni* Bateman  
 F. Rhomboidal tetrad pollen of *V. bensoni* Bateman

**Table 2. Pollinarium Morphology of Orchidaceae in 10 Species**

No.	Scientific name	Pollinarium		Pollinial sac			Attach- ment	Caudicle		Stipe			Viscidium		
		L & B (mm)	Num -ber	L & B (mm)	Shape	Colour		L & B (mm)	Num- ber	L & B (mm)	Shape	Colour	L & B (mm)	Shape	Colour
1.	<i>Coelogyne lactea</i> Rchb. f.	13.8–15.6 × 15.6–16.8	4	10.5 – 11.0 × 6.5 – 7.5	gib	sa	ap	n-pro	ab	ab	ab	ab	4.6 – 5.2 × 9.5 – 10.8	st	sa
2.	<i>Cymbidium lowianum</i> (Rchb. f.) Rchb. f.	19.2 – 24.0 × 30 – 36	2	6.4 – 8.0 × 15 – 18	bel	fu	ve	n-pro	si	2.4 – 4.8 × 3.6 – 4.8	rec	wh	10.8 – 12.0 × 26.3 – 31.5	st	wh
3.	<i>Eria stricta</i> Lindl.	4.8 – 5.4 × 4.8 – 5.4	8	3.0 – 3.3 × 2.0 – 2.3	obo	bei	ap	n-pro	ab	ab	ab	ab	1.0 – 1.3 × 2.4 – 2.7	qu	bei
4.	<i>Hemipilia cordifolia</i> Lindl.	28.8 – 29.4 × 16.0 – 16.3	2	14.0 – 14.2 × 8.0 – 8.3	obo	p	ap	13.0 – 13.2 × 1.8 – 2.0	ab	ab	ab	ab	1.8 – 2.0 × 2.0 – 2.2	ir	ma
5.	<i>Hygrochilus parishii</i> (Rchb. f.) Pfitzer	25.2–32.4 × 12.6 – 16.2	4	10.2 – 13.0 × 6.3 – 8.1	orb	fu	ve	n-pro	si	18.9 – 24.3 × 6.0 – 7.8	Y	wh	8.0 – 10.2 × 7.5 – 8.5	qu	wh
6.	<i>Papilionanthe teres</i> (Roxb.) Schltr.	36 – 42 × 30.0 – 34.8	2	15 – 20 × 14.5 – 17.4	orb	fu	ve	n-pro	si	19 – 21 × 7.5 – 8.4	cy	wh	19.5 – 22.0 × 28.0 – 32.5	obt	wh
7.	<i>Phaius tankervilleae</i> var. <i>pulchra</i> (King & Pantl.) Karthik.	16.0 – 18.4 × 24.0 – 27.6	8	5.6 – 6.6 × 10.0 – 12.5	el	fu	ap	n-pro	ab	ab	ab	ab	7.5 – 8.8 × 7.0 – 8.5	ir	fu
8.	<i>Robiquetia pachyphylla</i> (Rchb. f.) Garay	13.2 – 13.8 × 12.0 – 12.6	2	5.4 – 5.9 × 5.0 – 5.4	orb	cr	ve	n-pro	si	8.5 – 9.5 × 2.0 – 2.1	st	wh	6.6 – 6.9 × 4.0 – 4.2	rec	wh
9.	<i>Thunia alba</i> (Lindl.) Rchb. f.	33.6 – 36.0 × 50.4 – 54.0	8	29.4 – 31.5 × 13.0 – 13.7	obo	oc	ap	n-pro	ab	ab	ab	ab	7.4 – 7.9 × 12.8 – 13.5	ir	wh
10.	<i>Vanda bensoni</i> Bateman	30 – 36 × 18 – 24	2	11.4 – 12.5 × 9 – 12	orb	ta	ve	n-pro	si	16 – 22 × 11.0 – 12.6	tr	wh	13.5 – 18.0 × 17 – 23	qu	wh

ab = absent	el = elliptic	obt = obtriangular	sa = saffron	wh = white
ap = apical	fu = fulvous	oc = ochreous	si = single	y = ylike
be = beige	gib = gibbous	orb = orbicular	st = strap	
bel = bell	ir = irregular	p = purple	ta = tawny	
cr = cream	n-pro = not prominent	qu = quadrangular	tr = triangular	
cy = cylindrical	obo = obovate	rec = rectangular	ve = ventral	

**Table 3. Pollen Morphology in 10 Species of Orchidaceae**

No.	Scientific Name	Types of pollen tetrad	Pollen tetrad of length & breadth( $\mu\text{m}$ )	Individual grain of length & breadth( $\mu\text{m}$ )	Exine	
					Thickness ( $\mu\text{m}$ )	S/N
1	<i>Coelogyne lactea</i> Rchb. f.	tetragonal	17.5–30.0 $\times$ 21–35	5–11 $\times$ 5–15	2–3	S=N
2	<i>Cymbidium lowianum</i> (Rchb. f.) Rchb. f.	rhomboidal	33–39 $\times$ 35–70	10–19 $\times$ 10–23	2.5–5.0	S>N
3	<i>Eria stricta</i> Lindl.	rhomboidal	20.0–22.5 $\times$ 30–40	6.5–15.0 $\times$ 10–15	1.5–2.0	S>N
4	<i>Hemipilia cordifolia</i> Lindl.	rhomboidal	40 – 44 $\times$ 55 – 60	17.5 – 22.5 $\times$ 16.5 – 17.5	1.5 – 2.0	S>N
5	<i>Hygrochilus parishii</i> (Rchb. f.) Pfitzer	rhomboidal	17.5–20.0 $\times$ 25–39	6–9 $\times$ 6.5–10.0	2.5–3.0	S>N
6	<i>Papilionanthe teres</i> (Roxb.) Schltr.	rhomboidal	27.5–35.0 $\times$ 35–45	9.0–12.5 $\times$ 10–15	1.0–1.5	S>N
7	<i>Phaius tankervilleae</i> var. <i>pulchra</i> (King & Pantl.) Karthik.	rhomboidal	27.5–37.5 $\times$ 32.5–51.5	6.5–15.0 $\times$ 10.0–14.5	3–5	S=N
8	<i>Robiquetia pachyphylla</i> (Rchb.f.) Garay	rhomboidal	25 – 27 $\times$ 32.0 – 37.5	7.5 – 11.0 $\times$ 10.0–12.5	1.5 – 2.0	S>N
9	<i>Thunia alba</i> (Lindl.) Rchb. f.	rhomboidal	27.5–35.0 $\times$ 35.0–42.5	12.5–20.0 $\times$ 12.5–21.0	1.5–2.0	S>N
10	<i>Vanda bensoni</i> Bateman	rhomboidal	20 – 33 $\times$ 20 – 43	5.0 – 14.5 $\times$ 5 – 17	2.5 – 5.0	S>N

S/N = sexine and Nexine

S = N = sexine as thick as nexine

S > N = sexine thicker than nexine

## Discussion and Conclusion

Pollinial morphology of 10 species belong to 10 genera of Orchidaceae were studied in this research. The collected species of Orchidaceae were classified and identified according to the number, size, shape, colour, attachment of pollinia, caudicles, stipe and viscidium.

In the present study, the number of pollinia occurred in Orchidaceae were 2, 4 and 8. Among them, the two pollinia were found in five species: *Cymbidium lowianum* (Rchb. f.) Rchb. f., *Hemipilia cordifolia* Lindl., *Papilionanthe teres* (Roxb.) Schltr., *Robiquetia pachyphylla* (Rchb. f.) Garay and *Vanda bensoni* Bateman; four pollinia were found in two species: *Coelogyne lactea* Rchb. f. and *Hygrochilus parishii* (Rchb. f.) Pfitzer; eight pollinia were observed in three species: *Eria stricta* Lindl., *Phaius tankervilleae* var. *pulchra* (King & Pantl.) Karthik. and *Thunia alba* (Lindl.) Rchb. f.

The shape of pollinial sac were orbicular in 4 species: *Hygrochilus parishii* (Rchb. f.) Pfitzer, *Papilionanthe teres* (Roxb.) Schltr., *Robiquetia pachyphylla* (Rchb. f.) Garay and *Vanda bensoni* Bateman; obovate in 3 species: *Eria stricta* Lindl., *Hemipilia cordifolia* Lindl. and *Thunia alba* (Lindl.) Rchb. f.; gibbous, bell and elliptic were found in one species each.

The colour of pollinial sac were fulvous, saffron, beige, purple, cream, ochreous and tawny. The fulvous colour was found in 4 species : *Cymbidium lowianum* (Rchb. f.) Rchb. f., *Hygrochilus parishii* (Rchb. f.) Pfitzer, *Papilionanthe teres* (Roxb.) Schltr. and *Phaius tankervilleae* var. *pulchra* (King & Pantl.) Karthik.; saffron, beige, purple, cream, ochreous and tawny were found in one species each.

Position of attachment of caudicle or stipe to the pollinia is also an important diagnostic feature to evaluate the morphological diversification of pollinia different genera of Orchidaceae (Sinha and Mondal 2011). The caudicles attachment was apical or ventral. It was found that the apical attachment was found in 5 species: *Coelogyne lactea* Rchb. f., *Eria stricta* Lindl., *Hemipilia cordifolia* Lindl., *Phaius tankervilleae* var. *pulchra* (King & Pantl.) Karthik. and *Thunia alba* (Lindl.) Rchb. f.; the ventral attachment of pollinia was observed in 5 species: *Cymbidium lowianum* (Rchb. f.) Rchb. f., *Hygrochilus parishii* (Rchb. f.) Pfitzer, *Papilionanthe teres* (Roxb.) Schltr., *Robiquetia pachyphylla* (Rchb. f.) Garay and *Vanda bensoni* Bateman.

The morphological characters of pollinarium were different from each other. In this paper, the size of the pollinaria ranges from  $4.8 - 5.4 \times 4.8 - 5.4$  mm to  $33.6 - 36.0 \times 50.4 - 54.0$  m. The smallest size was found in *Eria stricta* Lindl. and the largest size was observed in *Thunia alba* (Lindl.) Rchb. f.. Moreover, pollinial sac was also measured, where it was found that *Eria stricta* Lindl. the smallest pollinial sac whose measurement was  $3.0 - 3.3 \times 2.0 - 2.3$  mm. The largest pollinial sac by measurement was observed in *Cymbidium lowianum* (Rchb. f.) Rchb. f. ( $6.4 - 8.0 \times 15 - 18$  mm).

The caudicle facilitates pollinia to divide into each pollinium (Rasmussen 1986 as cited in Hidayat *et al.* 2006). Freudenstein and Rasumussen (1999) as cited in Hidayat *et al.* (2006) stated that the caudicle is one of the important states for orchid relationships. The caudicle was prominent in 1 species, the not prominent in 9 species.

Orchidaceae have diverse size of stipe, the length of stipe was differently observed in various sizes ranging from smallest length  $8.5 - 9.5 \times 2.0 - 2.1$  mm to the largest length of  $16 - 22 \times 11.0 - 12.6$  mm. The smallest length of stipe was observed in *Robiquetia pachyphylla* (Rchb. f.) Garay and the largest length of stipe was found in *Vanda bensoni* Bateman. The stipe was found in 5 species and absent in 5 species. In the present investigation, members of Orchidaceae was diversified number and shape of stipe. The number of stipe was single, double or absent. In this paper, single stipe was found in 5 species and absence in 5 species. The shape of stipe was strap, cylindrical, triangular, Y like, rectangular in one species each. The colour of stipe was only white in all species.

The viscidium plays a role in attaching the pollinia to an insect allowing the pollinia to be carried to another flower (Hidayat *et al.* 2006). It was found that within the 10 species, the smallest viscidium was found in *Hemipilia cordifolia* Lindl. ( $1.8 - 2.0 \times 2.0 - 2.2$  mm), and the largest viscidium was observed in *Papilionanthe teres* (Roxb.) Schltr. ( $19.5 - 22.0 \times 28.0 - 32.5$  mm).

The studied species were diversified in shape of viscidium. The shape of viscidium was found in strap, quadrangular, irregular, obtriangular, rectangular. The strap shape of viscidium was found in 2 species, quadrangular in 3 species, irregular in 3 species, obtriangular and rectangular shape in one species each. The colour of viscidium was saffron, white, beige, mauve, fulvous. The white colour of viscidium was

observed in 6 species, saffron, beige, mauve and fulvous was found in one species each.

Chaudhary *et al.* (2012) reported that light microscope study of pollinia revealed that the pollen grains were liberated as tetrad into discrete types. Hesse *et al.* (2009) stated that the dispersal unit of four pollen grain arranged in one plane or multiplane. Kull *et al.* (2009) described that Orchidaceae have all six possible tetrad types: tetrahedral or tetragonal, decressate, square, rhomboidal, T shape and linear. In the present study, pollen tetrads were rhomboidal in 9 species and tetragonal in 1 species. These findings are comprised Hoen (1999) and Kull *et al.* (2009). The smallest size of tetrad pollen was found in *Coelogyne lactea* Rchb. f. (17.5 – 30.0 × 21 – 35 µm) and the largest size of tetrad pollen was observed in *Cymbidium lowianum* (Rchb. f.) Rchb. f. (33 – 39 × 35 – 70 µm).

The pollinia number of *Hygrochilus parishii* (Rchb.f.) Pfitzer was 4, number of stipe was single and caudicle was not prominent. Hidayat *et al.* (2006) reported that the pollinia number of *Hygrochilus parishii* (Rchb.f.) Pfitzer was 4, number of stipe was single and caudicle was not prominent. Therefore, the present results are the same with Hidayat *et al.* (2006).

Orchidaceae are known for their large diversity in pollen morphology. This diversity has been described at different levels: variability in packing of pollen in pollinia, in pollen wall structure, and in pollen surface sculpturing. Hence, the structure and shape of pollinia have been used frequently for the classification orchids (Chaudhary *et al.* 2012).

In the present research, on the basis of observation on pollinia, it was stated that the pollinia of different genera vary in morphology. These morphological features of pollinia will be supported for class information and identification of some species in Orchidaceae.

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