Pollen morphology of 15 species in Commelinaceae (Commelinids: Angiosperms) from Andhra Pradesh, India

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ABSTRACT

The present study deals with pollen morphology of fifteen species of Commelinaceae belonging to three genera: Commelina (6 species), Cyanotis (7 species) and Murdannia (2 species), collected from different localities in Andhra Pradesh, India. Species have shown diversity in size, shape and ornamentation, but all share a common feature; heteropolar and monosulcate apertural nature. While all the six species of Commelina have echinate ornamentation, four of them with prolate shape and two others have spheroidal shape. Seven species of Cyanotis have granular ornamentation and prolate in shape, except Cyanotis axillaris which is perprolate. Both the species of Murdannia have granular ornamentation; but differ in shape: prolate in M. nodiflora and perprolate in M. nimmoniana. These observations are of immense value in taxonomical, melissopalynological and aeropalynological studies.

Key words: Commelinaceae, Monosulcate, Pollen morphology.

INTRODUCTION

Pollen morphology is now recognised as an important tool in taxonomic studies. Diversity in pollen size, shape, polarity, symmetry, apertural structure, ornamentation and other characters can be used to highlight otherwise cryptic taxonomic relationships (Bhattacharya et al. 2009, Ganga Kailas et al. 2014a, b, 2015a and 2016a, 2016b). Besides identification of plant taxa, pollen morphology data is helpful in investigations of allergies and melissopalynology (Ganga Kailas et al. 2015b, Seetharam et al. 2015, Ponnuchamy et al., 2014; Devender et al. 2016) and palaeovegetation and palaeoclimatical studies (Shilpa Singh et al. 2010). Recently, pollen morphology is considered as an important tool to resolve the place and sometimes the season of the year of a fact in forensic investigation (Passarelli and Cortes, 2017).

Pollen morphological studies on members of Commelinaceae are deficient. Earlier works on pollen morphology of Commelinaceae include Dahl (1946), Brenan (1952, 1964 and 1966), Rowley (1959), Rowley and Dahl (1962), Chikkannaiah (1962) and Handlos (1975). Poole and Hunt (1980) is the only comprehensive work on the palynology of Commelinaceae who studied 24, mostly American genera and about 100 species. Except with stray reports, there is a dearth of literature on pollen characters of the members of Commelinaceae. Of the 15 species of our study, only Commelina benghalensis was studied by Poole and Hunt (1980), Chennakesavulu Naik et al. (2015); Murdannia nodiflora by Vrinda (1999). Sharma (1968) studied pollen morphology of Indian monocotyledons including Commelina and Cyanotis. Pertaining to Andhra Pradesh and Telangana States, Ramakrishna and Bhushan (2004, 2006) studied pollen from honey samples from Nizamabad district; Ramakrishna and Swathi (2013) on the pollen diversity of honey from Adilabad district; Devender et al. (2013) studied pollen morphology of selected medicinal plants of ArakuValley, Visakhapatnam district.

The present work is intended to provide paly- nological data for 15 species of the family Commelinaceae of Andhra Pradesh.

MATERIALS AND METHODS

Andhra Pradesh state (12°41’ and 22°NL; 77° and 84°40’EL) is with a total geographical area of 1,60,200 Km² is located in southern peninsular India. There are 13 districts in the state; nine in the coastal region and four in Rayalaseema region. Most of the area of the state falls in altitude of 0-600m. The total forest area is 20.55% to the geographical area and most of the forest area is part of Eastern Ghats. Andhra Pradesh is floristically rich and diversified representing over 3,000 species of vascular plants and 5,757 species of animals (Joseph et al., 2016). During our explorations in 2016-17, in different seasons from various localities of Andhra Pradesh (Fig 1).

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The material is fixed in glacial acetic acid and was processed slides were prepared following Erdtman’s acetolysis technique (Erdtman, 1960). The pollen grains were acetolysed using acetolysis mixture, i.e. acetic anhydride and concentrated sulphuric acid in the ratio of 9:1. Finally, the pollen samples were mounted in glycerin jelly on glass slides for microscopic examination (Light microscopy (LM). Photo documentation of palynomorphs was made by using a trinocular research microscope (Olympus microscope CH20i). Measurement of pollen size P/E × 100 the length of the polar axis (P) and the equatorial diameter axis (E) were measured from 9 pollen grains per representative species. The terminology used in the description of pollen is in accordance with Punt et al., (2007). These permanent pollen slides were deposited in Palaeobotany-Palynology Research lab, Department of Botany, University College of Science, Saifabad, Osmania University, Hyderabad, India.

RESULTS AND DISCUSSION
Systematic Enumeration: All the species are systematically enumerated in alphabetical order and nomenclature is updated following “The Plant List” (2013). Voucher specimens of all the species were deposited in Sri Krishnadevaraya University Herbarium (SKU), Anantapuramu, Andhra Pradesh. Pollen descriptions are provided here under species-wise.

**Commelina attenuata** K.D.Koenig ex Vahl (Plate: 1, Fig 1, 2)
Pollen grains prolate, P.A 45-46.5 µm × E.A 30.32 µm, polar outline more or less circular, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Ornamentation echinate, echine 2.25 µm height, 1.5 µm at base.

**Commelina benghalensis** L. (Plate: 1, Fig 3, 4)
Pollen grains Prolate, P.A 24-26 µm ×E.A 13.5µm-17 µm, polar outline more or less circular, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate, sulcus 21-22 µm long, 3-4.5 µm wide. Exine 1.75-2 µm thick, sexine thicker than nexine. Ornamentation microechinate.

**Commelina clavata** C.B. Clarke (Plate: 1, Fig 5, 6)
Pollen grains spheroidal, P.A 52.5-54 µm × E.A 52.5-54 µm, polar outline ± circular, equatorial outline circular. Heteropolar, radially symmetric. Aperture monosulcate. Exine 2-2.5 µm thick, sexine thicker than nexine. Ornamentation echinate, echine 4.5 µm height, 3 µm at base.

Plate 1: 1, 2. Commelina attenuata, 3, 4. Commelina benghalensis, 5, 6. Commelina clavata, 7, 8. Commelina forskalaei, 9, 10. Commelina kurzii, 11, 12. Commelina subulata, 13. Cyanotis arachnoidea, 14, 15. Cyanotis axillaris. Scale bars= 5 µm.
Commelina forskalaei Vahl (Plate: 1, Fig 7, 8)
Pollen grains prolate, P.A 22.5-24.5 µm × E.A 13.5-15 µm, polar outline and equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 1.5 µm thick, sexine as thick as nexine. Ornamentation microechinate.

Commelina kurzii C. B. Clarke (Plate: 1, Fig 9, 10)
Pollen grains spheroidal, P.A 52.5-54 µm × E.A 52.5-54 µm, polar outline circular, equatorial outline circular. Heteropolar, radially symmetric. Aperture monosulcate. Exine 1.5-2 µm thick, sexine thicker than nexine. Ornamentation echinate, echinule 2.5 µm height, 4 µm at base.

Commelina subulata Roth (Plate: 1, Fig 11, 12)
Pollen grains prolate, P.A 46.5-48 µm × E.A 34.5-36 µm, polar outline circular, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 2.5-3 µm thick, sexine thicker than nexine. Ornamentation echinate, echinule 2.5 µm height, 3.5 µm at base.

Cyanotis arachnoidea C. B. Clarke (Plate: 1, Fig 13)
Pollen grains prolate, P.A 24-26 µm × E.A 16.5-17 µm, polar outline more or less circular, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate, sulcus 20 µm long, 1.5 µm wide. Exine 2-2.5 µm thick, sexine thicker than nexine. Ornamentation granular.

Cyanotis cristata (L.) D. Don (Plate: 2, Fig 18, 19)
Pollen grains prolate, P.A 22.5-24 µm × E.A 13.5-14 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 1.5-2 µm thick, sexine as thick as nexine. Ornamentation granular.

Cyanotis fasciculata (B. Heyne ex Roth) Schult. and Schult.f. (Plate: 2, Fig 20, 21)
Pollen grains prolate, P.A 24-26 µm × E.A 15-16 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 1.5-2 µm thick, sexine thicker than nexine. Ornamentation granular.

Cyanotis vaga (Lour.) Schult. and Schult.f. (Plate: 2, Fig 22, 23)
Pollen grains prolate, P.A 30-32 µm × E.A 16.5-17.5 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate, sulcus 25 µm × 2 µm. Exine 2-2.5 µm thick, sexine thicker than nexine. Ornamentation granular.

Cyanotis villosa (Spreng.) Schult. and Schult.f. (Plate: 2, Fig 24, 25)
Pollen grains prolate, P.A 23.5-25 µm × E.A 14.5-16 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 2-2.5 µm thick, sexine thicker than nexine. Ornamentation granular.

Murdannia nimmoniana (J. Graham) S.M. Almeida (Plate: 2, Fig 26, 27)
Pollen grains perprolate, P.A 31.5-32 µm × E.A 15-16 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 1.5 µm thick, sexine thicker than nexine. Ornamentation granular.

Murdannia nudiflora (L.) Brenan (Plate: 2, Fig 28, 29, 30)
Pollen grains perprolate, P.A 33-34 µm × E.A 16.5-17 µm, polar outline elliptic, equatorial outline elliptic. Heteropolar, bilaterally symmetric. Aperture monosulcate. Exine 2-2.5 µm thick, sexine thicker than nexine. Ornamentation granular.
Among the 15 species studied for pollen morphology, *Commelina* is represented by six species; *Cyanotis*, 7 species and *Murdannia*, 2 species. All the 15 species pollen has shown monosulcate apertural pattern and heteropolarity (Table 1). Poole and Hunt (1980) stated that all the species of Commelinaceae are monosulcate, except of one species of *Tinantia*. Monosulcate aperture was already observed in three species of *Murdannia* by Vrinda (1999), viz., *M. loriformis, M. nudiflora* and *M. semiteres*. Nandikar and Gurav (2010) inferred that the pollen of *Murdannia lanuginosa* is monosulcate. The present investigation supports all the findings stated above. Five species in the present study have shown conspicuous measurable sulcus, viz., *Commelina benghalensis*, (21-22 µm × 3-4.5µm), *Cyanotis arachnoidea* (20µm × 1.5µm), *Cyanotis burmanniana* (15µm × 3µm), *Cyanotis vaga* (25µm × 2µm) *Murdannia nudiflora* (13.5µm × 6µm).

In the present study, *Commelina* species showed diversity in ornamentation: echinate in *C. clavata, C. kurzii* and *C. subulata*; microechinate in *C. attenuata* and *C. benghalensis* and granular *C. forskalaei*. In *C. attenuata*, echine is 2.25 µm × 1.5 µm, in *C. clavata* echine is 5µm × 3µm, in *C. kurzii* echine is 2.5µm × 4 µm. In genus *Cyanotis*, except *C. burmanniana* with microreticulate ornamentation, all other species have shown granular ornamentation. Both species of genus *Murdannia* have shown granular ornamentation.

In the genus *Commelina, C. clavata* and *C. kurzii* have shown spheroidal shape with 100 P/E value having same polar axis and equatorial axis (P: 52.5-54, E: 52.5-54) values. Shape is prolate in remaining four species of the genus. Polar axis, equatorial axis values has been presented in Table 1 for all the four species. In genus *Cyanotis, C. burmanniana* has shown suboblate shape with 86 P/E value. All other 5
Table 1: Pollen morphology of selected species of Commelinaceae (Polar axis (P) and equatorial diameter (E) measurements (in µm) and shape of pollen grains).

| Name of the plant                  | P   | E   | P/E | Shape       | Aperture          | Ornamentation |
|------------------------------------|-----|-----|-----|-------------|-------------------|---------------|
| Commelina attenuata                | 45-46.5 | 30-32 | 150 | Prolate     | Monosulcate       | Microechinate |
| Commelina benghalensis             | 24-26 | 13.5-17 | 177 | Prolate     | Monosulcate       | Microechinate |
| Commelina clavata                  | 52.5-54 | 52.5-54 | 100 | Spheroidal  | Monosulcate       | Echiniate     |
| Commelina forskalaei               | 22.5-24.5 | 13.5-15 | 166 | Prolate     | Monosulcate       | Granular      |
| Commelina kurzii                   | 52.5-54 | 52.5-54 | 100 | Spheroidal  | Monosulcate       | Echiniate     |
| Commelina subulata                 | 46.5-48 | 34.5-36 | 134 | Prolate     | Monosulcate       | Echiniate     |
| Cyanotis arachnoidea               | 24-26 | 16.5-17 | 145 | Prolate     | Monosulcate       | Granular      |
| Cyanotis australis                 | 31.5-32 | 15-16 | 210 | Perprolate  | Monosulcate       | Granular      |
| Cyanotis burmanniana               | 28.5-29 | 33-34 | 86  | Suboblate   | Monosulcate       | Microreticulate |
| Cyanotis cristata                  | 22.5-24 | 13.5-14 | 166 | Prolate     | Monosulcate       | Granular      |
| Cyanotis fasciculata               | 24-26 | 15-16 | 160 | Prolate     | Monosulcate       | Granular      |
| Cyanotis vagia                     | 30-32 | 16.5-17.5 | 181 | Prolate     | Monosulcate       | Granular      |
| Cyanotis villosa                   | 23.5-25 | 14.5-16 | 167 | Prolate     | Monosulcate       | Granular      |
| Murdannia nimmoniana               | 33-34 | 16.5-17 | 200 | Perprolate  | Monosulcate       | Granular      |
| Murdannia nudiflora                | 24-26 | 18-20 | 133 | Prolate     | Monosulcate       | Granular      |

Species has shown prolate shape except perprolate shape in *C. axillaris*. In *Murdannia nodiflora* the shape is prolate with P/E value 133µm and in *M. nimmoniana* it is perprolate with 200 P/E value.

Pollen morphology of certain species of *Cyanotis* has been recorded by Poole and Hunt (1980). Accordingly, the pollen is highly variable in tribe Tradescantieae and pollen variation is can be seen to a limited extent within the genera. The present study also registered differences among the *Cyanotis* species. The results observed in the present study supports the findings of Seema et al., (1994) who worked on 25 monocotyledonous species and reported members of Commelinaceae have uniform pollen types.

CONCLUSION

The pollen morphology of recorded 15 species of 3 genera collected from Andhra Pradesh was studied and identified stenopalynous condition of monosulcate and heteropolar as common character. These pollen have prolate has predominant condition and followed by perprolate, spheroidal and Suboblate. These data is useful for further authentic identification of pollen taxa belong to Commelinaceae family.

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APPENDIX-1

1. *Commelina attenuata* K.D. Koenig ex Vahl-S. K. University campus, B. Ravi Prasad Rao and S. Salamma, 51291, 20 August 2016 (SKU).
2. *Commelina benghalensis* L.-Samathamagram, B. Ravi Prasad Rao and M Anil Kumar, 48317, 13 September 2014 (SKU).
3. *Commelina clavata* C.B. Clarke-Forest near RJUKT, Vempally, S. Salamma and M Chennakesavulu Naik, 47414, 12 November 2013 (SKU).
4. *Commelina forskalaei* Vahl-S. K. University campus, B. Ravi Prasad Rao and S. Salamma, 51292, 20 August 2016 (SKU).
5. *Commelina kurzii* C. B. Clarke-Horsley Hills, Chittoor (AP)- B. Ravi Prasad Rao and S. Salamma, 52082, 25 September 2016 (SKU).
6. *Commelina subulata* Roth-Horsley hills, Chittoor (AP) - B. Ravi Prasad Rao and S. Salamma, 52072, 25 September 2016 (SKU).
7. *Cyanotis arachnoidea* C. B. Clarke- Horsley hills, Chittoor (AP), B. Ravi Prasad Rao and S. Salamma, 52081, 25 September 2016 (SKU).
8. *Cyanotis axillaris* (L.) D. Don ex Sweet, Samathamagram- B. Ravi Prasad Raoand S. Salamma, 52085, 25 September 2016 (SKU).
9. *Cyanotis burmanniana* Wight-Tyda forest, B. Ravi Prasad Rao and P. Anjineyulu, 52527, 29 November 2016 (SKU).
10. *Cyanotis cristata* (L.) D. Don-Horsley hills, Chittoor (AP)- B. Ravi Prasad Rao and M. Chennakesavulu Naik, 51342, 21 August 2016 (SKU).
11. *Cyanotis fasiculata* (B. Heyne ex Roth) Schult. and Schult.f.-Horsley hills, Chittoor (AP)- B. Ravi Prasad Rao and S. Salamma, 52083, 25 September 2016 (SKU).
12. *Cyanotis vaga* (Loureiro) Schult. and Schult.f. Horsley hills, Chittoor (AP)- B. Ravi Prasad Rao and S. Salamma, 52073, 25 September 2016 (SKU).
13. *Cyanotis villosa* (Spreng.) Schult. and Schult.f.- Horsley hills, Chittoor (AP)- B. Ravi Prasad Raoand S. Salamma, 52074, 25 September 2016 (SKU).
14. *Murdannia nimmoniana* (J. Graham) S.M. Almeida-Horsley hills, Chittoor (AP)-B. Ravi Prasad Rao and S. Salamma, 52080, 25 September 2016 (SKU).
15. *Murdannia nudiflora* (L.) Brenan- Horsley hills, Chittoor (AP)-B. Ravi Prasad Rao and S. Salamma, 52076, 25 September 2016 (SKU).
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