ISSN 0376-5156
Geophytology 51(1&2): 109–120
August 2022

Pollen morphology of selected species, endemic to Andaman and Nicobar Islands, India

Mudavath C. Naik[1], Ram B. Yadav[2], Jangam G. Kailas[3], Hari Ramakrishna[4] and Lal J. Singh[5*]

[1, 5*]Botanical Survey of India, Andaman & Nicobar Regional Centre, Port Blair–744102, India. E-mail: [1]chenna.lilly@gmail.com, [5*]laljisingh1970@rediffmail.com
[2]Department of Botany, Janta Mahavidyalaya Ajitmal, Auraiya–206121, India. E-mail: rbyadavjmv@gmail.com
[3, 4]Department of Botany, University College of Science, Osmania University, Hyderabad–500007, India. E-mail: [3]jgkbotany@gmail.com, [4]hrkpaleobot@gmail.com
*Corresponding Author

Manuscript received: 20 January 2022
Accepted for publication: 22 April 2022

ABSTRACT

Naik M.C., Yadav R.B., Kailas J.G., Ramakrishna H. & Singh L.J. 2022. Pollen morphology of selected species, endemic to Andaman and Nicobar Islands, India. Geophytology 51(1&2): 109–120.

In the present study, palynological properties of 41 taxa, collected from the Andaman and Nicobar Islands, are presented for the first time. These taxa, belonging to 39 genera and 26 families, are native of these islands. The pollen grains exhibit wide range of variation in size, shape, symmetry, aperture and ornamentation. These have diversity in shapes, viz. spheroidal, peroblate, oblate, prolate-spheroidal, prolate, subprolate and perprolate and sizes are in the range P: 10–78 µm in polar axis and E: 10–78 µm in equatorial axis. Sixteen pollen taxa have radial symmetry and remaining twenty-five pollen taxa have bilateral symmetry. The amb varies from circular to elliptic and triangular. The monosulcate condition was recorded in *Annonaceae*, *Icacinaceae*, *Musaceae*, *Orchidaceae* and *Poaceae*. Out of 4 species having triporate pollen, three species (*Cleistanthus andamanicus, Canthium gracilipes* and *Pseudodiplospora andamanica*) exhibit reticulate exine ornamentation whereas *Carissa andamanensis* pollen are psilate. Nine families were identified as having tricolporate pollen. These are *Anacardiaceae*, *Araliaceae*, *Clusiaceae*, *Fabaceae*, *Lythraceae*, *Orchidaceae, Rubiaceae*, *Rutaceae* and *Sapotaceae*. *Glochidion calocarpum* and *Hiptagetho thathri* were recorded as pantoporate. Hexacolporate pollen were found in *Strobilanthus glandulosus*. Inaperturate pollen were recorded in *Myristica andamanica* and *Maesa andamanica*. Among all the recorded apertural characters, striacolporate pollen taxa show predominance. Psilate pollen are dominantly recorded. This study furnished palynological data of endemic species contributing to future palynotaxonomic and evolutionary studies.

Keywords: Endangered, Endemic, Palynotaxonomy, Phylogenetic significance Threatened taxa.

INTRODUCTION

Except for a few notable exceptions (Singh et al. 2010, Kailas et al. 2016, Naik et al. 2016, 2017, Singh 2017, Singh & Misra 2017, 2020), pollen morphology of majority of the plants of Andaman & Nicobar Islands (ANI) has not been studied in detail and studies employing endemic plants have been few. The earlier studies mainly focused on taxonomic significance of palynological characters (Erdtman 1952, 1969, Walker & Walker 1984, Wei & Wu 1993). Pollen morphology of endemic cycads of the Andaman & Nicobar Islands are has been published by Singh (2017) and Singh &

Misra (2017, 2020). Vegetation of the ANI has been recorded by various workers (Singh et al. 2014, 2020a, b, 2021a, b, Naik et al. 2020, Singh & Misra 2020, Singh & Ranjan 2021). The Islands are well known for the tropical lowland rainforests with rare and unique flora that evolved through millions of years due to the physical isolation between the Islands and also from the neighboring continental landmasses (Oldham 1885, Pandey & Diwakar 2008, Singh et al. 2014, 2021b). ANIs are a phytogeographically important group of 572 Islands, constitute one of the hotspots of biodiversity. The plant diversity of Andaman group of islands exhibits general affinities towards the taxa of South East Asia and mainland India while those of the Nicobar Islands towards the taxa of Malaysia (Wallich 1850, Kurz 1870,1876, Balakrishnan 1989, Pandey & Diwakar 2008, Singh et al. (2014, 2021a, b). The Andaman group of Islands is separated from Nicobar group of Islands by 10º channel, a wide gap of 160 km with heavy tidal flows, making sea difficult for transportation. The degree of endemism among all vascular plants in the ANI's is high and is estimated to be ca 10 % of the total flora (Singh et al. 2014, 2021a, b). The endemic taxa comprise 432 species belonging to 196 genera under 81 families of angiosperms in the Islands (Singh et al. 2021a, b). Here, micromorphological features of the pollen grains of 41 endangered, endemic and threatened (EET) species are examined in detail based on fresh pollen. Our aim is to contribute to a clearer understanding of the pollen features of the EET taxa and to acquire further evidence that can be used to assess the phylogenetic significance of pollen micro-morphological features.

STUDY AREA

Plant samples were collected from Andaman group of Islands, which comprises 324 Islands. The climate is warm and humid with the temperature ranging between 22°C and 30°C, average annual rainfall of 3000 to 3500 mm and mean relative humidity 82 to 85%. Andaman Islands forest cover is 82.28% of the total geographical area (FSI, 2015). Fifteen Islands were recognized in the study area, South Andaman: Alexandra, North Cinque, South Cinque, Jolly Buoy, Havelock, Little Andaman, Neil, Outram, North Sentinal, Red Skin, Ross, Rutland, Sentinels, Sir William Peel Island, and Tarmugli. Different types of forests met with south Andaman Islands are: Andaman tropical evergreen forest, Southern hilltop tropical evergreen forest, Andaman semi-evergreen forest, Andaman moist deciduous forest, Littoral forest, Mangrove forest, and scrub.

MATERIALS AND METHODS

Fresh pollen grains were collected from mature stamens before anthesis during field surveys conducted between of 2013–2019 in Andaman group of Islands. Most specimens came from plants growing in the natural habitat of the Andaman group of Islands. To verify the identity of the selected species, we undertook critical analysis of morphological characters by comparing the herbarium specimens housed at CAL & PBL and relevant literature were also consulted. At least 20 grains were observed for each species, with light microscopy. For light microscopy (LM), the fresh grains were acetolyzed and mounted in glycerine jelly (Erdtman 1960). These permanent pollen slides were deposited in Palaeobotany-Palynology Research lab, Department of Botany, University College of Science, Saifabad, Osmania University, Hyderabad. The terminology used in the description of pollen is in accordance with Erdtman (1952).

Field work: The field explorations have conducted between 2013 to 2019 and pollen material of 41 EET taxa belonging to 39.genera of 26 families were collected in different seasons from various localities in the Andaman group of Islands (Figure 1).

Laboratory work: The collected pollen specimens of the different endemic plants were fixed in the glacial acetic acid solution and processed by the technique described by Erdtman (1960). The acotolysis mixture was prepared by adding acetic anhydride and concentrated sulphuric acid in 9:1 ratio. After completing the process of Acetolysis pollen grains were mounted in the glycerin jelly for microscopic

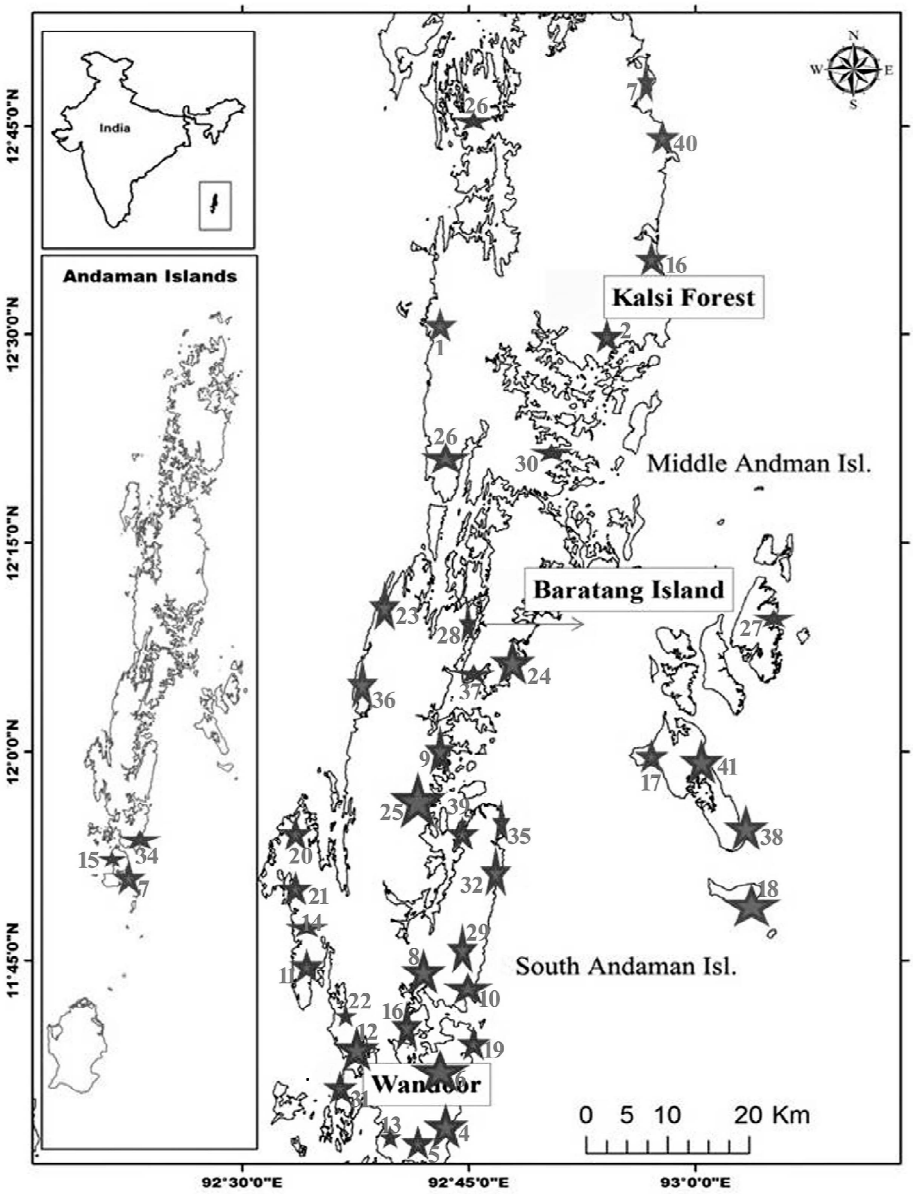

Figure 1. Localities of endemic species described in the present study. 1.Kausalya Nagar, 2. Panchavati, 3. Rutland Island, 4, 5. Munda Pahad, 6. Wandoor, 7. Mayabunder, 8. Portman Bay, 9. Kyd Island, 10. Mount Harriet, 11. Herbeta bad, 12. Bada Balu, 13. Malay Island, 14. Mile Tilek, 15. Woodmanson Bay, 16. Shivapuram, 17. Radha Nagar, 18. Neil Island, 19. Chidiya Tapu, 20. Jirkatang, 21. Mile Tilak, 22. Bada Balu, 23. Breakfast Bay, 24. Jarawa Reserve, 25. Jarwa Reserve, 26. Kadamtala, 27. Henry Lawrence Island, 28. Sundar Garh, 29. Ferrer Ganj, 30. Uttar Jetty, 31. Redskin Island, 32. Madhuban, 33. Bada Balu, 34. Chidia Tapu, 35. Shoal Bay, 36. Birplap Bay, 37. Middle Strait, 38. Havelock Island, 39. Anderson Island, 40. Nimbudera, 41. Havelock Island

observations under light microscope. Pollen size, P/E ×100, using the length of polar axis (P) and the equatorial diameter axis (E) was measured from multiple pollen grains per taxon. The description of pollen morphology was done according to the terminology of Punt et al. (2007). The permanent pollen preparations were submitted to the Palynology Research Laboratory, Department of Botany, University college of Botany, Osmania University, Hyderabad, India by one of us (JGK).

Identification of the species: Herbarium specimens (CAL, PBL) were thoroughly exam-ined and relevant literature was consulted to identify of the species.

ANDAMAN ENDEMIC POLLEN MORPHOLOGY

1. *Artabotrys nicobarianus* D. Das (*Annonaceae*)

Figure 2.1

Bilateral. Pollen grains are prolate, P.A. 22.5–24 µm, E.A.. 18–19 µm, aperture monosulcate. Heteropolar. Exine 2–3 µm thick, sexine thick 2 µm, nexine thin 1–1.5 µm. Echinate.

2. *Bambusa schizostachyoides* Kurz ex Gamble (*Poaceae*)

Figure 2.2

Bilateral. Pollen grains are spheroidal, P.A. 30–32 µm, E.A.. 30–32 µm, circular to ellipsoid, aperture monosulcate. Heteropolar. Exine 2 µm thick, sexine as thick as nexine. Psilate.

3. *Brassaiopsis andamanica* R.N. Banerjee (*Araliaceae*)

Figure 2.3

Radial. Spheroidal, P.A. 22.5–25 µm, E.A. 22.5–25. µm. Amb triangular, tricolporate, colpi long, tips acute, ora elliptic. Isopolar. Exine 1.5–2 µm thick, sexine 1.5. µm thick, nexine 1 µm thin. Reticulate.

4. *Canthium gracilipes* Kurz (*Rubiaceae*)

Figure 2.4–5

Bilateral. Oblate, P.A. 28.5–30, E.A. 45–47 µm. Amb triangular 30–32 µm, triporate. Isopolar. Exine 2.5 µm thick, sexine thicker than nexine. Reticulate.

5. *Carissa andamanensis* L.J. Singh & Murugan (*Apocynaceae*)

Figure 2.6

Radial. Spheroidal, P.A. 22.5–24 µm, E.A. 22.5–24 µm. Amb circular 22.5–23 µm, triporate, pores circular. Isopolar. Exine 1–2.2 µm thick, sexine thicker than nexine. Psilate.

6. *Cleistanthus andamanicus* N. Balach., Gastmans & Chakrab. (*Phyllanthaceae*)

Figure 2.7–8

Radial. Spheroidal, P.A. 22.5–25 µm, E.A. 22.5–25 µm. Amb circular 22.5–24 µm, triporate. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Reticulate.

7. *Codonacanthus sanjappae* Karthig., Sumathi, Jayanthi & D. Naras. (*Acanthaceae*)

Figure 2.9–10

Bilateral. Oblate, P.A. 22.5–24 µm, E.A.. 30–2 µm. Amb triangular 30–32 µm, tricolpate. Isopolar. Exine 2–2.5 µm thick, sexine 1.5 µm, nexine 1 µm thick. Ornamentation reticulate with heterobaculate, lumia polygonal.

8. *Diploknema butyracea* var. ***andamanensis*** P. Royen (*Sapotaceae*)

Figure 2.11–12

Bilateral. Prolate, P.A. 36–37.5 µm, E.A.. 27–28 µm. Amb circular 27–29 µm, tricolporate, ora circular. Isopolar. Exine 2–3 µm thick, sexine thicker than nexine. Psilate.

9. *Eria andamanica* Hook. f. (*Orchidaceae*)

Figure 2.13

Bilateral. Pollen grains are prolate, P.A. 45–46 µm, E.A.. 25–26 µm, circular to ellipsoid. Aperture monosulcate. Heteropolar. Exine 2–2.6 µm thick, sexine thicker than nexine. Echinate, spines long tips acute, echinae 3 µm height and 0.8 µm at wide.

10. *Garcinia andamanica* King var. ***andamanica*** (*Clusiaceae*)

Figure 2.14

Bilateral. Prolate, P.A. 22.5–25 µm, E.A.. 12–14 µm. Amb circular 18–20 µm, tricolporate, ora elliptic. Isopolar. Exine 1.5 µm thick, sexine as thick as nexine. Granular.

11. *Globba pauciflora* King ex Baker (*Zingiberaceae*)

Figure 2.15–16

Bilateral. Prolate, P.A. 24–25 µm, 16.5–17 µm. Amb triangular 22–24 µm, tricolpate. Isopolar. Exine 2–2.5 µm thick, sexine thicker (1.5 µm) than nexine (1 µm). Reticulate.

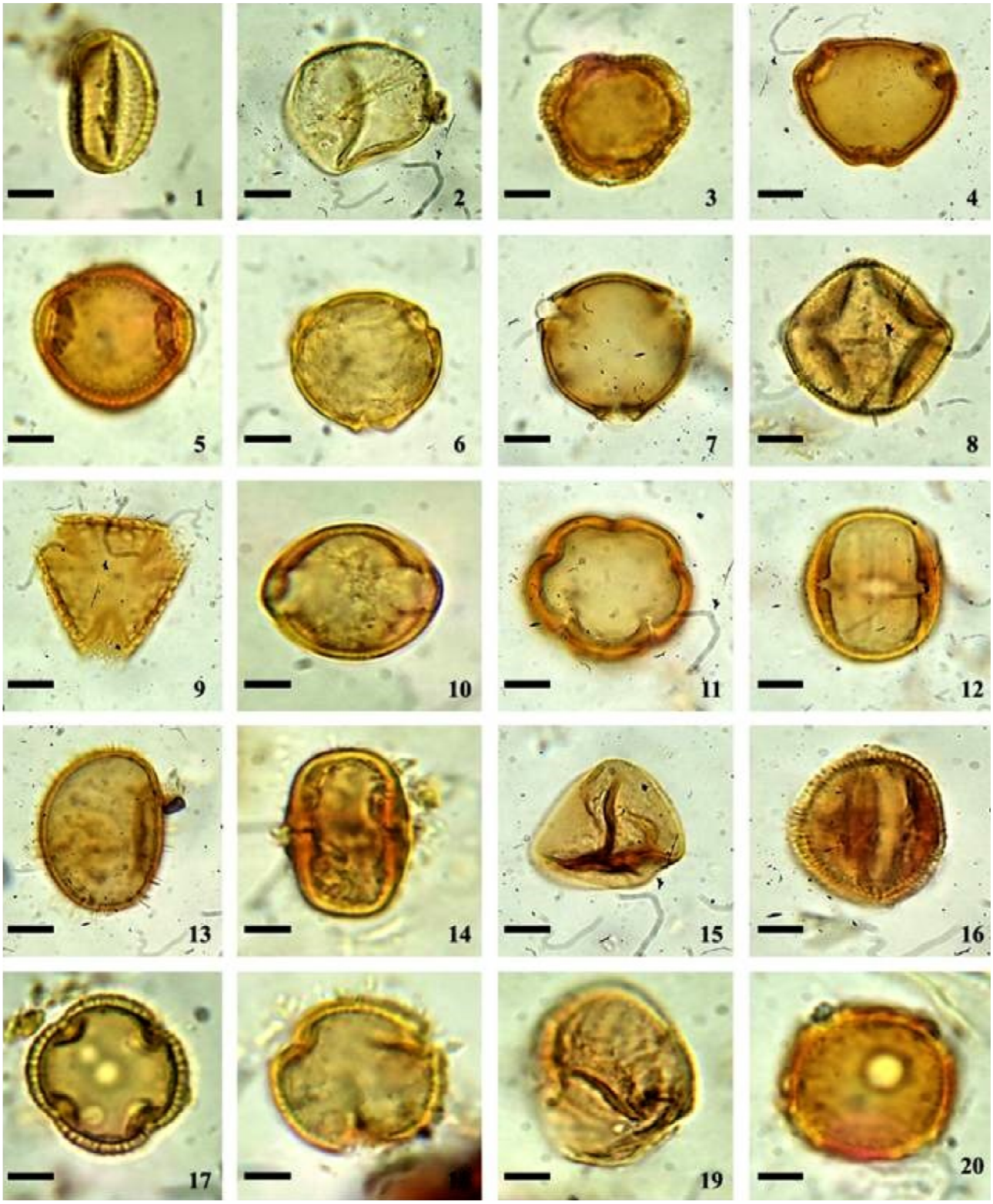

Figure 2. 1. *Artabotrys nicobarianus.* **2.** *Bambusa schizostachyoides*. **3.** *Brassaiopsis andamanica*. **4–5.** *Canthium gracilipes.* **4.** P.V., **5.** E.V. **6.** *Carissa andamanensis.* **7–8.** *Cleistanthus andamanicus.* **7.** P.V., **8.** E.V. **9–10.** *Codonacanthus sanjappae.* **9.** P.V., **10.** E.V. **11–12.** *Diploknema butyracea var. andamanensis.* **11.** P.V., **12.** E.V. **13.** *Eria andamanica*. **14.** *Garcinia andamanica* var. *andamanica.* **15–16.** *Globba pauciflora.* **15.** P.V., **16.** E.V. **17.** *Glochidion calocarpum.* **18.** *Glycosmis mauritiana* var. *andamanensis.* **19.** *Gomphandra comosa.* **20.** *Hiptage thothathri.* Scale Bar = 5 μm.

12. *Glochidion calocarpum* Kurz (*Phyllanthaceae*)

Figure 2.17

Radial. Spheroidal, P.A. 18–20 µm, E.A..18–20 µm. Amb circular 16.5–18 µm, Pantoporate. Isopolar. Exine 1.5–2 µm thick, sexine thicker than nexine. Reticulate.

13. *Glycosmis mauritiana* var. ***andamanensis*** (V. Naray.) B.C. Stone (*Rutaceae*)

Figure 2.18

Radial. Spheroidal, P.A. 16.5–17 µm, E.A.. 16.5–17 µm. Isopolar. Amb triangular 16.5–17 µm, tricolporate, ora circular. Exine 1.5–2.5 µm thick, sexine thicker than nexine. Reticulate.

14. *Gomphandra comosa* King (*Stemonuraceae*)

Figure 2.19

Bilateral. Pollen grains are perprolate, P.A. 45–47 µm, E.A.. 21–22.5 µm. circular to ellipsoidal. Aperture monosulcate. Heteropolar. Exine 2 µm thick, sexine as thick as nexine. Granular.

15. *Hiptage thothathri* Balakr. & R.C. Srivastava (*Malpighiaceae*)

Figure 2.20

Radial. Spheroidal, 22.5–24 µm, 22.5–24 µm. Amb circular 22.5–23 µm, pantoporate, pores circular to elliptic. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Granular.

16. *Ixora andamanensis* Bremek. (*Rubiaceae*)

Figure 3.1–2

Radial. Spheroidal, P.A. 15–16 µm, E.A. 15–16 µm. Amb circular 16.5–18 µm, tricolporate, colpi long margin thick. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Reticulate.

17. *Ixora barbata* Roxb. ex J.E. Sm. (*Rubiaceae*)

Figure 3.3–4

Bilateral. Prolate spheroidal, P.A. 16.5–18 µm. E.A. 15–17 µm. Amb triangular 12–14 µm, tricolporate, colpi long, tips acute, ora circular. Isopolar. Exine 2–2.2 µm thick, sexine thicker than nexine. Reticulate.

18. *Macrosolen andamanensis* L.J. Singh (*Loranthaceae*)

Figure 3.5

Bilateral. Perprolate, P.A. 55.5–58 µm, E.A. 25.5–27 µm. Amb triangular 31.5–33 µm, tricolpate-syncolpate. Isopolar. Exine 1.5–2 µm thick, sexine thicker than nexine. Granular.

19. *Maesa andamanica* Kurz (*Primulaceae*)

Figure 3.6

Radial. Spheroidal, P.A. 45–47 µm, E.A. 45–47 µm. Isopolar. Amb circular 45–47 µm, inaperturate. Exine 2 µm thick, sexine thicker than nexine. Verrucate.

20. *Mangifera andamanica* King (*Anacardiaceae*)

Figure 3.7–8

Radial. Spheroidal, P.A. 13–15 µm. E.A. 13–15 µm. Amb Triangular 30–32 µm, tricolporate, colpi long tips acute, ora lolongate. Isopolar. Exine 1.8 µm thick, sexine as thick as nexine. Psilate.

21. *Marsypopetalum crassum* (R. Parker) B. Xu (*Annonaceae*)

Figure 3.9

Bilateral. Pollen grains are suboblate, P.A. 30–32 µm, E.A. 39–42 µm, ellipsoid. Aperture monosulcate. Heteropolar. Exine 1–1.5 µm thick, sexine as thick as nexine. Psilate.

22. *Macaranga andamanica* Kurz (*Euphorbiaceae*)

Figure 3.10

Oblate, 13.5 µm x 18–19 µm, bilateral isopolar, amb circular 15 µm, tricolporate with annulus colpi thin narrowly elliptic tips acute, ora elongate, exine 1.3 µm thin sexine as thick as nexine, ornamentation psilate.

23. *Myristica andamanica* Hook. f. (*Myristicaceae*)

Figure 3.12

Radial. Spheroidal, P.A. 22.5–24 µm, E.A. 22.5–24 µm. Amb circular 22.5–24 µm. Inaperturate. Isopolar. Exine 2–2.5 µm thick, sexine 1.5 µm thick and nexine 1 µm thin. Echinate.

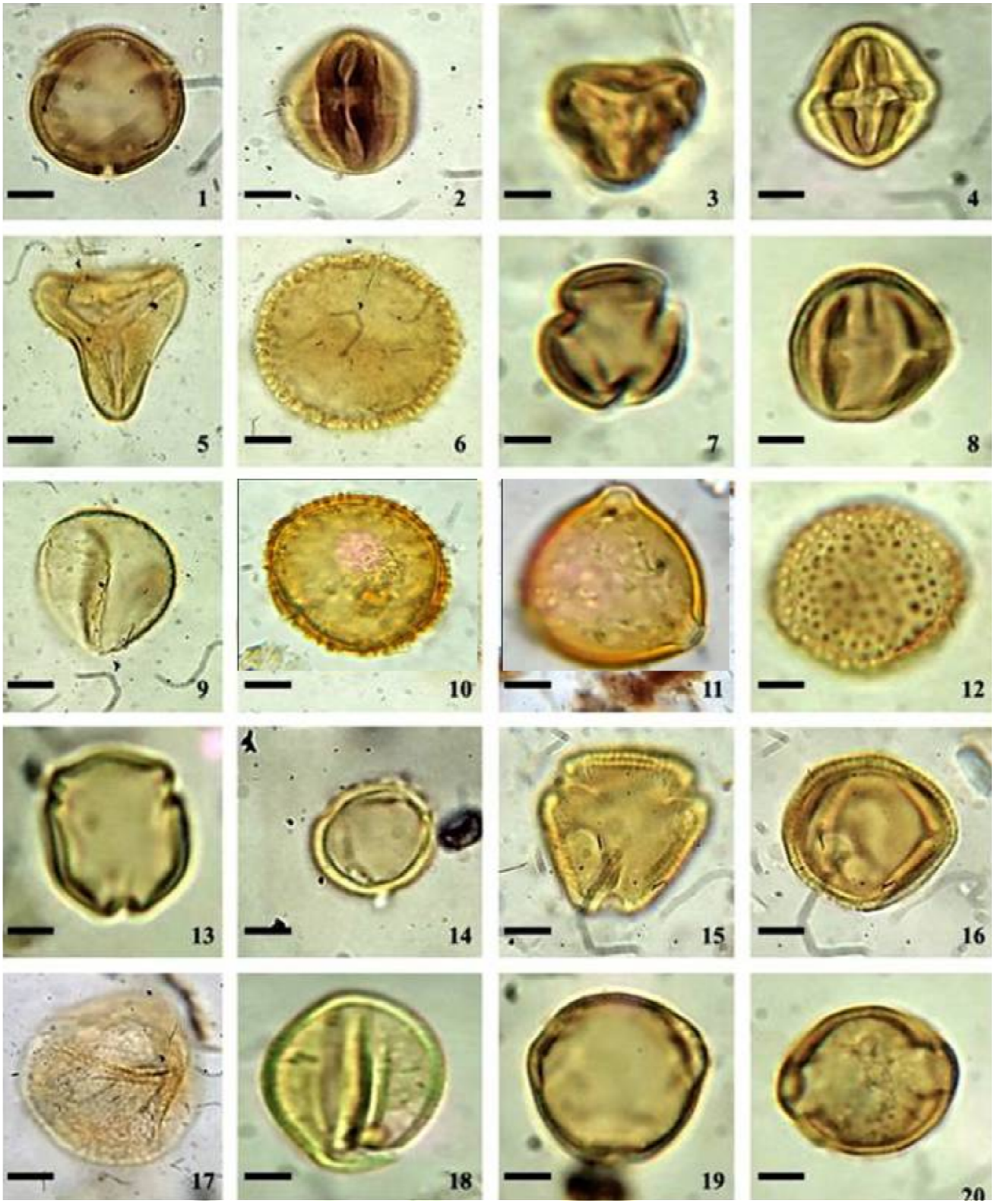

Figure 3. 1–2. *Ixora andamanensis.* **1.** P.V., **2.** E.V. **3–4.** *Ixora barbata.* **3.** P.V., **4.** E.V. **5.** *Macrosolen andamanensis.* **6.** *Maesa andamanica.* **7–8.** *Mangifera andamanica.* **7.** P.V., **8.** E.V. **9.** *Marsypopetalum crassum.* **10.** *Macaranga andamanica.* **11.** *Planchonia andamanica.* **12.** *Myristica andamanica.* **13–14.** *Neonauclea gageana.* **13.** P.V., **14.** (E.V.). **15–16.** *Ophiorrhiza infundibularis.* **15.** P.V., **16.** (E.V.). **17.** *Orophea torulosa.* **18.** *Peristylu sbalakrishnanii.* **19–20.** *Pseudodiplospora andamanica.* **19.** P.V., **20.** E.V. Scale Bar = 5 µm.

24. *Neonauclea gageana* (King) Merr. (*Rubiaceae*)

Figure 3.13–14

Radial. Spheroidal, P.A. 10.5–12 µm, E.A. 10.5–12 µm. Amb triangular 10.5–12 µm, tricolporate. Isopolar. Exine 1–2 µm thick, sexine thicker than nexine. Psilate.

25. *Ophiorrhiza infundibularis* Balakr. (*Rubiaceae*)

Figure 2.15–16

Bilateral. Subprolate, P.A. 21–23 µm, E.A. 16–17.5 µm. Amb triangular 18–20 µm, tricolporate, colpi long, tips acuminate. Isopolar. Exine 1.5–2 µm thick, sexine thicker than nexine. Reticulate.

26. *Orophea torulosa* Hutch. (*Annonaceae*)

Figure 3.17

Bilateral. Pollen grains are prolate spheroidal, P.A. 45–46 µm, E.A. 43.5–44 µm, circular to ellipsoidal. Aperture monosulcate. Heteropolar. Exine 1–1.5 µm thick, sexine as thick as nexine. Granular.

27. *Peristylus balakrishnanii* K. Karthig., R. Sumathi & J. Jayanthi (*Orchidaceae*)

Figure 3.18

Bilateral. Pollen grains are prolate, P.A. 15–16, E.A. 10.5–12 µm, ellipsoidal. Aperture monosulcate. Heteropolar. Exine 2 µm thick, sexine as thick as nexine. Psilate.

28. *Planchonia andamanica* King (*Lecythidaceae*)

Figure 3.11

Spheroidal, 100 µm, radial, isopolar amb circular 4.5 µm, Diporate, exine 1 µm thin sexine as thick as nexine, ornamentation psilate.

29. *Pseudodiplospora andamanica* (Balakr. & N. G. Nair) Deb (*Rubiaceae*)

Figure 3.19–20

Bilateral. Suboblate, P.A. 16.5–18 µm, E.A. 21–23 µm. Amb circular 19.5–21 µm, triporate. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Reticulate.

30. *Pterocarpus dalbergiodes* DC. (*Fabaceae*)

Figure 4.1

Radial. Spheroidal, P.A. 13–14 µm, E.A. 13–14 µm. Amb circular 13.4–14 µm, tricolporate. Isopolar. Exine 1.5–2 µm thick, sexine thicker than nexine. Psilate.

31. *Rotala andamanensis* S.P. Mathew (*Lythraceae*)

Figure 4.2–3

Radial. Spheroidal, 15–17.5 µm, 15–17.5 µm. Amb circular 13.5–15 µm, tricolporate, colpi long thick, tips acute, ora circular. Isopolar. Exine 2–2.2 µm thick, sexine thicker than nexine. Psilate.

32. *Rothmannia pulcherrima* (Kurz) Tirveng. (*Rubiaceae*)

Figure 4.4–5

Bilateral. Prolate, P.A. 22.5–24 µm, E.A. 15–16 µm. Amb circular 22.5–24 µm, tricolporate, ora circular. Isopolar. Exine 2.2–2.5 µm thick, sexine thicker than nexine. Granular.

33. *Scolopia parkinsonii* N. Balach, Gastman & Chakrab. (*Salicaceae*)

Figure 4.6–7

Bilateral. Subprolate, P.A. 15–16 µm, E.A. 12–13.5 µm. Amb circular 15–17 µm, tricolpate, colpi long tips acute. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Reticulate.

34. *Scutellaria andamanica* Prain (*Lamiaceae*)

Figure 4.8–9

Bilateral. Prolate, P.A. 16.5–18 µm, E.A. 11.5–12 µm. Amb circular 16.5–17.5 µm, tricolpate, colpi long, tips acute. Isopolar. Exine 2 µm thick, sexine thicker than nexine. Psilate.

35. *Secamone andamanica* Goel & Vasud**.** (*Apocynaceae*)

Figure 4.10

Radial. Spheroidal, P.A. 22.5–24 µm, E.A. 22.5–24 µm. Isopolar. Amb triangular 22.5–24 µm, tricolpate-syncolpate. Exine 1.5–2 µm thick, sexine thicker than nexine. Psilate.

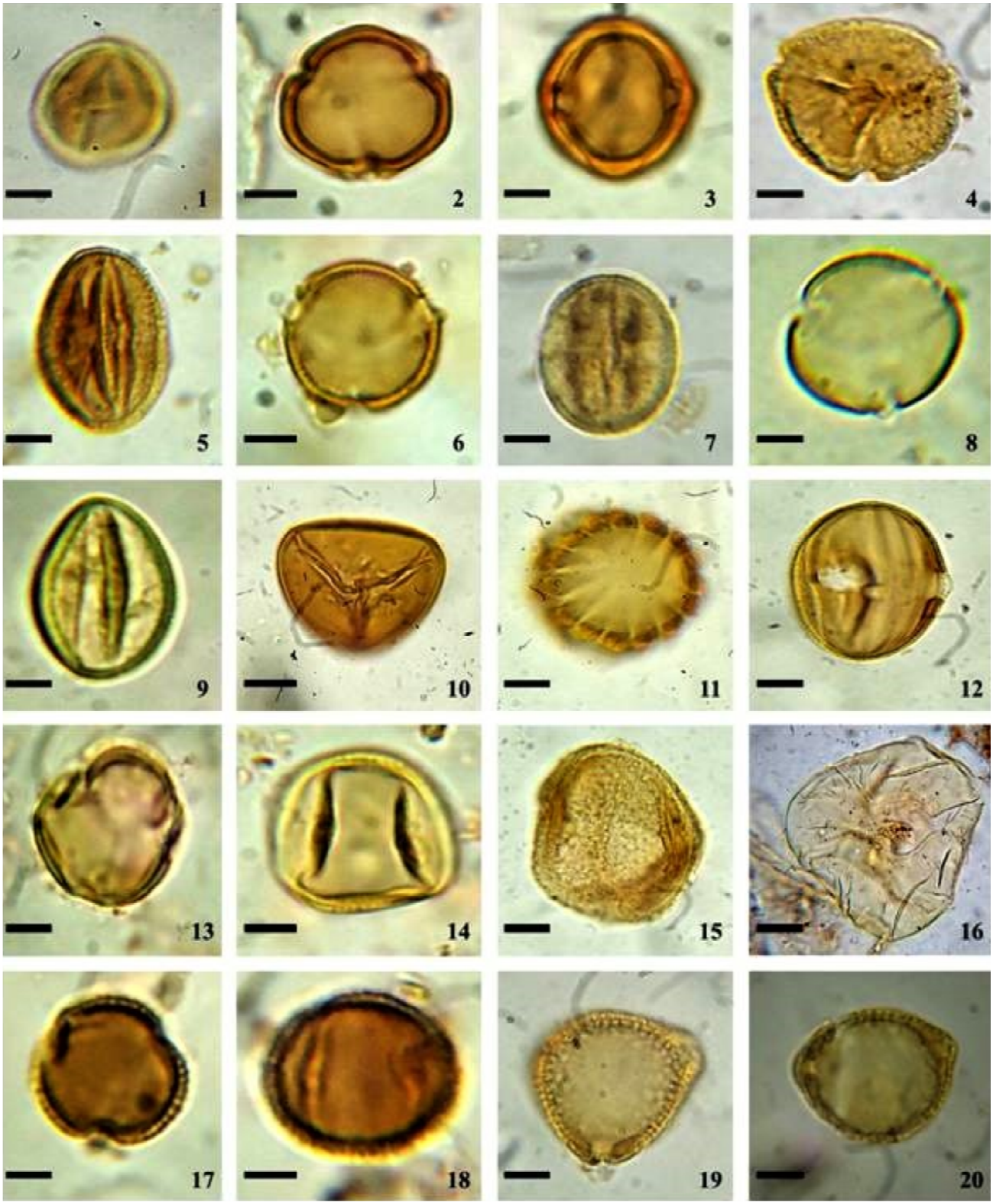

Figure 4. 1. *Pterocarpus dalbergiodes.* **2–3.** *Rotala andamanensis.* **2.** P.V., **3.** E.V. **4–5.** *Rothmannia pulcherrima.* **4.** P.V., **5.** E.V. **6–7.** *Scolopia parkinsonii.* **6.** P.V., **7.** E.V. **8–9.** *Scutellaria andamanica.* **8.** P.V., **9.** E.V.. **10.** *Secamone andamanica.* **11–12.** *Strobilanthes glandulosa.* **11.** P.V., **12.** E.V. **13–14.** *Tetrastigma andamanicum.* **13.** P.V., **14.** E.V.. **15.** *Trigonostemon viridissimus.* **16.** *Vitex diversifolia.* **17–18.** *Wendlandia andamanica.* **17.** P.V., **18.** E.V. **19–20.** *Zeuxine andamanica.* **19.** P.V., **20.** E.V.). Scale Bar = 5 µm.

36. *Strobilanthes glandulosa* Blume (*Acanthaceae*)

Figure 4.11–12

Bilateral. Prolate, P.A. 36–38 µm, E.A. 22.5–24 µm. Amb circular 24–26 µm, hexacolporate. Isopolar. Exine 1.5–2 µm thick, sexine thicker than nexine. Psilate.

37. *Tetrastigma andamanicum* (King) Suesseng. (*Vitaceae*)

Figure 4.13–14

Radial. Spheroidal, P.A. 15–16 µm, E.A. 15–16 µm. Amb circular 15–17 µm, tricolpate. Isopolar. Exine 1–1.5 µm thick, sexine thicker than nexine. Psilate.

38. *Trigonostemon viridissimus* (Kurz) Airy Shaw (*Euphorbiaceae*)

Figure 4.15

Bilateral. Pollen grains are spheroidal, P.A. 45–47 µm, E.A. 45–47 µm, circular to ellipsoid. Heteropolar, aperture monosulcate, Exine 2–2.5 µm thick, sexine thicker than nexine. Granular.

39. *Vitex diversifolia* Kurz ex C.B. Clarke (*Vitaceae*)

Figure 4.16

Bilateral. Prolate, P.A. 22–23 µm, E.A. 15–17 µm. Amb circular 18–20 µm, tricolpate. Isopolar. Exine 1–2 µm thick, sexine thicker than nexine. Reticulate.

40. *Wendlandia andamanica* Cowan (*Rubiaceae*)

Figure 4.17–18

Radial. Spheroidal, P.A. 12–14 µm, E.A. 12–14 µm. Amb circular 13.5–15 µm, tricolpate. Isopolar. Exine 2 µm thick, sexine thicker than nexine. Reticulate.

41. *Zeuxine andamanica* King & Pantl. (*Orchidaceae*)

Figure 4.19–20

Bilateral, Subprolate, P.A. 22.5–24 µm, E.A. 19.5–21 µm. Amb triangular 18–20 µm, tricolporate, colpi long tips acute. Isopolar. Exine 2–2.5 µm thick, sexine thicker than nexine. Reticulate.

DISCUSSION

Pollen morphology of 41 endemic species was studied and considerable variation was recorded in pollen morphological characters. Very few palynological data are available regarding the endemic species of India (Tissot et al. 1994, Singh et al. 2010, Basumatary et al. 2014, Anoop et al. 2016, Balan et al. 2016, Kailas et al. 2016, Murthy & Rajanikanth 2017, Naik et al. 2016, 2017, Singh 2017, Singh & Misra 2017, 2020). The recorded endemic taxa diversified with pollen morphology, i.e. size, shape, symmetry, apertural characters and ornamentation. The pollen grains show both radial and bilateral symmetry. Bilateral pollen is dominated by radial symmetric pollen grains (Figures 2– 4). Among 41 pollen grains, only ten pollen taxa are found as heteropolar condition remaining are isopolar (Figures 2–4). The shapes of recorded pollen are Spheroidal, Prolate spheroidal, Prolate, Subprolate, Perprolate, Peroblate and Oblate based on the P/E×100 values (P=Polar axis diameter and E=Equatorial axis diameter). Among these spheroidal grains are predominantly reordered (Figures 2–4).

The apertures and ornamentation of the pollen grains have an important role in palynotaxanomy. Six types of apertures (monosulcate, triporate, tricolpate, tricolporate, hexacolporate and pantoporate) were recorded from 41 pollen taxa (Figures 2–4). Exine thickness varies from 1µm to 3.5 µm and the exine ornamentation shows significant variation of psilate to echinate, granulate, psilate, reticulate (16) and verrucate (Figures 2–4).

Monosulcate (monocolpus) pollen grains are diversified with shape and ornamentation. Spherodial and granulate are recorded in *Trigonostemon viridissimus*, Prolate spheroidal with granulate found in *Orophea torulosa*. Spheroidal with psilate in *Bambusa schizostachyoides*, *Musa balbisiana, M. sabuana* and *Peristylus balakrishnanii*. Suboblate with psilate in *Marsypopetalum crassum*. Prolate with reticulate in *Artabotrys nicobarianus*. Prolate with echinate found in *Eria andamanica* whereas Perprolate with granular in *Gomphandra comosa*.

All the recorded triporate pollen grains are reticulate except *Carissa andamanensis* (Psilate). Two

pollen are spheroidal (*Canthium gracilipes* and *Cleistanthus andamanicus*), the other two pollen are oblate (*Canthium gracilipes* and *Pseudodiplospora andamanica*).

Of the recorded nine tricolpate pollen, prolate with reticulate is in *Globba pauciflora* and *Vitex diversifolia*, Perprolate with psilate in *Scutellaria andamanica*, Perprolate with granular in *Macrosolen andamanensis*, Subprolate with reticulate in *Scolopia parkinsonii*, Spheroidal with psilate in *Secamone andamanica* and *Tetrastigma andamanicum*, Oblate with reticulate found in *Codonacanthus sanjappae,* whereas Spheroidal with reticulate in *Wendlandia andamanica* were observed.

Among 41 species, tricolporate apertural type is predominantly recorded. In these pollen, diversity in shape and ornamentation is significant. Spheroidal shape and reticulate ornamentation were observed in *Brassaiopsis andamanica, Glycosmis mauritiana, Ixora andamanensis* and Prolate spheroidal with reticulate in *Ixora barbata*. Psilate as in 3 species viz., *Neonauclea gageana, Pterocarpus dalbergioides* and *Rotala andamanensis*. Prolate shape and reticulate ornamentation is found in *Diploknema butyracea*, Prolate with granular in *Garcinia andamanica* and *Rothmannia pulcherrima* and has Subprolate and psilate in *Mangifera andamanica,* Subprolate with reticulate recorded in *Zeuxine andamanica*. Within 41 recorded pollen taxa only one *Strobilanthes andamanensis* recorded as hexacolporate with prolate shape and psilate ornamentation.

Pantoporate with spheroidal pollen were recorded in two species *Glochidion calocarpum* (reticulate) and *Hiptage thothathri* (granular). Whereas in aperturate, spheroidal in *Maesa andamanica* which is verrucate and *Myristica andamanica* with echinate.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. A.A. Mao, Director and Dr. Paramjit Singh, Former Director, Botanical Survey of India for constant support and facilities. Authors are thankful to Dr. R. K. Saxena, Chief Editor, Geophytology and anonymous reviewers for critical comments and suggestions that helped to improve the manuscript. One of the authors (JGK) is grateful to Department of Biotechnology, New Delhi for financial assistance (BT/PR12954/NDB/ 52/146/2009). The authors express their gratitude to the Ministry of Environment, Forests and Climate Change for facilities and Department of Environment and Forests, Andaman and Nicobar Administration for necessary permission and logistic support in conducting field studies. The authors are thankful to scientists and staff of BSI who have always shown readiness for help.

REFERENCES

Balakrishnan N. P. 1989. Andaman Islands –vegetation and floristics. In: Saldanha CJ. (Editor) – Andaman, Nicobar and Lakshadweep: An impact assessment. Oxford and IBH Publishing House, New Delhi, India.

Balan A.P., Udayan P.S. & Predeep S.V. 2016. Pollen morphological studies of 10 endemic legumes from India. International Journal of Advanced Research 4(6): 597–605.

Basumatary S.K., Tripathi S., Bera S.K. & Kumar S. 2014. Pollen morphology of *Nepenthes khasiana* Hook. f. (*Nepenthaceae*), an endemic insectivorous plant from India, Palynology 38(2): 324–333, DOI: 10.1080/01916122.2014.912993

Erdtman G. 1952. Pollen morphology and plant taxonomy – Angiosperms (An Introduction to Palynology I), Almqvist & Wiksell. Stockholm.

Erdtman G. 1960. The acetolysis method. A revised description. Svensk Botanisk Tidskrift 54: 561–564.

Erdtman G. 1969. Handbook of Palynology: Morphology-Taxonomy, Ecology: An introduction to the study of pollen grains and spores. Hafner Publishing Co., New York. 486 pp., 1 foldout.

Kailas J.G., Naik M.C., Bheemalingappa M., Ramakrishna H. & Rao B.R.P. 2016. Arboreal diversity of the Andaman Islands, India, based on pollen analysis, Palynology DOI: 10.1080/01916122.2016.1209592

Kurz S. 1870. Report on the vegetation of the Andaman Islands. Office of the Superintend of Government Printing, Calcutta.

Kurz S. 1876. A sketch of the vegetation of the Nicobar Islands. Journal Asiatic Society Bengal, Pt. 2, Nat. Hist. 45: 105–164.

Murthy S. & Rajanikanth A. 2017. Palynology and palaeoenvironment of late Permian Sawang OCM, East Bokaro Coalfield, Damodar Basin, India. The Palaeobotanist 66: 61–70.

Naik M.C., Kailas J.G., Ramakrishna H. & Rao B.R.P. 2016. Palynodiversity in the climbers of Andaman Islands, India. Indian Journal of Forestry 39(2): 1–8.

Naik M.C., Kailas J.G., Sugali S., Ravula D., Ramakrishna H. & Rao B.R.P. 2017. The non-arboreal diversity of the Andaman Islands, India, based on pollen analysis, Palynology DOI: 10.1080/01916122.2016.1257517.

Naik M.C., Singh L.J. & Ganeshaish K.N. 2020. Floristic diversity and analysis of South Andaman Islands (South Andaman District), Andaman and Nicobar Islands, India. Species 21(68): 343–409.

Oldham R.D. 1885. Note on the geology of Andaman and Nicobar Islands. Records of the Geological Survey of India 8(3): 135–145.

Pandey R.P. & Diwakar P.G. 2008. An integrated check-list of flora of Andaman and Nicobar Islands, India. Journal of Economic Taxonomic Botany 32: 403–500.

Punt W., Hoen P.P., Blackmore S., Nilsson S. & Le Thomas A. 2007. Glossary of pollen and spore terminology. Review of Palaeobotany and Palynology. 143: 1–81.

Singh L.J. 2017. *Cycas dharmrajii* sp. nov. (*Cycadaceae*), a new species from the Andaman Islands, India. Nordic Journal of Botany 35(1): 69–76 https://doi.org/10.1111/njb. 01284

Singh L.J. & Misra D.R. 2017. Identity and status of recently described *Cycas pschannae* (*Cycadaceae*) in the Andaman and Nicobar Islands, India. Bionature 37(1):38–55 https://doi.org/10.1111/njb.01284.

Singh L.J. & Misra D.R. 2020. Reappraisal of the genus *Cycas* L. (*Cycadaceae*) in Andaman and Nicobar Islands, India Indian Journal of Forestry 43: 46–57.

Singh L.J. & Ranjan V. 2021. New Vistas in Indian Flora. Vol. 1 & 2: Bishen Singh Mahendra Pal Singh, Dehra Dun, Uttarakhand, India, pp. 417 & 819.

Singh L.J., Gautam A.E., Mishra S., Vivek C.P., Shiva Shankar V., Naik M.C. & Saleem F. 2020a. Habitat status of *Musa paramjitiana* L.J. Singh (*Musaceae*): a critically endangered, endemic species in Andaman and Nicobar Islands, India Pleione 14(1): 121–127.

Singh L.J., Dwivedi M.D., Kasana S., Naik M.C., Ekka G.A. & Pandey A.K. 2020b. Molecular systematics of the genus Musa L. (*Zingiberales*: *Musaceae*) in Andaman and Nicobar Islands Biologia https://doi.org/10.2478/s11756–020–00552–5.

Singh L.J., Ekka G.A., Vivek C.P. & Misra D.R. 2021a. Gymnosperms of the Andaman and Nicobar Islands: An overview. In: Singh L.J. & Ranjan V. (Editors) – New Vistas in Indian Flora. Bishen Singh Mahendra Pal Singh, Dehra Dun, India 1: 265–278.

Singh L.J., Murugan C. & Singh P. 2014. Plant genetic diversity of endemic species in the Andaman and Nicobar Islands. In: National Conference on Islands Biodiversity, U.P. State Board Biodiversity Board, Lucknow, pp 49–57.

Singh L.J., Ranjan V., Sinha B.K., Mishra S., Purohit C.S., Vivek C.P., Naik M.C. & Ekka G.A. 2021b. An Overview of Phytodiversity of the Andaman and Nicobar Islands, India. In: Singh L.J. & Ranjan V. (Editors), New Vistas in Indian Flora. Bishen Singh Mahendra Pal Singh Dehra Dun, India 2: 381–399.

Singh S., Kar R. & Khandelwal A. 2010. Impact on modern pollen grain studies from South and Little Andaman Islands, India, to interpret present and past vegetation. Current Science 99(9): 1251–1256.

Tissot C., Chikhi H. & Nair T.S. 1994. Pollen of wet evergreen forests of the Western Ghats of India. French Institute, Pondicherry. pp 30–31.

Walker J.W. & Walker A.G. 1984. Ultrastructure of Lower Cretaceous angiosperm pollen and the origin and early evolution of flowering plants. Annals of the Missouri Botanical Garden 71: 464–521.

Wallich N. 1850. "Remarks on the flora of the Nicobar Islands (Translated from Commodore Steen Bille's Beretming Corvetten Galathea's Reise Omkring Jordon)". Hooker's Journal of Botany 2: 1–11.

Wei Z.X. & Wu Z.Y. 1993. Pollen ultrastructure of Liriodendron and its systematic significance. Acta Bot. Yunnan 15: 163–166.