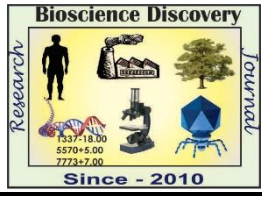
Print & Online, Open Access, Research Journal Available on http://jbsd.in
ISSN: 2229-3469 (Print); ISSN: 2231-024X (Online)
Research Article



Palynomorphic studies on the pteridophytes of Kolli Hills, Eastern Ghats, Tamil Nadu

P. Vijayakanth*, S. Sahaya Sathish, R. Palani, T. Thamizharasi and A. Vimala

Centre for Cryptogamic Studies, Department of Botany, St. Joseph's College (Autonomous), Tiruchirappalli- 620002, Tamil Nadu
*Email: apvijayakanth@gmail.com

Article Info

Received: 25-08-2017,
Revised: 29-09-2017,
Accepted: 01-10-2017

Keywords:
Eastern Ghats, Kolli Hills, Morphological patterns, Palynology, Pteridophytes spores,

Abstract

In the present study a total of 275 samples were collected from Kolli Hills of Eastern Ghats, Tamil Nadu. Out of which, 41 species under 29 genera belonging to 14 families were identified. In the present study the morphological characters of pteridophytes spores were analysed. The size, shape, colour and surface pattern of spores were studied. Among the homosporous typed two types of spores such as monolete and trilete were found. The spore colours are brown, dark brown and yellow. The spore size ranges from 27 × 32 µ to 580 × 588 µ. The largest spore is found in *Selaginella wightii*. The spores observed were showed different surface patterns such as reticulate, granulose, verrucate, psilate, rugulate, cristate, echinate, tuberculate and different shapes such as tetrahedral, globose, ellipsoidal and spherical. Most of the spores are ellipsoidal and tetrahedral shape with reticulate and granulose elements on the surface.

INTRODUCTION

Pteridophytes, the seedless vascular plants characterised with independent heteromorphic alternation of generation and primitive vasculature are very conspicuous and elegant elements of the present-day flora. Pteridophytes are an important component of the flora of the major region of species-diversity. More than 1200 species of ferns and fern allies have reported from India. Ferns and fern allies are fascinating group of Pteridophytes; this is almost distributed in Himalaya, Western Ghats, and Eastern Ghats (Patil *et al.,* 2016; Dudani *et al.*, 2014; Parashurama *et al.,* 2016; Chowdhury *et al.,* 2016). Spores are taxonomical markers in deducing phylogenetic relationship amongst species. The morphological data of spores may be useful for palynologists and for allergic studies. The spore characteristics were useful to differentiate some genera and compared to other spore-bearing vascular plants (Gamal, 2012). Spore also involving in dispersal of the plants. Very small spore travel to long distances there by well distributed in the pteridophytes species. The spores are classified into homosporous and heterosporous (Devi, 1977). In general, the spores are monolete (a single laesura) and trilete (three laesura) but in some species intermediate spore types also found (Nampy and Madhusoodanan, 1998). The most significant work in the field of palynology of pteridophyte was published by Erdtman (1945, 1957). Palynology data are very useful for taxonomic purposes at all level of fern family and it is below (Yea *et al.*, 2000). Hence the present study aims of to determine spores size, shape, surface and colour of pteridophytes of Kolli Hills.

MATERIALS AND METHODS

The Kolli Hills are a part of the Eastern Ghats, which is a mountain range that runs almost parallel to the east coast of Tamil Nadu. Kolli Hills are located in Namakkal district of Tamil Nadu. It extends to an area of about 418 Km^2 between $11^0$10'00" – $11^0$30'00" N latitude and $78^0$15'00" - $78^0$30'00" E longitude (Figure 1). Its elevation ranges from 700-1600 m. The vegetation is prominently dry deciduous with patches of moist deciduous and semi-evergreen forests. Foot hills have dry deciduous shrub forests. Taxonomic surveys and field visits were conducted periodically from July 2015 to September 2016. Merely 41 species of pteridophyte flora under 29 genera of 14 families were identified from the collected samples of 275 (Table 1). The fern spores were collected from living plants growing in the field. Spores were washed with 95% alcohol and mounted in glycerin and observed in light microscope (Erdtman, 1952, 1957).

For measuring size, the spores are selected at random, taking particular care that personal preference of the observer does not prejudice the selection. Abnormal and underdeveloped spores, whenever found are omitted. All the measurement were made using micrometry with light Microscope (10X). The size of the spores was measured by calculating mean averages of a minimum of 10 readings of each sample, by the formula length of the Polar axis (P) × Equatorial axis (E) (Devi, 1977; Elzbieta, 2012) (Figure 4. n). Palynological terminology is used to describe the characters of spore (Punt *et al.*, 2007). According to Erdtman (1957), the spores are categorized into the following based on their sizes: very small < 10 µ, small 10-25µ, medium 25- 50µ, large 50-100µ, very large 100-200µ, and gigantic > 200µ. The entire specimens were observed and photographs were taken on an Olympus-CX21 Research Microscope under 40X and 100X magnification.

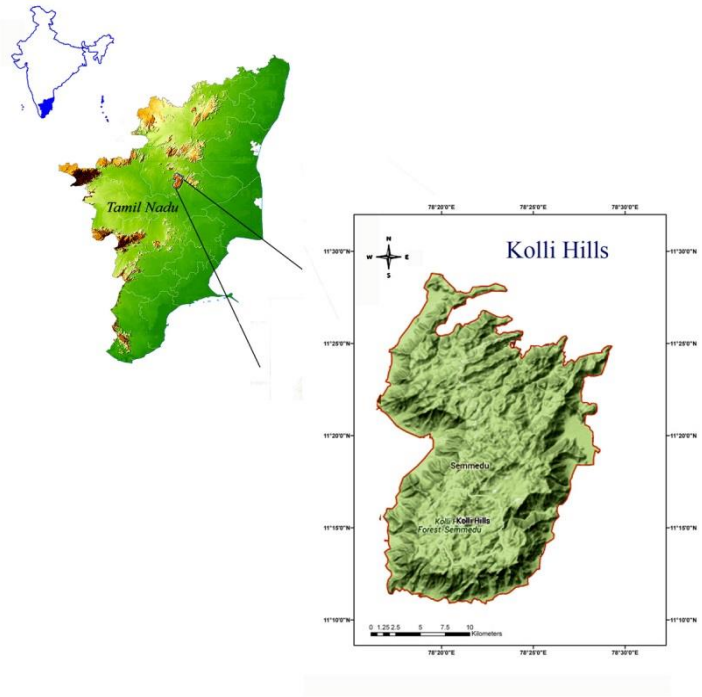


Figure 1. Map of the study area - Kolli Hills.

RESULTS AND DISCUSSION

The spore morphology of pteridophytes species was investigated. The 41 species of pteridophytes spores is divided in to two types such as monolete and trilete. *Selaginella* genus was found in microspore and megaspore. Monolete spore was found in 22 species and trilete spores are found in 19 species. The trilete spores have radial symmetry and were flat or convex at the distal face, while monolete, ellipsoidal or reniform and elliptic spore have bilateral symmetry. Spore generally ranges between 27 × 32 to 580 × 588 µ and the largest spore is found in *Selaginella wightii* (580 × 588 µ) (Table 1).

Among the 22 monolete spores, 17 are ellipsoidal in shape, 4 elliptic in shapes and spherical shape in one species ic., *Athyrium parasnathense* (Figure 4. b). The colour of the spores is brown, yellow and dark brown except of the yellowish brown colour of *Blechnum orientale* (Figure 3. o). Most of the trilete spores were tetrahedral in shape (11 species), 6 species are globose and two are spherical such as *Abrodictyum obscurum* and *Crepidomanes latealatum* (Figure 2. e & f). These trilete spores were different in color like brown, dark brown, greenish brown, greenish yellow, light brown, pale yellow, reddish brown, whitish brown, whitish yellow, yellowish brown and dark green.

The near threatened taxa *Lindsaea malabarica* was with trilete spores, tetrahedral in shape, medium size with brown colour and exine granulose, perinous non - visible (Figure 2. i). The rare species *Polystichum squarrosum* has monolete type, ellipsoidal shape, brown colour and granulose surface, perine folded into irregular thin lobate ridges (Figure 4. g.). The maximum spore's surfaces were granulose (15 species) and remaining spores were irregular granulose, gemmate, ornamented, perforate, psilate, reticulate, rugulate, spinulose, tuberculate, vermiculate and verrucate (Figure 5.). *Crepidomanes latealatum* is specific character of granulose with papillae (Figure 2. f.). In spores surface is found to be vermiculate within the granulose (*Cyclosorus dentatus)* (Figure 3. k.) and *Dryopteris cochleata* spores are granulose with anastomosed and heavily thickened perispore.

10 spores were perinous remaining 33 spores is non- perinous. The perispore are closely adhering with loose folds with brown, red, yellow and light brown in colour. Among the 10 perinous spores 9 were monolete-perinous and one is trilete-perinous (*Selaginella wightii*). These perinous spores were smooth with light brown. The characters of the spores suggest that they possess an important significant phylogenic value at the species level particularly in ornamentation and structure of the perispores (Moran *et al.*, 2007, 2010). Some spores belonging to some species were interesting and have attractive surfaces viz., *Lygodium microphyllum*, *Azolla pinnata*, *Polystichum squarrosum* and *Pteris vittata*. The characters of the spores suggest that they possess an important value at the specific levels particularly in ornamentation (Yea *et al.*, 2000; Vijayakanth and Sahaya Sathish 2016). The structures of the perispores also vary considerably among the species studied.

Table 1. Morphological characters of the spores of pteridophytes of Kolli Hills.

S. No	Taxon	Type/Shape/Colour	Size (µ) P/E	Surfaces
	Selaginellaceae			
1.	*Selaginella repanda*	Trilete/Globose/Reddish brown	41 × 41 µ (Medium)	Verrucate
		Trilete/Globose/Greenish brown*****	492 × 537 µ (Gigantic)	Psilate
2.	*S. wightii*	Trilete/Globose/Yellowish brown	44 × 47 µ (Medium)	Granulose with perinous
		Trilete/Globose/Reddish brown*****	580 × 588 µ (Gigantic)	Vermiculate
	Hymenophyllaceae			
3.	*Abrodictyum obscurum*	Trilete/Spheroidal/Dark green	32 × 36 µ (Medium)	Granulose
4.	*Crepidomanes latealatum*	Trilete/Spheroidal/ Greenish yellow	37 × 43 µ (Medium)	Granulose with papillae
	Lygodiaceae			
5.	*Lygodium microphyllum*	Trilete/Globose /Whitish brown	64 × 70 µ (Large)	Ornamented

	Cyatheaceae			
6.	*Cyathea nilgirensis*	Trilete/Tetrahedral/Light brown	32 × 36 µ (Medium)	Granulose or Psilate
	Lindsaeaceae			
7.	*Lindsaea malabarica*	Trilete/Globose/Light brown	27 × 32 µ (Medium)	Granulose
8.	*Odontosoria chinensis*	Monolete/Ellipsoidal/Dark brown	34 × 49 µ (Medium)	Granulose
	Pteridaceae			
9.	*Actiniopteris radiata*	Trilete/Tetrahedral/Pale yellow	55 × 59 µ (Large)	Rugulate
10.	*Adiantum hispidulum*	Trilete/Tetrahedral/Brown	40 × 47 µ (Medium)	Granulose or Tuberculate
11.	*A. incisum*	Trilete/Tetrahedral/Dark brown	29 × 34 µ (Medium)	Granulose
12.	*A. philippense*	Trilete/Tetrahedral/Reddish brown	42 × 50 µ (Large)	Irregular granulose
13.	*Antrophyum plantagineum*	Trilete/Tetrahedral/Whitish yellow	43 × 50 µ (Large)	Tuberculate
14.	*Cheilanthes tenuifolia*	Trilete/Tetrahedral/Dark brown	46 × 49 µ (Medium)	Spinulose
15.	*C. farinosa*	Trilete/Globose/Brown	36 × 36 µ (Medium)	Spinulose
16.	*C. viridis*	Trilete/Globose/Brown	53 × 67 µ (Large)	Spinulose or Echinate
17.	*Parahemionitis cordata*	Trilete/Tetrahedral/Brown	43 × 55 µ (Large)	Reticulate
18.	*Pellaea boivinii*	Trilete/Tetrahedral/Reddish brown	50 × 55 µ (Large)	Granulose
19.	*Pteris vittata*	Trilete/Tetrahedral/Yellowish brown	49 × 58 µ (Large)	Rugulate
20.	*Vittaria elongata*	Monolete/Ellipsoidal/Yellow	37 × 70 µ (Large)	Gemmate
	Aspleniaceae			
21.	*Asplenium crinicaule*	Monolete/Ellipsoidal/Brown	39 × 58 µ (Large)	Reticulate with perinous
22.	*A. normale*	Monolete/Ellipsoidal/Brown	27 × 41 µ (Medium)	Spinulose with perinous
23.	*A. obscurum*	Monolete/Elliptic/Brown	48 × 52 µ (Large)	Reticulate with perinous
	Thelypteridaceae			
24.	*Cyclosorus dentatus*	Monolete/Ellipsoidal/Dark brown	27 × 41 µ (Medium)	Reticulate
25.	*C. interruptus*	Monolete/Ellipsoidal/Brown	35 × 47 µ (Medium)	Vermiculate
26.	*C. papilio*	Monolete/Ellipsoidal/Brown	30 × 49 µ (Medium)	Vermiculate
27.	*Trigonospora caudipinna*	Trilete/Tetrahedral/Reddish brown	49 × 49 µ (Medium)	Granulose

	Blechnaceae			
28.	*Blechnum orientale*	Monolete/Ellipsoidal/Yellow	29 × 38 µ (Medium)	Psilate
	Athyriaceae			
29.	*Athyrium hohenackerianum*	Monolete/Ellipsoidal/Brown	40 × 47 µ (Medium)	Granulose with perinous
30.	*A. parasnathense*	Monolete/Spherical/Brown	41 × 43 µ (Medium)	Psilate with perinous
31.	*A. schimperi*	Monolete/Elliptic/Brown	43 × 43 µ (Medium)	Psilate with perinous
32.	*Deparia petersenii*	Monolete/Elliptic/Brown	39 × 47 µ (Medium)	Spinulose
	Dryopteridaceae			
33.	*Dryopteris cochleata*	Monolete/Elliptic/Brown	38 × 46 µ (Medium)	Granulose with perinous
34.	*D. sparsa*	Monolete/Ellipsoidal/Brown	43 × 46 µ (Medium)	Granulose with perinous
35.	*Polystichum squarrosum*	Monolete/Ellipsoidal/Brown	55 × 61 µ (Large)	Reticulate
	Tectariaceae			
36.	*Tectaria wightii*	Monolete/Ellipsoidal/Brown	35 × 45 µ (Medium)	Spinulose or Verrucate
	Davalliaceae			
37.	*Davallodes pulchra*	Monolete/Ellipsoidal/Yellow	34 × 50 µ (Large)	Verrucate or Reticulate
	Polypodiaceae			
38.	*Lepisorus nudus*	Monolete/Ellipsoidal/Yellow	54 × 75 µ (Large)	Perforate
39.	*Microsorum punctatum*	Monolete/Ellipsoidal/Brown	45 × 63 µ (Large)	Tuberculate
40.	*Phymatosorus membranifolium*	Monolete/Ellipsoidal/Yellow	30 × 44 µ (Medium)	Psilate
41.	*Pyrrosia porosa*	Monolete/Ellipsoidal/Yellow	63 × 89 µ (Large)	Verrucate or Granulose

*** Megaspores**

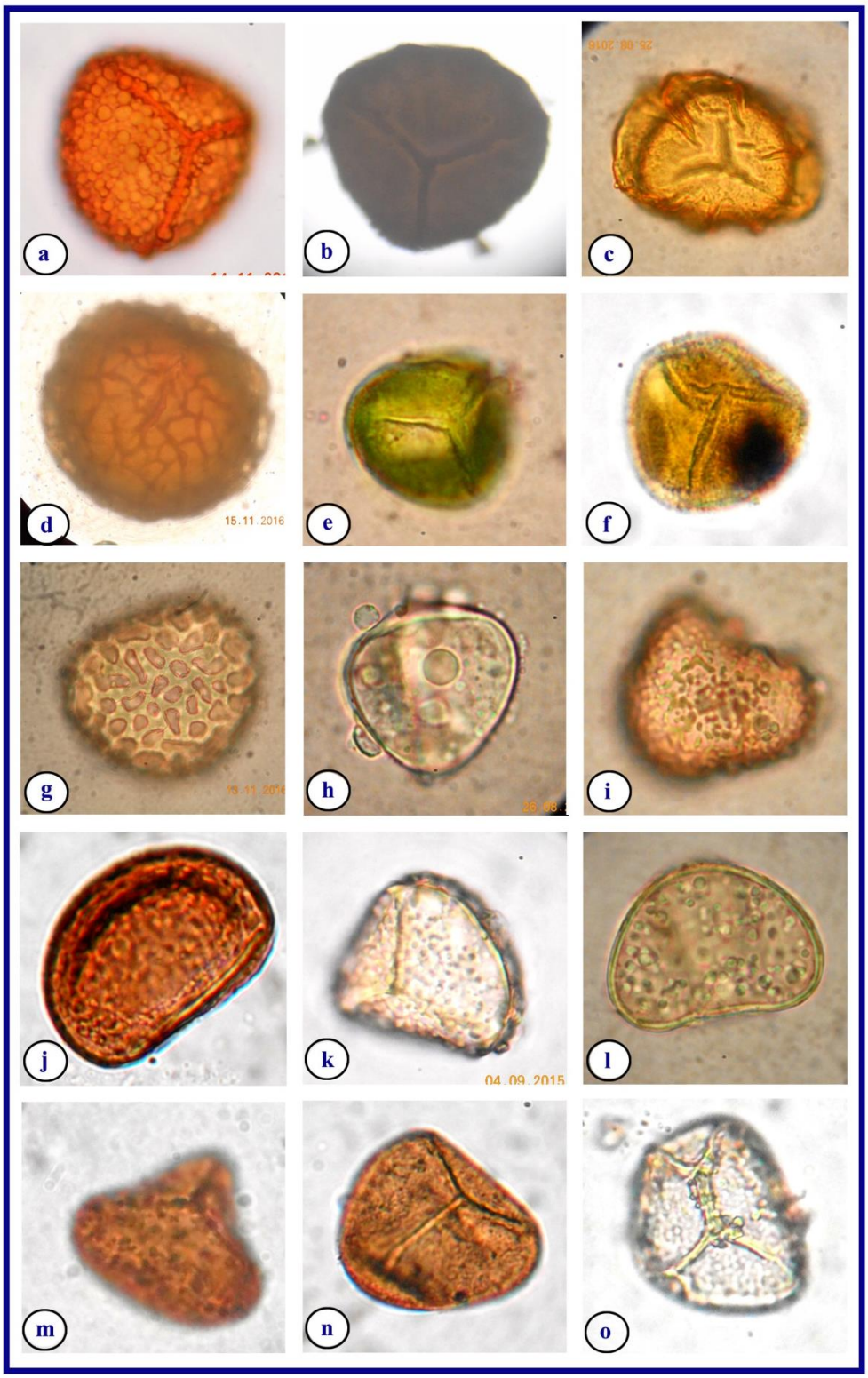


Figure 2. a. *Selaginella repanda* (microspore), b. *S. repanda* (megaspore), c. *S. wightii* (microspore), d. *S. wightii* (megaspore), e. *Abrodictyum obscurum*, f. *Crepidomanes latealatum*, g. *Lygodium microphyllum*, h. *Cyathea nilgirensis*, i. *Lindsaea malabarica*, j. *Odontosoria chinensis*, k. *Actiniopteris radiata*, l. *Adiantum hispidulum*, m. *A. incisum*, n. *A. philippense*, o. *Antrophyum plantagineum.*

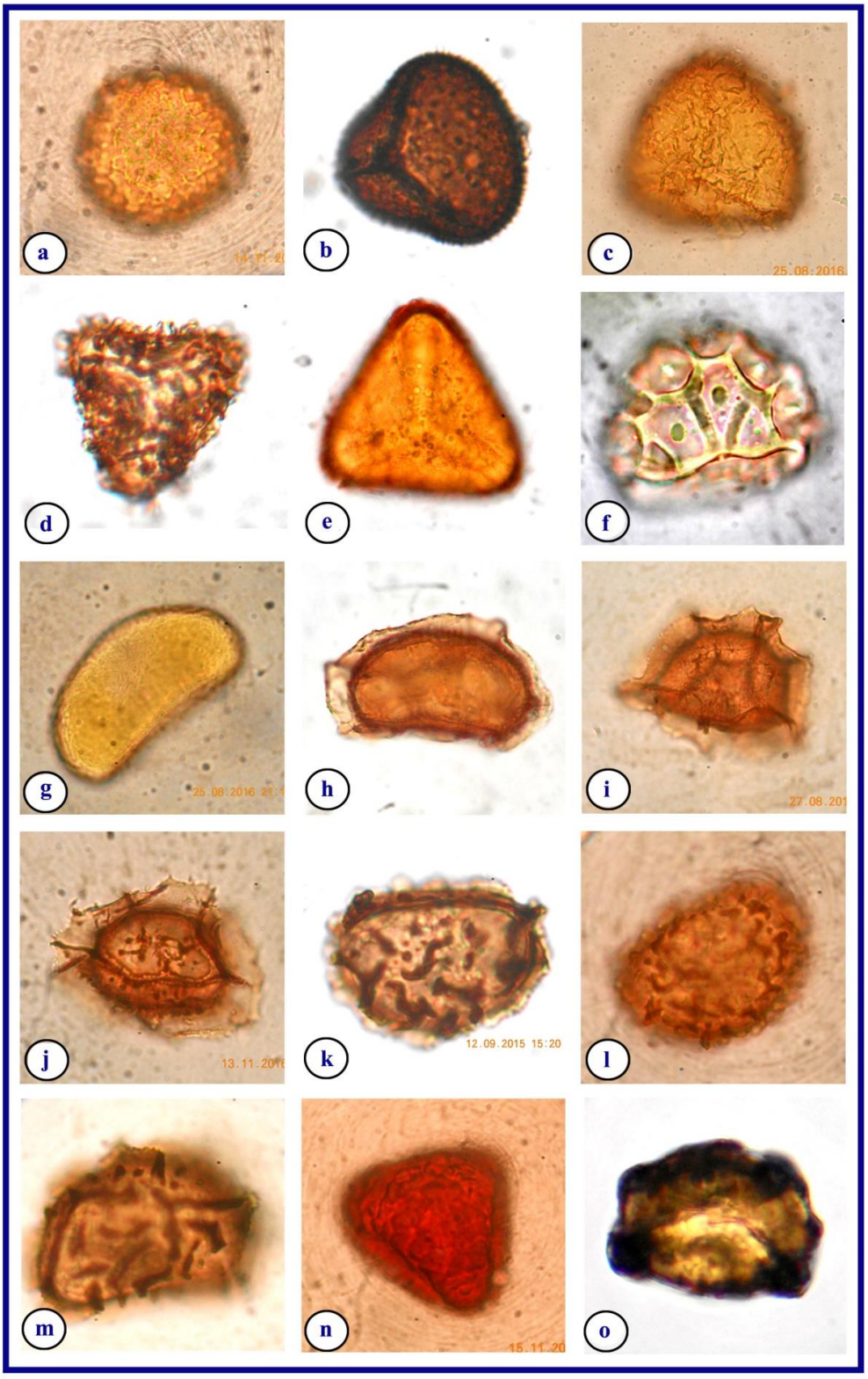


Figure 3. a. *Cheilanthes tenuifolia*, b. *C. farinosa*, c. *C. viridis*, d. *Parahemionitis cordata*, e. *Pellaea boivinii*, f. *Pteris vittata*, g. *Vittaria elongata*, h. *Asplenium crinicaule*, i. *A. normale*, j. *A. obscurum*, k. *Cyclosorus dentatus*, l. *C. interruptus*, m. *C. papilio*, n. *Trigonospora caudipinna*, o. *Blechnum orientale.*

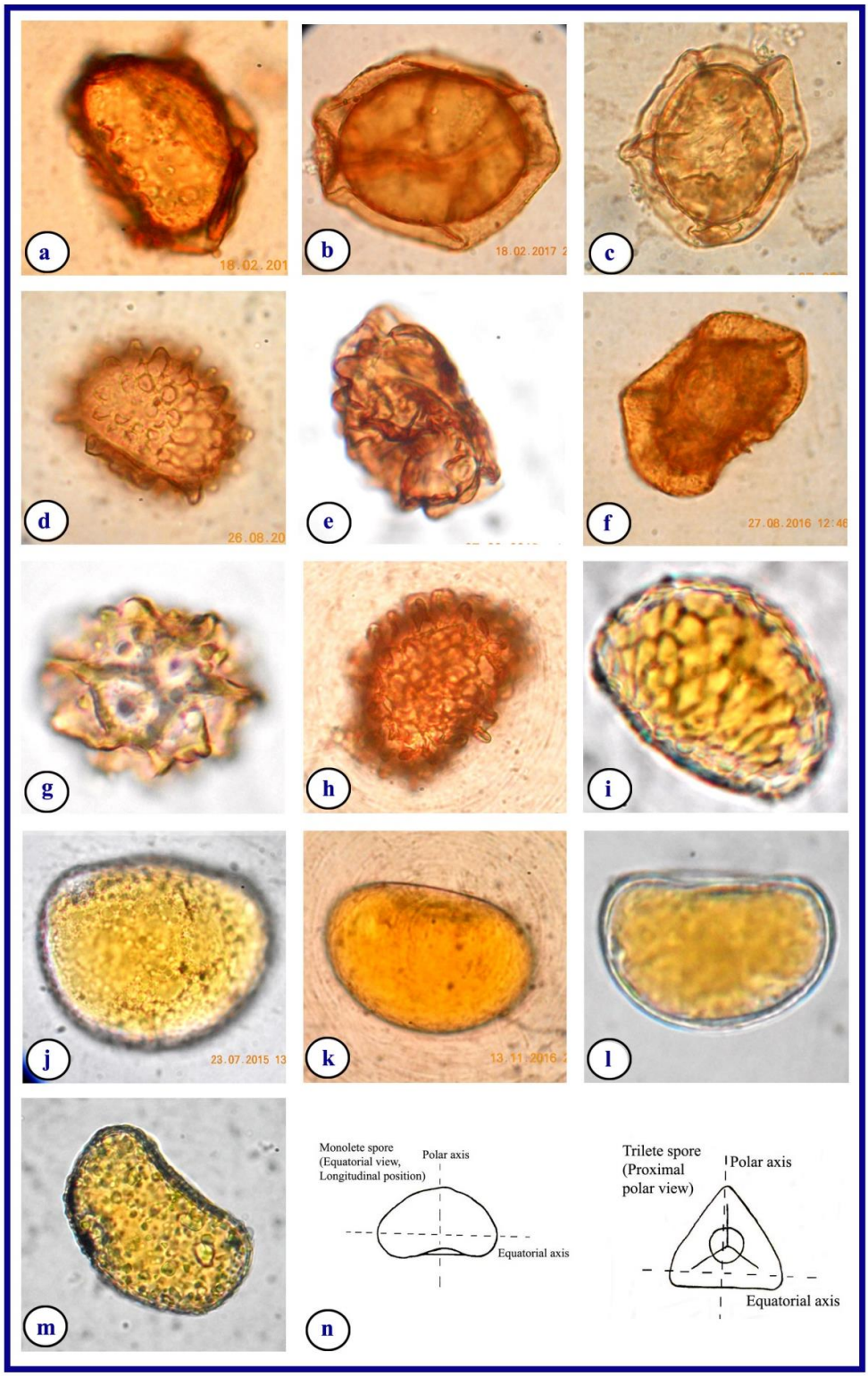


Figure 4. a. *Athyrium hohenackerianum*, b. *A. parasnathense*, c. *A. schimperi*, d. *Deparia petersenii*, e. *Dryopteris cochleata*, f. *D. sparsa*, g. *Polystichum squarrosum*, h. *Tectaria wightii*, i. *Davallodes pulchra*, j. *Lepisorus nudus*, k. *Microsorum punctatum*, l. *Phymatosorus membranifolium*, m. *Pyrrosia porosa*, n. measurement of monolete and trilete spore.

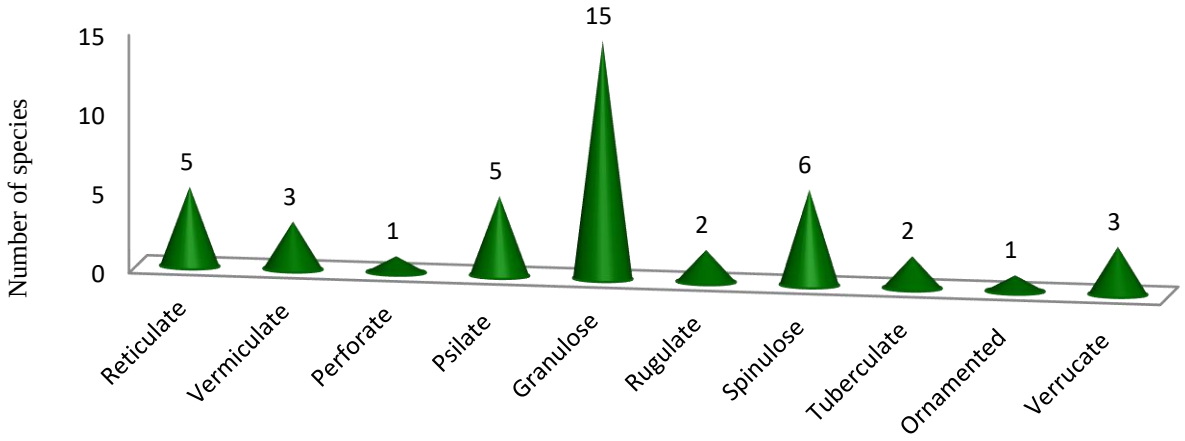


Figure 5. Types of surface in pteridophytes.

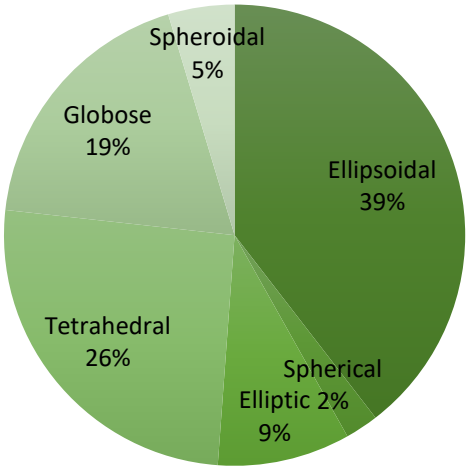


Figure 6. Types of shapes in pteridophytes.

The spore morphology of 41 species of pteridophyte from Kolli Hills was described. The spore sizes were medium in 25 species, large in 9 species and gigantic in one species. The spore size ranges from 27 × 32 µ to 580 × 588 µ. The largest spore is found in *Selaginella wightii*. Spores colour were commonly brown, dark brown and yellow. Some were slightly reddish brown, whitish brown, yellowish brown, greenish yellow and white. The spore surface patterns were reticulate, granulose, verrucate, psilate, rugulate, cristate, echinate and tuberculate. Some of the spores were granulose with papillae and vermiculate with granulose. The spores have a perine but in some group of genera the perine is reduced and eventually lost. The spore characters are considered together with morphological features of the sporophytes they become useful complementary tool that could lead to the establishment of more natural group in the genus. Spore morphology would be very useful in solving the pending problems of taxonomy, phylogeny and phytogeography.

ACKNOWLEDGEMENT

The authors are thankful to Dr. V. Irudayaraj, Department of Plant Biology and Plant Biotechnology, St. Xavier's College (Autonomous), Palayamkottai, Tirunelveli for conformation of the specimens.

REFERENCES

Barrington DS, Paris CA and Ranker TA, 1986. Systematic inferences from spore and stomata size in the ferns. *American Fern Journal,* **76**:149-159.

Chowdhury A, Sarkar S and Chowdhury M. 2016. Diversity, Ecology and Utilization of Tea Garden Pteridophytes at Duars in West Bengal, India, *International Research Journal of Biological Sciences,* **5**(1): 47-53.

Devi S, 1977. *Spore in Indian fern,* Todays and Tomorrows Printers and Publications. New Delhi, Pp 1-228.

Dudani SN, Mahesh MK, Subash Chandran MD and Ramachandra TV. 2014. Pteridophyte diversity in wet evergreen forests of Sakleshpur in Central Western Ghats, *Indian Journal of Plant Sciences,* **3**(1): 28-39.

Elzbieta Z, 2012. Morphology and peculiar features of spores of fern species occurring in Poland. *Acta Agrobotanica*, **65**(2):3-10.

Erdtman G, 1945. *Pollen morphology and plant taxonomy. III Morin L., with an addition on pollen-morphological terminology,* Sven Bot Tidskr, Pp 279-285.

Erdtman G, 1957. *Pollen and spore morphology and plant taxonomy: Gymnospermae, Pteridophyta, Bryophyta. Illustrations,* Stockholm : Almqvist & Wiksell, New York, Pp 1-151.

Erdtman, G. 1952. *Pollen morphology and plant taxonomy. Angiosperms,* Stockholm : Almqvist & Wiksell ; Waltham, Mass, Chronica Botanica Co, Pp 1-539.

Gamal MA Lashin, 2012. Palynological studies of some species of Aspleniaceae-Pteridophyta. *American Journal of Plant Sciences,* **3**:397-402.

Manickam VS and Irudayaraj V, 1992. *Pteridophyte flora of the Western Ghats-South India,* B I Publications, New Delhi, Pp 1-653.

Manickam VS, 1986. *Fern flora of Palni hills (South India),* Today and Tomorrow Printers and Publishers, New Delhi, Pp 1-187.

Moran RC, Hanks JG and Rouhan G. 2007. Spore morphology in relation to phylogeny in the fern genus *Elaphoglossum* (Dryopteridaceae). *International Research Journal of Plant Sciences,* **168**: 905-929.

Moran RC, Hanks JG, Labiak P and Sundue M. 2010. Perispore morphology of Bolbitidoid ferns (Dryopteridaceae) in relation to phylogeny. *International Journal of Plant Sciences,* **171**: 872-881.

Nampy S and Madhusoodanan PV, 1998. *Fern flora of South India,* Daya publishing house. New Delhi, Pp 1-130.

Parashurama TR, Deepa J and Prakash K. 2016. Pteridophyte diversity in Mudigere Taluk, Central Western Ghats, Karnataka, *International Journal of Current Research,* **8**(10): 40339-40342

Patil S, Lavate L, Rawat R and Dongare M. 2016. Diversity and distribution of pteridophytes from Satara District, Maharashtra (India). *Plant Science Today,* **3**(2): 149-156.

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

Vijayakanth, P and Sahaya Sathish, S. 2016. Studies on the spore morphology of pteridophytes from Kolli hills, Eastern Ghats, Tamil Nadu, India. *International Journal of Research in Engineering and Bioscience,* **4**(1): 1 - 12.

Yea CL, Chen MK and Ho YL, 2000. SEM studies on spore in Taiwanese fern genera *I. Athyrioids*. *Taiwania,* **45**(2): 181-200.

How to cite this article

P. Vijayakanth, S. Sahaya Sathish, R. Palani, T. Thamizharasi and A. Vimala, 2017. Palynomorphic studies on the pteridophytes of Kolli Hills, Eastern Ghats, Tamil Nadu. *Bioscience Discovery*, **8**(4):752-761.