

Short Communication: Morpho-palynological study of the endemic species *Sarcopyramis subramanii* (Melastomataceae) from Northeast India

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Manuscript received: 7 July 2025. Revision accepted: 11 January 2026.

Abstract. Das B, Nath N. 2026. Short Communication: Morpho-palynological study of the endemic species *Sarcopyramis subramanii* (Melastomataceae) from Northeast India. *Biodiversitas* 27 (1): d270105. <https://doi.org/10.13057/biodiv/d270105>. The family Melastomataceae is known for its diplostemonous flowers and appendaged anther connectives. *Sarcopyramis* is a very small genus within this family with only four accepted taxa across the world. The structure of the calyx apex plays a vital role in differentiating the taxa under this genus. *Sarcopyramis subramanii* is an endemic plant from northeast India, and has not been studied in detail. This plant was misidentified as *S. napalensis*, a morphologically similar plant, for a long time. This study aimed to analyze the detailed taxonomic aspects along with palynological features using SEM microscopy to facilitate the adequate identification of this lesser-known species. Plant samples have been collected from three different locations in Assam, northeast India. Photographs of habit, floral parts, and SEM images of pollens are included here for proper validation. The pollen of *S. subramanii* is prolate-spheroidal in shape with colpate and colpate apertures. From the palynological data, these two species can be easily distinguished as the pollens of *S. subramanii* possess an outgrowth structure in the colpi. The P/E ratio of *S. subramanii* is 1.06, whereas *S. napalensis* is 1.63. The plant should be conserved due to the ongoing rapid habitat destruction, as it has a limited geographical range and a very small population.

Keywords: Endemic, Melastomataceae, northeast India, pollen, *Sarcopyramis subramanii*

INTRODUCTION

The family Melastomataceae is distributed mainly in the tropical and subtropical regions of the world (Christenhusz and Byng 2016). The family comprises about 170 genera and 5400 species of the New World (Renner 1993; Conti et al. 1997; Stone 2006; Caetano et al. 2018). This family shows diversity in terms of habit, reproductive and vegetative architecture. The members can be identified by the presence of diplostemonous flowers and prolonged appendaged anther connectives. In the absence of flowers, the members can be recognized by their leaves, which have acrodromous venation and lack stipules. Melastomataceae possess notable taxonomic value due to their morphological variability and complex evolutionary lineage. Most members of Melastomataceae play a significant role in the ecosystem. The flowers are rich in nectar and attract a wide range of pollinators; birds and other animals consume the fruits. According to Melo et al. (2021), Melastomataceae has the largest radiation of buzz-pollinated flowers. In nectarless flowers of Melastomataceae, passerine birds visit the flowers to feed on nutritive staminal parts, thereby facilitating pollination (Dellinger et al. 2014). The family is well studied for floral evolution (Gavrutenko et al. 2020; Melo et al. 2021), pollination biology (Dellinger et al. 2021, 2022) and coevolution (Stein and Tobe 1989; Stiles and Rosselli 1993). Among the accepted genera within the family, *Sarcopyramis* is a relatively small genus, comprising only four recognized species distributed globally.

The genus *Sarcopyramis* is native to tropical and subtropical Asia, including India (POWO 2025). The genus *Sarcopyramis* is placed under the tribe Sonerileae (Renner 1993). The members of the tribe Sonerileae can be recognized by the presence of capsules with a crown, axillary placentas and non-cochleate seeds (Liu et al. 2022). The tribe comprises 44 genera with 1080 species found to grow in humid habitats, including forest beds, mountain slopes, river banks, stream sides, and even as epiphytes on trees (Ulloa Ulloa et al. 2022). In India, three taxa of *Sarcopyramis* have been reported so far, i.e., *Sarcopyramis napalensis* var. *napalensis* Wall., *S. napalensis* var. *bodinieri* (H.Lév.) H.Lév., and *Sarcopyramis subramanii* M.P.Nayar (Debta et al. 2022). In the 'Flora of Assam', only *S. napalensis* is reported under the genus (Kanjilal 1940). *S. subramanii* has been recently rediscovered from the Ultapani Forest (Chirang District), Assam, after 94 years from the first collection of its type specimen by MP Nayar (Basumatary and Baruah 2021).

Palynological studies on taxa within Melastomataceae have been conducted by many workers over time, including Erdtman (1952), Nair (1965), Huang (1972), and Patel et al. (1984). Patel et al. (1984) studied 19 genera and reported that the pollen was isopolar, tricolpate, and monads; they also classified the pollen into three groups. Chantaranonthai (1997) reported the pollens of Melastomataceae members in Thailand and divided them into five groups.

During the present floristic survey, *Sarcopyramis* samples were collected from different parts of Assam, NE India. After consulting relevant literature, the specimens were identified as *S. subramanii*, and new distributional areas were recorded in several locations, including West Karbi Anglong, Kakoi Reserve Forest (Lakhimpur), and Dihing Patkai (Dibrugarh). In all distributional areas, the species were found to grow along stream banks and on the forest floor of moist evergreen forests. This species is very similar to the other known member, *S. napalensis*, found in NE India. However, careful observation of floral and other vegetative features allows them to be differentiated into two species.

So far, *S. subramanii* has been reported from the Lushai Hills of Mizoram and Assam (Basumatary and Baruah 2021), which makes the species an endemic to NE India. The species has not yet been included in the IUCN Red List. Endemic species are bioindicators of environmental change, indicating their ecological significance. Despite its importance, *S. subramanii* remains understudied and unexplored by the scientific community. No palynological study has been conducted to date on this species of Melastomataceae. Therefore, this work aimed to analyze the morphological and palynological features of the lesser-known *S. subramanii*.

MATERIALS AND METHODS

Study area and collection site

Samples were collected from three different locations from Assam, i.e., Ultapani Reserve Forest (90° 17' 33.7992" E, 26°46' 2.4312"N), Kakoi Rain Forest (94°13'20.2188" E, 27° 26' 49.6644" N), and Dihing Patkai (95° 24' 16.524" E, 27° 15' 21.3516" N) (Figure 1). Assam is the center state of Northeast India. The state is rich in biodiversity as it comprises different geographical features. The state shares the boundaries with two neighboring countries, Bangladesh and Bhutan.

Preparation of voucher specimen and identification

After sample collection, voucher specimens were prepared according to standard herbarium techniques (Jain and Rao 1977). The voucher specimens were submitted to the Gauhati University Herbarium, GUBH (abbreviations follow Thiers 2025). The specimens were identified following relevant literature, such as Nayar (1967), Basumatary and Baruah (2021), and Debta et al. (2022), as well as digital herbarium microfilms available online from the Kew Herbarium (K) (<http://specimens.kew.org/herbarium/K000867702>). Morphological features were studied, and photographs were taken for proper taxonomic description.

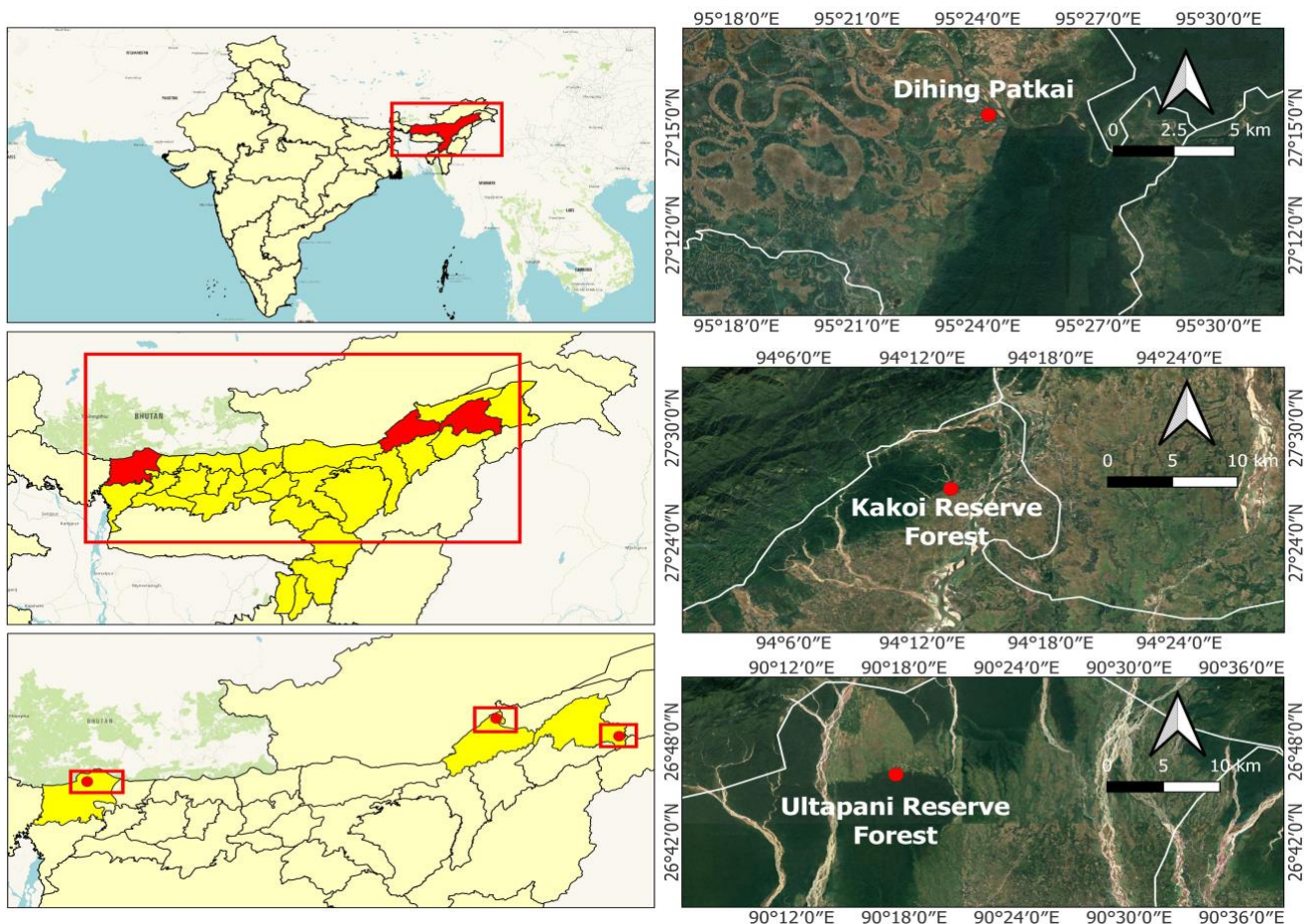


Figure 1. The collection sites of *Sarcopyramis subramanii* used in the present study

Palynological study

For the palynological study, anthers were collected before complete anthesis. The pollen grains were kept dry. Pollen samples were prepared using gold coats and observed under Scanning Electron Microscope (Gemini1SEM, ZEISS, Germany). Measurements were taken on three randomly selected pollen grains for each taxon; images at different magnifications (5KX, 6KX, 16KX, 20KX, and 40KX) were obtained; measurements were made using the scales available in the SEM software; and pollen morphology was thoroughly studied. Illustrated Pollen Terminology by Halbritter et al. (2018) was followed to describe the palynological characters.

RESULTS AND DISCUSSION

Taxonomic enumeration

Sarcopyramis subramanii M.P. Nayar, Proc Indian Acad Sci B 66: 279 (1967) (Figures 2 and 3)

Delicate herb, up to 20 cm tall. **Stem** glabrous, sparsely branched, angular with ridges and furrows, brown to yellowish green. **Leaves** opposite, color variable sometimes variegated, ovate to ovate-lanceolate, 0.5- 4 × 1-9 cm, apex acute to acuminate, base obliquely obtuse; finely serrulate margin with pinkish hair at the end, dorsal surface bristly with glandular hairs, pubescent; ventral surface glabrous; 3 distinct nerves at the base, petiolate, petiole glabrescent, 0.3-2.5 cm long. **Inflorescence** cyme, mostly terminal. **Flowers** 1-4, bracts foliaceous, obovate, ciliated margins with glandular hair, flowers tetramerous, pedicellate, bisexual, pedicel 1-4 mm long; 4-sided hypanthium, glabrous; calyx persistent, greenish, 4 lobed with tip 2-3 ciliated projection; corolla whitish to pale pink, 4, apex acuminate, 3-7 × 2-4 mm; stamens 8, equal, filaments swollen at base, connective whitish-yellow, appendage prominent, spurred; anthers cordate, yellow to brownish-red, 0.1-0.4 mm long; ovary tetralocular, completely attached to hypanthium, multiple ovules, style glabrous, thick, 0.2-0.4 mm long, stigma papillose, capitate; capsule campanulate, greenish. **Fruit** berry, angular. **Seeds** minute, numerous.

Flowering and fruiting: July to September.

Habitat: streamside and forest bed of moist evergreen forest; 250 m above sea level.

Distribution: NE India (Assam and Mizoram)

Although *S. subramanii* was misidentified as *S. napalensis*, close morphological observation helped delimit the closely related taxa within the same genus. The most distinguishing characteristic of these closely related species is the calyx lobe. The calyx apex of *S. subramanii* is 2-3 ciliate, whereas that of *S. napalensis* is fimbriate (Figures 4 and 5).

Key to the species of *Sarcopyramis*

- 1a. Hypanthium glabrous; no outgrowth except calyx apex..... 2
 1b. Hypanthium not glabrous; hair-like projections present all over the calyx margin..... *S. gracilis*

- 2a. Stem quadrangular; bract subsessile..... 3
 2b. Stem 5 or 6-sided; bract obovate along with stalk..... *S. subramanii*
 3a. Bract ovate; apex of calyx lobe fimbriate.....
*S. napalensis*
 3b. Bract obovate; apex of calyx lobe bifid, not fimbriate..... *S. bodinieri*

Palynological study

The present study reveals that the pollen of both species is isopolar, with similar apertures, but they differ in size and shape (Table 1). Moreover, pollen of *S. subramanii* has three distinct bulging outgrowth-like structures alternately on the colpi, which are absent in *S. napalensis* (Figures 6 and 7). However, the function of the bulge in the colpi of *S. subramanii* is not known yet. The pollen of *S. subramanii* is larger in size with a prolate-spheroidal shape. However, the polar-equatorial diameter ratio of *S. napalensis* pollen is longer than that of *S. subramanii*.

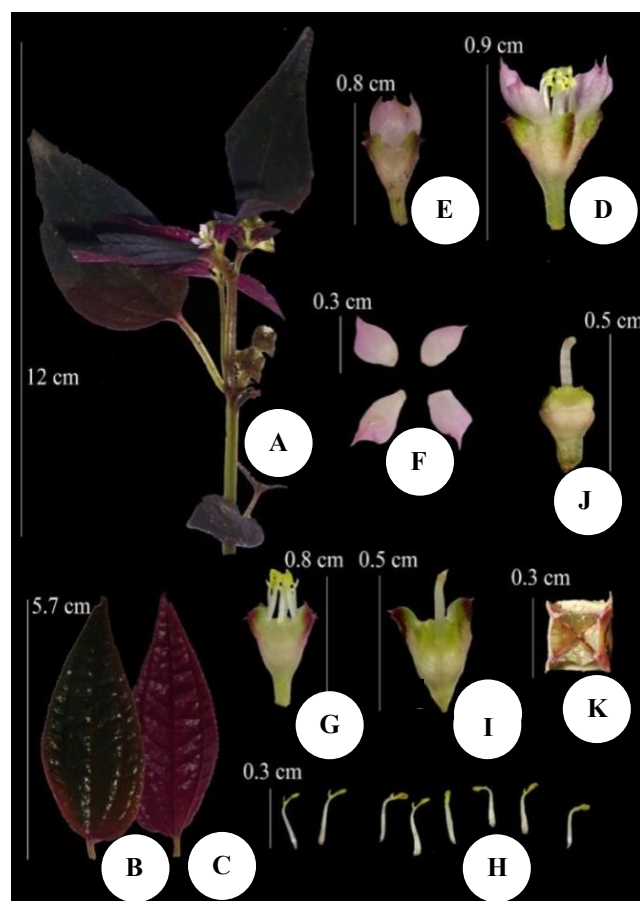


Figure 2. *Sarcopyramis subramanii*. A. Twig, B-C. Leaf, D. Complete flower, E. Bud, F. Petals, G. Stamens and carpel in hypanthium, H. Stamens, I-J. Gynoecium, K. Hypanthium (front view) [Collected from Dihing-Patkai, Collection No. BD19]



Figure 3. *Sarcopyramis subramanii* in the Ultapani Reserve Forest: A. Habit, and B. Habitat



Figure 4. Flower of *Sarcopyramis subramanii* showing ciliate calyx lobe

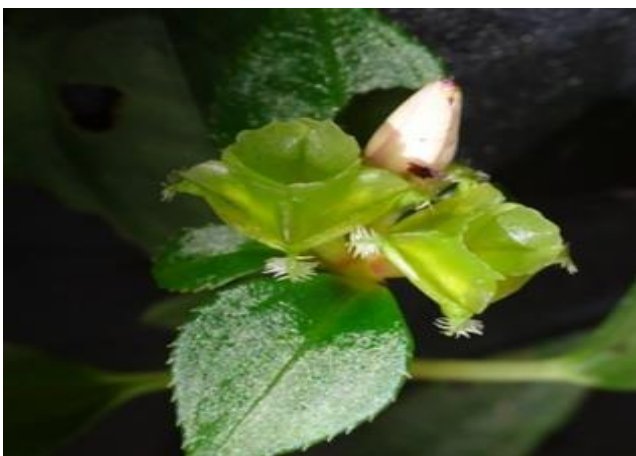


Figure 5. Hypanthium of *Sarcopyramis napalensis* showing fimbriate calyx lobe

Discussion

Endemic plants are often considered as indicators of the rich floristic diversity of a particular area. *S. subramanii* is strictly confined to the NE region of the Indian sub-continent

with restricted distributional reports. The specimen was discovered in Assam, yet it has not been listed in any regional floristic literature. However, its rediscovery after 94 years by Basumatary and Baruah (2021) has taxonomic and conservation significance as it confirmed the existence of the species. This update supports the inclusion of the species in the regional flora, thereby enhancing the diversity of the family Melastomataceae in Assam and the NE region of India. *S. subramanii* can be distinguished from *S. napalensis* by the presence of 2-3 ciliate structures instead of fimbriate structures at the apex of the calyx lobe. Moreover, the presence of bulgy outgrowths at the colpi of *S. subramanii* pollen helps to differentiate the species from the morphologically similar *S. napalensis*.

Pollen characters are less affected by environmental changes compared to other vegetative features. Pollen grains are considered to be the chief floral resource in the family Melastomataceae; the pollen viability of pollen grains affects the pollination by biotic components, as the unviable pollens have low nutritive content (Goldenberg and Shepherd 1998; Dos Santos et al. 2012; Maia et al. 2016). Most of the pollens of the Melastomataceae members get released in the bicellular stage (Tobe and Raven 1984; Medeiros and Ross 1996). The anthers of most of the melastome flowers are tubular, sickle-shaped and poricidal (Da Paz and Pigozzo 2017). Many Melastomataceae members have dimorphic stamens. Study proved that the longer stamens serve the purpose of pollination while the shorter ones act as feeding stamens. According to Brito et al. (2021), the length difference between the dimorphic stamens helps in location-specific pollen deposition on the pollinator's body, which facilitates the pollination process. This process of dimorphism also depends on the size and behaviour of the pollinator (Konzmann et al. 2020). Co-evolution of style length in the Melastomataceae flower having dimorphic stamens occurred along with the length of pollinating stamens (Melo et al. 2021). The dimorphism in staminal parts also affects palynological features, including morphology, viability, and volume (Müller 1881, 1883). Palynology has long been used as a taxonomic tool amongst the members of Melastomataceae for the delimitation of morphologically similar taxa. Palynotaxonomic work on the genus *Ossaea* (Melastomataceae) in Brazil was reported by dos Santos et al. (1997), including 9 species and 2 varieties. Cortez et al. (2015) studied the anther wall and pollen development of the genus *Miconia*, covering six closely related species occurring in the Neotropical regions. Suryani and Ramona (2020) studied the pollen ultrastructure of five *Melastoma* species. The pollen morphology of the genus *Huberia* helped to delimit 22 closely related species (Martins et al. 2024). The pollen morphology has been used to resolve many taxonomic ambiguities in other taxa, such as monocotyledons (Harley 2004), Asteroideae (Asteraceae) (Punt and Hoen 2009), *Sorbus* (Rosaceae) (Li et al. 2023), Moraceae (Khan et al. 2025), *Impatiens* (Rahman et al. 2025), and *Passiflora* (Mezzonato-Pires et al. 2025). These previous works demonstrate the use of pollen morphology as a diagnostic tool and support the view that *S. subramanii*'s distinct pollen trait has taxonomic significance.

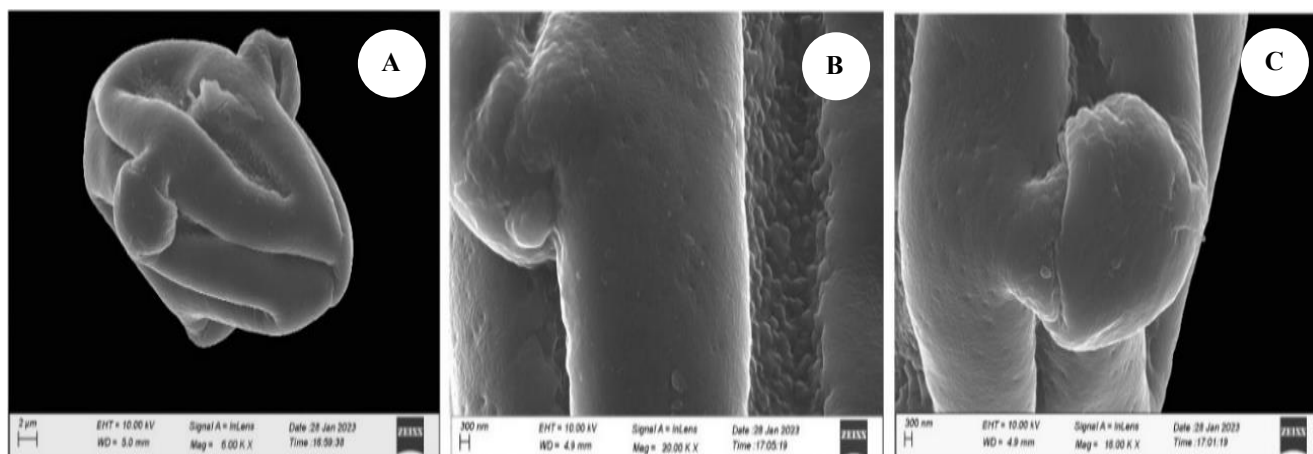


Figure 6. SEM images of *Sarcopyramis subramanii* pollen. A. Showing single unit of pollen (at 6K X magnification, scale bar- 2µm), B. Exine ornamentation (at 20K X magnification, scale bar- 300 nm), C. Outgrowth in colpi (at 16K X magnification, scale bar- 300 nm)

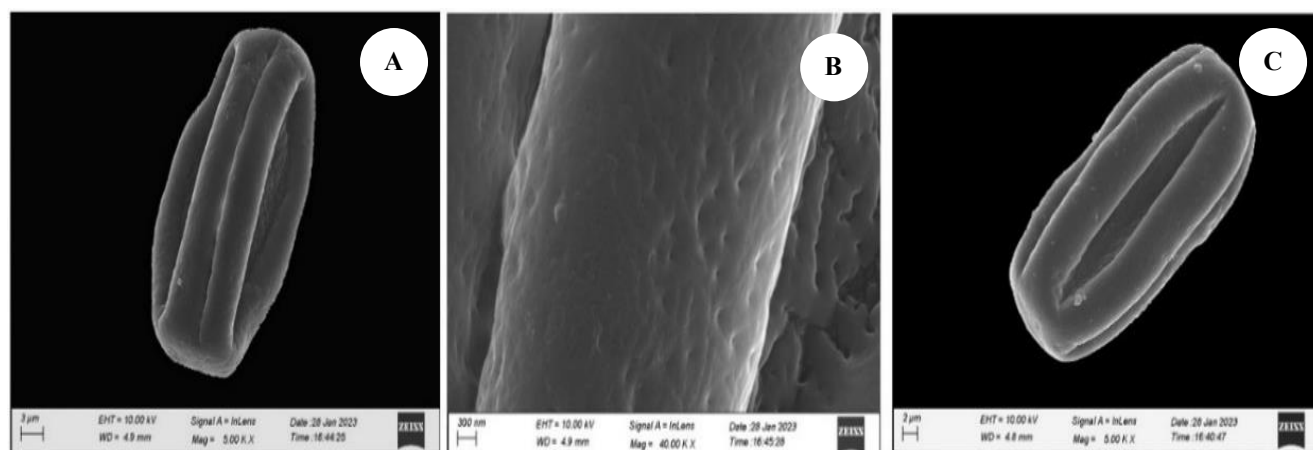


Figure 7. SEM images of *Sarcopyramis napalensis* pollen: A. Single unit of pollen (5K X magnification, scale bar- 3µm), B. Exine ornamentation (40 K X magnification, scale bar- 300 nm), C. Single unit of pollen (5K X magnification, scale bar- 2µm)

Table 1. Comparison of palynological features between *Sarcopyramis subramanii* and *Sarcopyramis napalensis*

Characters	<i>Sarcopyramis subramanii</i>	<i>Sarcopyramis napalensis</i>
Pollen class	Mediae	Mediae
Aperture type	Colporate and colpate	Colporate and colpate
Number of apertures	6	6
Polarity	Isopolar	Isopolar
Pollen unit	Monad	Monad
Polar diameter (µm)	37.79±0.15	30.37±0.33
Equatorial diameter (µm)	35.58±0.34	18.56±0.18
P/E ratio	1.06	1.63
NPC class	N6p4c5	N6p4c5
Pollen shape	Prolate-spheroidal	Prolate
Exine ornamentation	Psilate	Psilate
Outgrowth in colpi	Present	Absent

Members of Melastomataceae are used in ethnomedicinal treatments as anti-inflammatory (Ishii et al. 1999), antimicrobial (Ventura et al. 2007), antioxidant (Susanti et al. 2007), antihepatitis (Nicholl et al. 2001), antihyperglycemic (Amalraj et al. 1998), and antihypertensive (Cheng et al. 1993). Phytochemical studies also reveal that members of Melastomataceae contain numerous compounds, including flavonoids (Isaza et al. 2001), polyphenols, and tannins (Yoshida et al. 1994). *S. napalensis* has been used in traditional Chinese medicine, is widely distributed in southern China, and its whole plant has long been used to treat acute and chronic hepatitis as a folk medicine “*Feng gui dou cao*”. Guo et al. (2012) reported that the Ethanol extract of *S. napalensis* (ESNN) contains antioxidants with hepatoprotective properties and has therapeutic potential for liver diseases and liver injuries. The plant tastes sour and is used to treat liver fire and cough caused by lung heat (Lin et al. 2017). The study revealed that the *S. napalensis* extract helped cure fibrosis and liver inflammation by

reducing triglyceride synthesis in the liver and limiting fatty acid uptake (Wang et al. 2022). The plant contains many metabolic compounds, such as organic acids, saponins, polyphenols, and flavonoids, indicating that the species is a potential candidate for the treatment and prevention of Non-Alcoholic Fatty Liver Disease (NAFLD) (Huang et al. 2013). Huang et al. (2013) isolated Quercetin from *S. bodinieri* var. *delicata* for the first time. This isolated compound can induce apoptosis in HepG2 cancer cells. Quercetin also has antiproliferative potential. The study also reveals that the aqueous solution of dried *S. bodinieri* var. *delicata* is helpful in treatment of hepatoma and choloplania (Wang et al. 2008). Thus, comprehensive phytochemical profiling of *S. subramanii* is necessary to characterize its bioactive components and validate its potential as a promising ethnomedicinal species for future pharmacological research.

Due to its limited geographical range, delicate herbaceous habit, and small population, *S. subramanii* is highly susceptible to habitat degradation and environmental changes. Today, severe habitat deterioration caused by deforestation, habitat fragmentation, and the illegal smuggling of rare plants from forests poses a threat to the survival of this sparsely populated species. So, this highlights the urgent need for conservation strategies for this lesser-known endemic species of NE India.

In conclusion, *S. subramanii* differs from *S. napalensis* in floral morphology and from a palynological point of view, though they exhibit similar morphology in vegetative structures. The present study will help us differentiate closely related taxa based on pollen morphology. This endemic species of Melastomataceae remains understudied, creating a research gap. This research gap will pave the way for future researchers to explore and study aspects such as the phytochemical composition, pharmacognosy, and conservation biology of the species. Also, ecological studies on habitat preferences can be conducted to help conserve the species. The pollen traits can be further studied across the genus *Sarcopyramis* to assess the characters and the segregation of taxa, thereby leading to taxonomic stability.

ACKNOWLEDGEMENTS

The authors are thankful to Rakesh Talukdar of the Department of Chemistry, Gauhati University, India, for helping in SEM analysis and to Dr. Sanswarang Baumatary and Dr. Pranati Gogoi for their assistance in field surveys. Thanks are also delivered to DST, Government of India, for providing DST-FIST support to the Department of Botany, Gauhati University, where this research work was carried out.

REFERENCES

Amalraj T, Ignacimuthu S. 1998. Evaluation of the hypoglycaemic effect of *Memecylon umbellatum* in normal and alloxan diabetic mice. *J Ethnopharmacol* 62: 247-250. [https://doi.org/10.1016/s0378-8741\(98\)00070-1](https://doi.org/10.1016/s0378-8741(98)00070-1).

- Basumatary S, Baruah S. 2021. Rediscovery of *Sarcopyramis subramanii* Nayar (Melastomataceae) 94 years after type collection from India. *Check List* 17 (1): 233-237. <https://doi.org/10.15560/17.1.233>.
- Caetano APS, Basso-Alves JP, Cortez PA, De Brito VLG, Michelangeli FA, Reginato M, Goldenberg R, Carmello-Guerreiro SM, Teixeira SP. 2018. Evolution of the outer ovule integument and its systematic significance in Melastomataceae. *Bot J Linn Soc* 186 (2): 224-246. <https://doi.org/10.1093/botlinnean/box093>.
- Chantaranonthai P. 1997. Palynological studies in the family Melastomataceae from Thailand. *Grana* 36 (3): 146-159. <https://doi.org/10.1080/00173139709362602>.
- Cheng JT, Hsu FL, Chen HF. 1993. Antihypertensive principles from the leaves of *Melastoma candidum*. *Planta Med* 59: 405-407. <https://doi.org/10.1055/s-2006-959719>.
- Christenhusz MJM, Byng JW. 2016. The number of known plants species in the world and its annual increase. *Phytotaxa* 261 (3): 201-217. <https://doi.org/10.11646/phytotaxa.261.3.1>.
- Conti E, Litt A, Wilson PG, Graham SA, Briggs BG, Johnson LAS, Sytsma KJ. 1997. Interfamilial relationships in Myrtales: Molecular phylogeny and patterns of morphological evolution. *Syst Bot* 22 (4): 629-647. <https://doi.org/10.2307/2419432>.
- Cortez PA, Caetano APS, Carmello-Guerreiro SM, Teixeira SP. 2015. Anther wall and pollen development in Neotropical species-rich *Miconia* (Melastomataceae). *Plant Syst Evol* 301: 217-230. <https://doi.org/10.1007/s00606-014-1067-z>.
- Da Paz JRL, Pigozzo CM. 2017. Aspectos da polinização de duas espécies endêmicas de Melastomataceae (tribo Melastomeae) em uma Restinga da Bahia, Nordeste do Brasil. *Natureza Online* 15 (1): 9-18. [Portuguese]
- Debta MR, Maity R, Dash SS, Kumar S. 2022. *Sarcopyramis napalensis* var. *bodinieri* (Melastomataceae): A new addition to the Indian flora and typification of two names. *Rheedea* 32 (4): 321-326. <https://doi.org/10.22244/rheedea.2022.32.04.06>.
- Dellinger AS, Kopper C, Kagerl K, Schönenberger J. 2022. Pollination in Melastomataceae: A family-wide update on the little we know and the much that remains to be discovered. In: Goldenberg R, Michelangeli FA, Almeda F (eds). *Systematics, Evolution, and Ecology of Melastomataceae*. Springer, Cham. https://doi.org/10.1007/978-3-030-99742-7_26.
- Dellinger AS, Penneys DS, Städler YM, Fragner L, Weckwerth W, Schönenberger J. 2014. A specialized bird pollination system with a bellows mechanism for pollen transfer and staminal food body rewards. *Curr Biol* 24 (14): 1615-1619. <https://doi.org/10.1016/j.cub.2014.05.056>.
- Dellinger AS, Pérez-Barrales R, Michelangeli FA, Penneys DS, Fernández-Fernández DM, Schönenberger J. 2021. Low bee abundance explains pollinator shifts to vertebrates in tropical mountains. *New Phytol* 231 (2): 864-877. <https://doi.org/10.1111/nph.17390>.
- Dos Santos FAR, D'El Rei Souza ML, Watanabe HM, Borges HBN, Goldenberg R. 1997. Palinotaxonomia de espécies Brasileiras do gênero *Ossaea* DC. (Melastomataceae). *Polibotânica* 5: 1-12. [France]
- Dos Santos APM, Fracasso CM, Luciene dos Santos M, Romero R, Sazima M, Oliveira PE. 2012. Reproductive biology and species geographical distribution in the Melastomataceae: A survey based on New World taxa. *Ann Bot* 110: 667-679. <https://doi.org/10.1093/aob/mcs125>.
- Erdtman G. 1952. *Pollen Morphology and Plant Taxonomy: Angiosperms*. Almqvist & Wiksell, Stockholm.
- Gavrutenko M, Reginato M, Kriebel R, Nicolas AN, Michelangeli FA. 2020. Evolution of floral morphology and symmetry in the Miconieae (Melastomataceae): Multiple generalization trends within a specialized family. *Intl J Plant Sci* 181 (7): 732-747. <https://doi.org/10.1086/708906>.
- Goldenberg R, Shepherd GJ. 1998. Studies on the reproductive biology of Melastomataceae in "cerrado" vegetation. *Pl Syst Evol* 211: 13-29. <https://doi.org/10.1007/BF00984909>.
- Guo J, Zhang J, Yao G, Liao M, Chen H, Yang X, Zhang Y. 2012. Hepatoprotective Activity of the Ethanol Extract of *Sarcopyramis nepalensis*. *J Huazhong Univ Sci Technolog Med Sci* 32 (6): 844-848. <https://doi.org/10.1007/s11596-012-1045-z>.
- Halbritter H, Ulrich S, Grímsson F, Weber M, Zetter R, Hesse M, Buchner R, Svojtka M, Frosch-Radivo A. 2018. *Illustrated Pollen Terminology*. Springer, Cham. <https://doi.org/10.1007/978-3-319-71365-6>.
- Harley MM. 2004. Triparturate pollen in the monocotyledons: Configurations and conjectures. *Plant Syst Evol* 247: 75-122. <https://doi.org/10.1007/s00606-003-0107-x>.

- Huang TC. 1972. Pollen Flora of Taiwan. Botany Department Press, National Taiwan University, Taipei.
- Huang W, Chungpeng Wan CP, Zhou SR. 2013. Quercetin - a flavonoid compound from *Sarcopyramis bodinieri* var delicate with potential apoptotic activity in HepG2 liver cancer cells. Trop J Pharm Res 12 (4): 529. <https://doi.org/10.4314/tjpr.v12i4.13>.
- Isaza JH, Ito H, Yoshida T. 2001. A flavonol glycoside-lignan ester and accompanying acylated glucosides from *Monochaetum multiflorum*. Phytochemistry 58: 321-327. [https://doi.org/10.1016/s0031-9422\(01\)00247-3](https://doi.org/10.1016/s0031-9422(01)00247-3).
- Ishii R, Saito K, Horie M, Shibano T, Kitanaka S, Amano F. 1999. Inhibitory effects of hydrolyzable tannins from *Melastoma dodecandrum* Lour on nitric oxide production by a murine macrophage-like cell line, RAW264.7, activated with lipopolysaccharide and interferon- γ . Biol Pharm Bull 22: 647-653. <https://doi.org/10.1248/bpb.22.647>.
- Jain SK, Rao RR. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
- Kanjilal UN. 1940. Flora of Assam, Vol. II. Government of Assam Press, Shillong.
- Khan MR, Zafar M, Majeed S, Makhkamov T, Naraliyeva N, Bakhramov I, Ibrahim SM, Inomova M, Rakhimov B, Ptaszynska AA. 2025. Palynology as a taxonomic tool in the identification of riparian Moraceae species. Genet Resour Crop Evol 72: 7893-7904. <https://doi.org/10.1007/s10722-025-02397-w>.
- Konzmann S, Hilgendorf F, Niester C, Rech AR, Lunau K. 2020. Morphological specialization of heterantherous *Rhynchanthera grandiflora* (Melastomataceae) accommodates pollinator diversity. Plant Biol 22: 583-590. <https://doi.org/10.1111/plb.13102>.
- Lin Y, Wu Q, Chen Y. 2017. Study on the antioxidation of flavonoids compounds extracted from *Sarcopyramis nepalensis* Wall in South Fujian Province. J Baotou Med Coll 33: 3. <https://doi.org/10.16833/j.cnki.jbmc.2017.09.035>.
- Liu Y, Veranso-Libalah MC, Kadereit G, Zhou RC, Quakenbush JP, Lin CW, Wai JS. 2022. Systematics of the tribe Sonerileae. In: Goldenberg R, Michelangeli FA, Almeda F (eds). Systematics, evolution, and ecology of Melastomataceae. Springer International Publishing, Switzerland.
- Maia FR, Varassin IG, Goldenberg R. 2016. Apomixis does not affect visitation to flowers of Melastomataceae, but pollen sterility does. Plant Biol 18: 132-138. <https://doi.org/10.1111/plb.12364>.
- Martins TRB, Baumgratz JFA, Mendonça CBF, Gonçalves-Esteves V. 2024. Palynology of *Huberia* (Melastomataceae: Cambessedesieae): Diversity and taxonomic implications. Palynology 48 (3): 2334063. <https://doi.org/10.1080/01916122.2024.2334063>.
- Medeiros JD, Roos AL. 1996. Aspectos do microsporangio, microsporogenese e do gametofito masculino de *Tibouchina cerastifolia* (Naud.) Cogn. (Melastomataceae). Biotemas 9: 5-14. <https://doi.org/10.5007/%25x>.
- Melo LRF, Vasconcelos T, Reginato M, Caetano APS, de Brito VLG. 2021. Evolution of stamen dimetrisism in Melastomataceae, a large radiation of pollen flowers. Perspect Plant Ecol Evol Syst 48: 125589. <https://doi.org/10.1016/j.ppees.2021.125589>.
- Mezzonato-Pires AC, Bernacci LC, De Souza Freitas Teixeira GHG, de Freitas Cruz P, Pacheco G, Mendonça CBF, Gonçalves-Esteves V. 2025. Palynological characterization and taxonomical delimitation of the subgenera within *Passiflora* L. (Passifloraceae: Malpighiales), the largest genus of lianas in the Neotropics. Eur J Taxon 981 (1): 239-264. <https://doi.org/10.5852/ejt.2025.981.2829>.
- Müller H. 1881. Two kinds of stamens with different functions in the same flower. Nature 24: 307-308. <https://doi.org/10.1038/024307c0>.
- Müller F. 1883. Two kinds of stamens with different functions in the same flower. Nature 27: 364-365. <https://doi.org/10.1038/027364b0>.
- Nair PKK. 1965. Pollen Grains of Western Himalayan Plants. Asia Publishing House, New York.
- Nayar MP. 1967. A new species of *Sarcopyramis* Wall. (Melastomataceae) from North-East India. Proc Indian Acad Sci 66: 279-281. <https://doi.org/10.1007/bf03052104>.
- Nicholl DS, Daniels HM, Thabrew MI, Grayer RJ, Simmonds MSJ, Hughes RD. 2001. In vitro studies on the immunomodulatory effect extracts of *Osbeckia aspera*. J Ethnopharmacol 78: 39-44. [https://doi.org/10.1016/s0378-8741\(01\)00319-1](https://doi.org/10.1016/s0378-8741(01)00319-1).
- Patel VC, Skvarla JJ, Raven PH. 1984. Pollen characters in relation to the delimitation of Myrtales. Ann Missouri Bot Gard 71 (3): 858-969. <https://doi.org/10.2307/2399170>.
- POWO. 2025. Plants of World Online. Available from: <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:26580-1>.
- Punt W, Hoen PP. 2009. The northwest European pollen flora, 70: Asteraceae-Asteroidae. Rev Palaeobot Palynol 157 (1-2): 22-183. <https://doi.org/10.1016/j.revpalbo.2008.12.003>.
- Rahman F, Ullah Z, Ali A, Sher H, Zaman S, Sert TD, Kayani S. 2025. Palynological characterization and taxonomic delimitation of the genus *Impatiens* L. in Pakistan: An LM and SEM study. Microsc Res Tech 88 (9): 2512-2527. <https://doi.org/10.1002/jemt.24843>.
- Renner SS. 1993. Phylogeny and classification of the Melastomataceae and Memecylaceae. Nord J Bot 13 (5): 519-540. <https://doi.org/10.1111/j.1756-1051.1993.tb00096.x>.
- Stein BA, Tobe H. 1989. Floral nectaries in Melastomataceae and their systematic and evolutionary implications. Ann Missouri Bot Gard 76 (2): 519-531. <https://doi.org/10.2307/2399498>.
- Stiles FG, Rosselli L. 1993. Consumption of fruits of the Melastomataceae by birds: How diffuse is coevolution? Vegetatio 107: 57-73. <https://doi.org/10.1007/bf00052211>.
- Stone RD. 2006. Phylogeny of major lineages in Melastomataceae, subfamily Oliniaceae: Utility of nuclear glyceraldehyde 3-phosphate dehydrogenase (*GapC*) gene sequences. Syst Bot 31 (1): 107-121. <https://doi.org/10.1600/036364406775971741>.
- Suryani L, Ramona F. 2020. Ultrastructure morphology of *Melastoma* L. (Melastomataceae) pollen. Jurnal Biologi Unand 8 (1): 9-13. <https://doi.org/10.25077/jbioua.8.1.9-13.2020>. [Indonesian]
- Susanti D, Sirat HM, Ahmad F, Ali RM, Aimi N, Kitajima M. 2007. Antioxidant and cytotoxic flavonoids from the flowers of *Melastoma malabathricum* L. Food Chem 103: 710-716. <https://doi.org/10.1016/j.foodchem.2006.09.011>.
- Thiers B. 2025 (continuously updated). *Index Herbariorum*. The William & Lynda Steere Herbarium (nybg.org). <http://sweetgum.nybg.org/ih>
- Tobe H, Raven PH. 1984. The embryology and relationships of Oliniaceae. Plant Syst Evol 146: 105-116. <https://doi.org/10.1007/BF00984057>.
- Ulloa Ulloa C, Almeda F, Goldenberg R, Kadereit G, Michelangeli FA, Penneys DS, Stone RD, Veranso-Libalah MC. 2022. Melastomataceae: Global diversity, distribution, and endemism. In: Goldenberg R, Michelangeli FA, Almeda F (eds). Systematics, evolution, and ecology of Melastomataceae. Springer International Publishing, Switzerland.
- Ventura CP, Braga de Oliveira A, Braga FC. 2007. Antimicrobial activity of *Trembleya laniflora*, *Xyris platystachia* and *Xyris pterygoblephara*. Revista Brasileira de Farmacognosia 17: 17-22. <https://doi.org/10.1590/S0102-695X2007000100005>.
- Wang XM, Wan CP, Zhou SR, Qiu Y. 2008. Two New Flavonol Glycosides from *Sarcopyramis bodinieri* var. *delicate* Molecules 13: 1399-1405. <https://doi.org/10.3390/molecules13061399>.
- Wang Y, Cai F, Xue K, Hua B, Guo C, Li Y, Qiu L. 2022. *Sarcopyramis nepalensis* Wall extract improves hepatic lipidosis in mice through regulating lipid metabolism. Acta Vet Et Zootechnica Sinica 53: 925-937.
- Yoshida T, Arioka H, Fujita T, Chen XM, Okuda T. 1994. Monomeric and dimeric hydrolysable tannins from two melastomataceous species. Phytochemistry 37: 863-866. [https://doi.org/10.1016/S0031-9422\(00\)90372-8](https://doi.org/10.1016/S0031-9422(00)90372-8).