RHEEDEA
Journal of the Indian Association for Angiosperm Taxonomy

RESEARCH ARTICLE

Vol. 32(3): 201-208 (2022)
ISSN: 0971-2313 (Print edition)
ISSN: 2582-2438 (Online edition)
https://dx.doi.org/10.22244/rheedea.2022.32.03.05

Lepidagathis spinosa (Barlerieae: Acanthaceae), a steno-endemic species of Tamil Nadu, India: its taxonomy, lectotypification and distribution

Gnanasekaran G.[1]*, King A.F.J.[1] & W. Arisdason[2]
[1]Department of Botany, Madras Christian College (Autonomous), Tambaram East, Chennai, Tamil Nadu – 600 059, India
[2]Botanical Survey of India, Southern Regional Centre, TNAU Campus, Lawley Road, Coimbatore, Tamil Nadu – 641 003, India
*E-mail: gnanasekaran@mcc.edu.in

Abstract: The taxonomy of *Lepidagathis spinosa* Wight ex Nees (Barlerieae: Acanthaceae), a little-known endemic species from Tamil Nadu is discussed with a detailed description, colour photographs, light and scanning electron micrographs and IUCN conservation status. Besides, the name *L. spinosa* is lectotypified here and a digital image of the lectotype specimen is provided. Furthermore, this study confirms that the earlier report of occurrence of this species from the states of Karnataka and Kerala is based on mistakenly identified specimens of *L. incurva* Buch.-Ham. ex D.Don.

Keywords: Conservation status, Endemism, *Lepidagathis*, Revision, Typification.

Introduction

Lepidagathis Willd. (Barlerieae: Acanthaceae) is distributed mainly in the tropical and subtropical regions of the world with 147 accepted species (POWO, 2022). It is represented by 30 species and seven varieties in India (Arisdason *et al*., 2020; Biju *et al*., 2020; Chandore *et al*., 2020; Prasad & Reddy, 2020; More *et al*., 2022), of which 18 species and one variety are endemic.

As a part of the SERB-funded research project on the 'Taxonomy, molecular phylogeny and biogeography of *Lepidagathis* Willd. (Acanthaceae) in India', field explorations have been conducted throughout the states of Kerala and Tamil Nadu. During one of our explorations, *L. spinosa* Wight ex Nees, a little-known endemic species from Tamil Nadu was collected from different parts of Madurai, Thoothukudi and Virudhunagar districts. Scrutiny of earlier literature and examination of herbarium specimens housed in various national and international herbaria (BM$^+$, C$^+$, E$^+$, G$^+$, K$^+$, Madras Christian College Herbarium, Chennai*, MH* and RHT* – herbaria visited are indicated with * and digital images of specimens seen are marked with $^+$; acronyms, where available, according to Thiers, continuously updated) revealed ambiguities in the identity, lack of detailed description and data on the distribution in addition to the need of designation of a lectotype. Therefore, a detailed account on the taxonomy, lectotypification and geographical distribution of the species is presented here along with colour photographs, light and scanning electron micrographs, IUCN conservation status and a digital image of the selected lectotype of the name for the accurate identification of the species.

Received: 04.04.2022; *Revised & Accepted*: 25.09.2022
Published Online: 30.09.2022

Materials and Methods

A detailed description was made based on fresh and herbarium specimens using Stemi 508 Stereomicroscope (Zeiss, Oberkochen, Germany) coupled with Axiocam 208 camera (Zeiss) to include complete range of variation in the gross morphological characters. The micro-morphological characters of leaf and seed were studied using Evo M18 Scanning Electron Microscope (Zeiss, Oberkochen, Germany). Samples were mounted on stubs using double-sided adhesive tape, and then sputter-coated by a thin layer of gold-palladium using a Mini Sputter Coater (SC7620, Emitech).

Later, the sputter coated samples were examined at an accelerating voltage of 5-15 kV and micrographed in different magnifications.

Taxonomic Treatment

Lepidagathis spinosa Wight ex Nees in Wall., Pl. Asiat. Rar. 3: 97. 1832 & in DC., Prodr. 11: 258. 1847; T.Anderson, J. Linn. Soc., Bot. 9: 495. 1867; C.B.Clarke in Hook.f., Fl. Brit. India 4: 517. 1885; Gamble, Fl. Madras: 1067. 1924. *Barleria spinosa* (Wight ex Nees) Wall. ex Steud., Nomencl. Bot. 1: 188. 1840. *Lectotype* (designated here): Without specific location (India Orientalis?), 31.10.1815, *B. Heyne s.n.* in herbarium Wight (Wall., Numer. List: n. 2497) (K [K001116214 digital image!]; residual syntypes (BM [BM013860261], K [K000950142], G [G00390435] digital images!).

Acanthus mucronatus B.Heyne ex C.B.Clarke in Hook.f., Fl. Brit. India 4: 517. 1885, *pro. syn.*

Barleria spinosa Wall., Numer. List: n. 2497. 1830, *nom. nud.* **Figs. 1–3**

Perennial, prostrate or decumbent herbs with woody rootstock, spreading up to 80 cm long in diam., rooting at basal nodes. Stems purplish to green when young, spreading, well-branched, angular, winged, glabrous or very few hairs only at the nodes of young branches, internodes 3–18 mm long. Leaves sessile or sub-sessile, isophyllous, opposite-decussate, oblance-ovate to broadly obovate, 9–22 × 4–7 mm, base attenuate, margins undulate with minutely serrulate, apex obtuse or rounded with spinose apical process, glabrous throughout; midvein broad at base, lateral veins 3–5 pairs, conspicuous on lower surface. Inflorescence a spike, broadly ovoid due to spreading or diverged fertile bracts, terminal or axillary, 14–20 mm long. Bracts: sterile ones in 2–5 pairs, oblong or lance-ovate, 10–18.5 × 3.3–4.5 mm, margins serrulate, apex caudate with spinose apical process; fertile bract 1, similar to sterile bracts except the size (11–18.5 × 2.7–3.2 mm). Bracteoles 2, oblong, 14–19 × 2–3.3 mm, margins minutely ciliolate, apex caudate with spinose apical process, sparsely hirsute on both surfaces. Calyx 5-lobed, heteromorphic, margins pilose below, glabrous above, apex caudate with spinose apical process, pilose inside, glabrous outside; anticous lobes 2, unequal, overlapping, connate at base (less than one-fourth of their total length, *i.e.*, 1.3–2.1 mm); lobes elliptic (broadly elliptic in fruiting calyx), 9.5–11 × 1.5–2.8 mm; posticous lobe 1, elliptic (broadly elliptic in fruiting calyx), 9.7–10.8 × 2.5–5 mm; lateral lobes 2, equal, arcuate, linear (elliptic in fruiting calyx), 8.9–11.2 × 0.8–1.2 mm. Corolla bilabiate, 14.8–16 mm long, white with many purplish brown markings throughout inside and yellow dots or patches on the palate; tube 8.4–9.6 mm long, cylindric below, 4.2–4.8 mm long, glabrous inside, abruptly expanded above, 3.7–4.7 mm long, retrorsely hirsute just above the cylindrical tube to throat on either side of lower lip inside, retrorsely hirsute throughout outside; upper lip arcuate, 2.8–4.2 × 4.8–5.7 mm, margins entire, apex minutely 2-lobed (0.61–0.66 mm long), each lobe 3-veined; lower lip 3-lobed, 6.3–7.2 mm long including lobes; middle lobe broader than the lateral lobes, sub-orbicular, 2.7–3.2 × 5.2–5.3 mm, crenulate, 3-veined; lateral lobes oblong, 1.8–2.7 × 2.5–3.3 mm, 3-veined. Stamens 4, didynamous; anticous (longer) filaments 4.3–5.7 mm, posticous (shorter) filaments 2–4 mm, purple-striped, glabrous; anthers oblong, divergent, 1.4–2.0 mm long, white to yellowish, sparsely hairy at the base of the slit, scabrous at the connectives, longitudinally dehiscing. Ovary sub-globose, 1.4–1.5 × 0.8–1.1 mm, glabrous, 2-loculed; ovules 2 in each locule; style 9.3–10 mm long, antrorsely bristled-hairy; stigma entire. Capsules lance-ovoid, 6.3–7.1 × 2.7–2.9 mm, glabrous, yellowish to brown; seeds 1 or 2 fertile, ovoid, 3.5–3.6 × 2.4–2.7 mm, flat, densely clothed with hygroscopic white hairs on both surfaces (longer than seed).

Flowering & fruiting: Flowering from October to March and fruiting from January to July.

Habitat: This species usually grows on dry barren

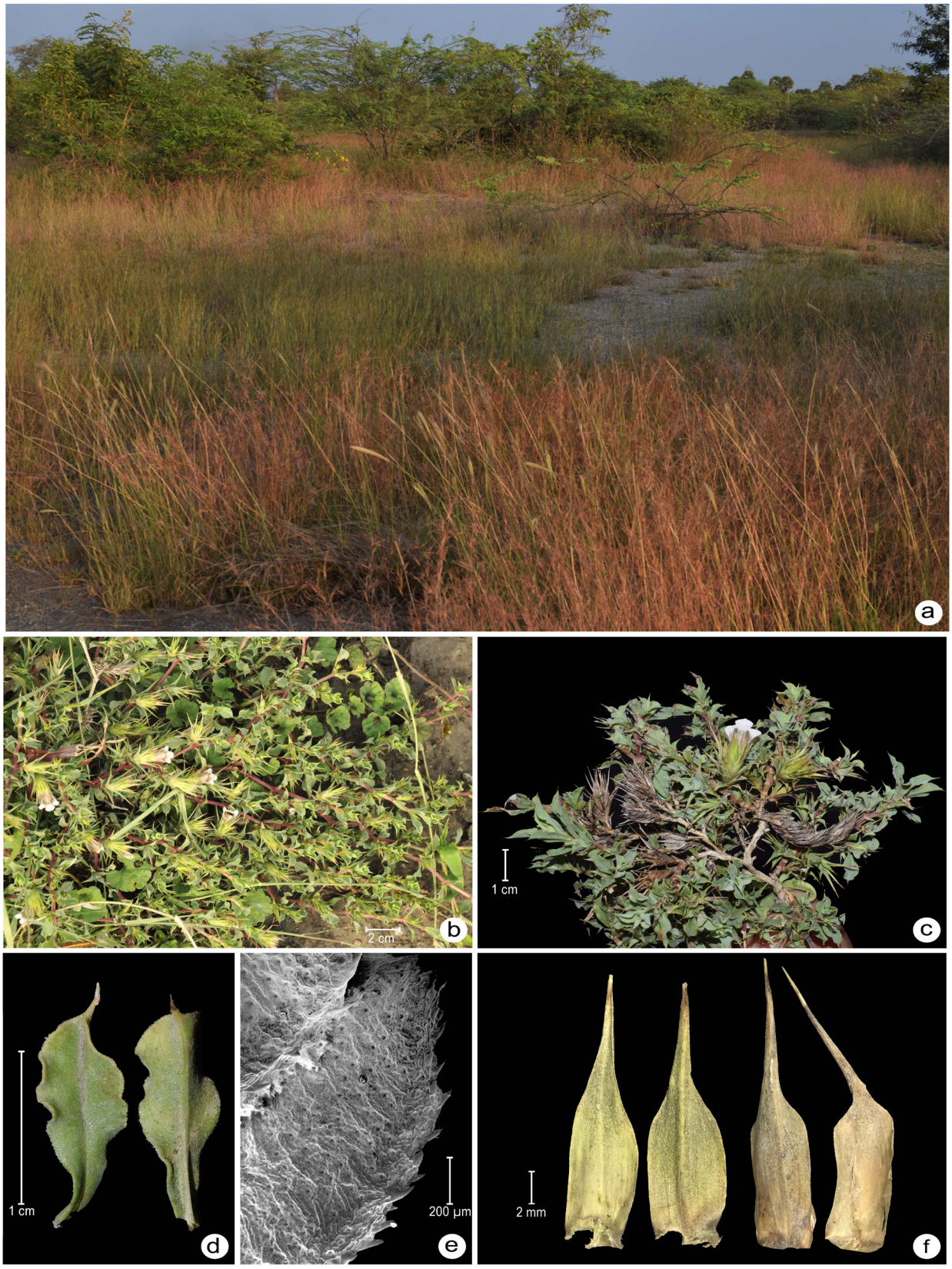

Fig. 1. *Lepidagathis spinosa* Wight ex Nees: **a.** Habitat; **b.** Habit; **c.** Flowering twig in face view; **d.** Leaf upper (left) and lower (right) surface; **e.** SEM micrograph showing leaf margin; **f.** Sterile bracts (photos **a**-**c** by G. Gnanasekaran; **d** & **f** by A.F.J. King; **e** by W. Arisdason; from *G. Gnanasekaran* & *A.F.J. King* 12868).

wastelands with black cotton soil, at elevations ranging from 50 to 130 m.

Distribution: India, endemic to Tamil Nadu.

Etymology: The specific epithet "*spinosa*" refers to the spinose apical process of the oblance-ovate to broadly obovate leaves, bracts and bracteoles.

Specimens examined: INDIA, **Tamil Nadu**, Coimbatore district, Coimbatore plains, *s.d*., *R.H. Beddome* 459 (BM [BM013860265 digital image!]); Madurai district, T. Kallupatti, N 09°78'46.64", E 77°93'74.03", 131 m, 07.01.2022, *G. Gnanasekaran & A.F.J. King* 12868, 12869; T. Pudupatti, N 09°46'29.1", E 77°54'50.0", 130 m, 07.01.2022, *G. Gnanasekaran & A.F.J. King* 12867 (Madras Christian College Herbarium, Chennai); Ramanathapuram district, Muthukulathur, 75 m, 18.06.1978, *N.C. Nair* 57329; Pandalgudi, 09.03.1953, *C.H. Maduram* 21783; Perayanur, 24.02.1953, *J. Sakharam Rao* 21765; Perunazhi, 75 m, 14.01.1989, *V. Balasubramaniam* 2063; Sethupathinagar, 50 m, 11.02.1987, *V. Balasubramaniam* 1269 (MH); Tiruchirappalli district, Ponmalaipatti, 50 m, 16.12.1985, *K.M. Matthew* 18659; Tiruchy, September, *s.coll*., *s.n.* (RHT); Tirunelveli district, Siwalaperi (Sivalaperi), 02.10.1795, *Rottler s.n.* (K [K000950057 digital image!]); Thoothukudi district, Kovilpatti, 18.07.1901, *C.A. Barber* 3429 (MH); Kovilpatti, N 09°12'77.2", E 77°82'35.8", 120 m, 08.01.2022, *G. Gnanasekaran & A.F.J. King* 12877, 12878 (Madras Christian College Herbarium, Chennai); Virudhunagar district, Maittanpatti, N 09°40'02.7", E 77°57'58.2", 126 m, 08.01.2020, *G. Gnanasekaran & A.F.J. King* 12876 (Madras Christian College Herbarium, Chennai); Sattur, May 1903, *C.A. Barber s.n.*; Sattur, May 1903, *C.A. Barber s.n.* (MH). Peninsula Indiae Orientalis, *s.d*., *s.coll*., *s.n.* (BM [BM013860263 digital image!]); *s.d*., *R. Wight* 1972 (E [E01024337, E01024338, E01024339 digital images!]); *s.d*., *R. Wight* 2232 (C digital image!); India, *s.d*., *Royle s.n.* (hb. J.S. Mill) (K [K000950058 digital image!]); Maisor (Mysore) & Carnatic, *s.d*., *G. Thomson s.n.* (C, G [G00390434], K [K000950141] digital images!).

Conservation status: The species is provisionally assessed here as 'Near Threatened [NT]' using the IUCN Red List Categories and Criteria version 15.1 (IUCN, 2022). The examination of herbarium specimens in national and international herbaria (digital images) with our fresh collections shows that this species is distributed in 13 different localities in the state of Tamil Nadu. The species distribution polygon has been prepared to calculate the Extent of Occurrence (EOO) and Area of Occupancy (AOO) for this species using GeoCAT (Bachman *et al*., 2011) available at http://geocat.kew.org/. The result of this analysis shows that the EOO and AOO are 30,461 km² and 52 km², respectively. Although the AOO of this species fits well for the Endangered [EN] category as per Criterion B2, the minimum number of conditions required to qualify under the EN category is insufficient. However, the EOO and the number of locations show that it might be eligible for the threatened categories at any time in the near future. Furthermore, it is observed in the present study that habitat quality is declining due to various developmental activities and the spread of invasive alien species (*Prosopis juliflora* (Sw.) DC. of Fabaceae), which may pose a severe threat to many subpopulations of this steno-endemic species.

Lectotypification

Nees (1832) validated a pro synonym *Lepidagathis spinosa* Wight based on Wallich's Numer. List n. 2497 with a detailed description. The search of this specimen resulted in finding three duplicate specimens, one each at BM (BM013860261), G (G00390435) and K (K001116214), in addition to a collection with a label of *E.I.C.* 2497 at K (K000950142). The examination of Wallich's Numer. List n. 2497 (K001116214) specimen with the original label revealed that this collection was made on 31 October 1815. This shows clearly that this specimen cannot be a collection made by Robert Wight as he had arrived Madras (India) only on 17 September 1819 (Noltie, 2005). Therefore, we assume that it may be a collection made by the Moravian German Missionary, Benjamin Heyne based on handwriting and details on the annotation pasted on the right top of the sheet (pers. comm. Ian M. Turner, K). Furthermore, it is noted that there is no annotation of the name made by Nees on the specimens BM013860261, G00390435, K001116214, and K000950142.

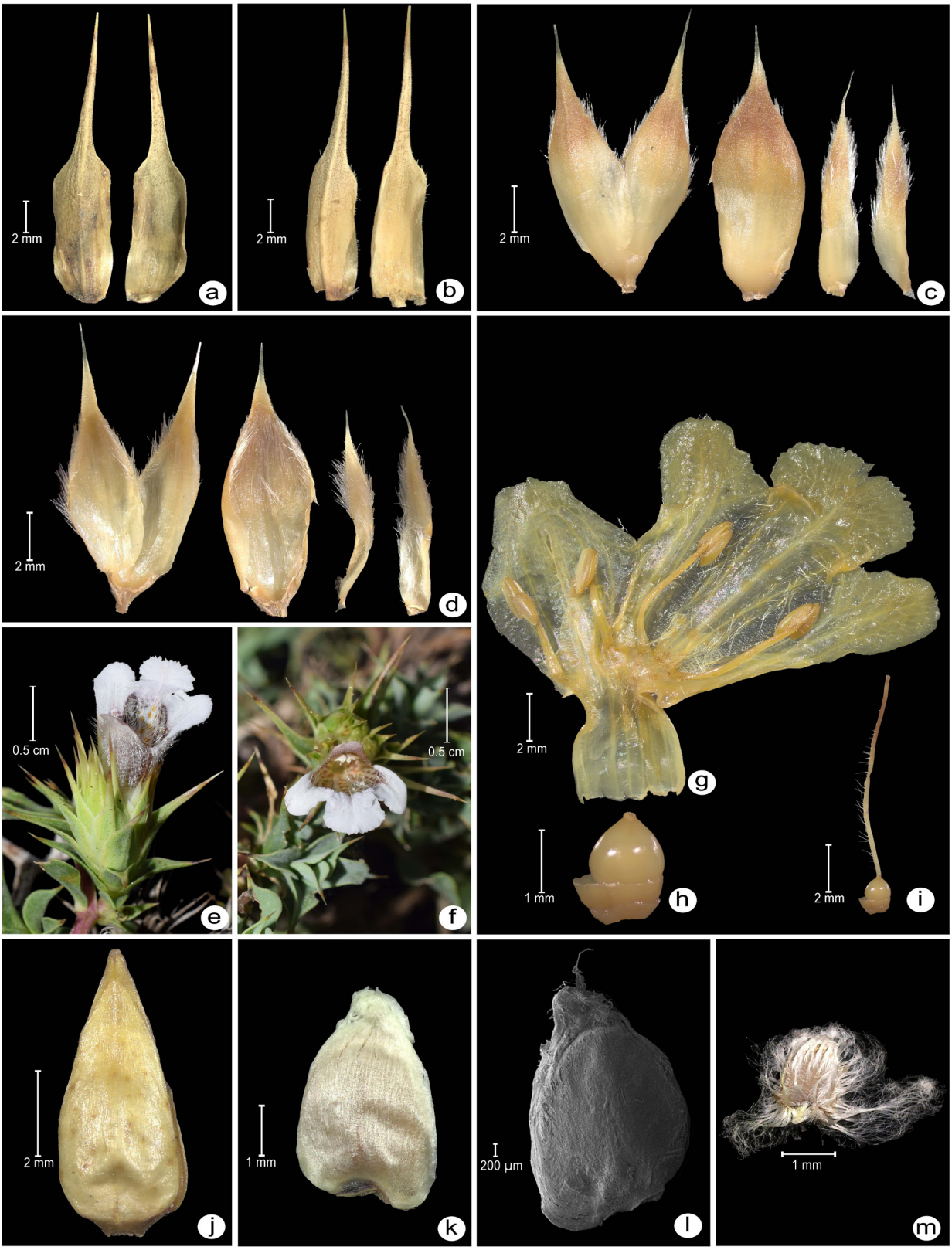

Fig. 2. *Lepidagathis spinosa* Wight ex Nees: **a.** Outer (left) and inner (right) surface of fertile bract; **b.** Outer (left) and inner (right) surface of bracteole; **c.** Outer surface of calyx lobes; **d.** Inner surface of calyx lobes; **e.** Flower – side view; **f.** Flower – front view showing lower lip; **g.** Corolla – split open; **h.** Ovary; **i.** Pistil; **j.** Capsule; **k.** Seed; **l.** SEM micrograph of seed; **m.** Seed with hygroscopic hairs (photos **a**-**d**,**g**-**k**, **m** by A.F.J. King; **e** & **f** by G. Gnanasekaran; **i** by W. Arisdason; from *G. Gnanasekaran* & *A.F.J. King* 12868).

Although there is no annotation made by the validating author, the original specimen of Wallich's Numer. List n. 2497 (K001116214) is designated here as the lectotype for this name in accordance with the article 9.3 of the ICN (Turland *et al*., 2018), as the identity of the species and the description provided in the protologue matches well with this specimen. The other three specimens are considered here as the residual syntypes. Subsequently, Nees (1847) included *Wight herb. proper number* 1972 (E01024337, E01024338, E01024339) as an additional collection examined under the name *L. spinosa*. An examination of all these sheets showed that there is no annotation of the name by Nees (per. comm. Henry J Noltie, E). After going through all these specimens (Wall. Numer. List n. 2497 and *R. Wight* 1972) examined by the original author, what is not clear here is that where and when Robert Wight had proposed the pro synonym, *L. spinosa*, as mentioned by Wallich (1830) in his *Numerical List*. However, the author citation for this name is attributed as "Wight ex Nees" as it was published by Nees (1832) on the basis of Wallich (1830).

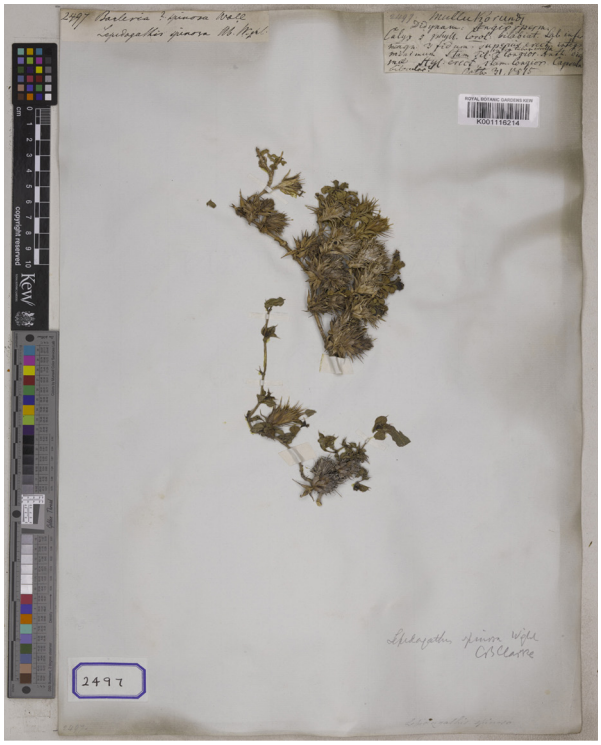

Fig. 3. Lectotype of *Lepidagathis spinosa* Wight ex Nees (K, K00111 6214). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

Clarke (1885) cited a *nomen nudum*, *Acanthus mucronatus* Heyne in Herb. Rottler in the *Flora of British India* based on *Rottler s.n*., a collection made on 26 October 1795 (K000950057) with a label containing the description. Therefore, it is only a pro synonym and not validated by Clarke in 1885. Furthermore, a detailed review on the collector of this specimen shows that it was collected by Rottler and not by B. Heyne as attributed by the Clarke in 1885 (pers. comm. Ian M. Turner, K). Although it was a Rottler collection, the pro synonym is attributed to Heyne based on Clarke (1885) because without his publication the name would not have been indexed.

Geographical Distribution

Yoganarasimhan *et al*. (1981) reported *L. spinosa* in the *Flora of Chikmagalur district* from Karnataka based on a collection from the rocky crevices in shola forests at about 1000 m elevation, with a remark that their material has '*the single spine at the tip of the ovate leaf*….'.

During the present study, it is noticed that the presence of a spinose apical process is a characteristic feature of all the known species growing on the lateritic plateaus of the Western Ghats. Furthermore, the scrutiny of description provided in the Flora is not in congruence with the diagnostic characters of *L. spinosa, i.e., 'leaves ovate-lanceate, acute or acuminate at apex with one spine at the tip and hairy on both surfaces especially on nerves*' versus oblance-ovate to broadly obovate, apex obtuse or rounded with spinose apical process and glabrous throughout (*L. spinosa*). Therefore, it is concluded here that the report of *L. spinosa* from Chikmagalur district is based on an erroneous identification of *L. incurva* Buch.-Ham. ex D.Don.

Furthermore, an examination of the digital images of herbarium specimens housed at C, G (G00390434) and K (K000950141) resulted in locating three specimens of *L. spinosa* made by *G. Thomson s.n.* from the Maisor (Mysore) & Carnatic without date. Other than this, there is no single collection available from the present political boundaries of Karnataka. The probable date of collection of Thomson specimen is almost around 1850. During then, the boundaries of Mysore and Carnatic region include the major portion of

Karnataka (Mysore) and Tamil Nadu (Carnatic). Thus, we presume that Thomson collection might be from the then Carnatic region (Tamil Nadu). As there is no report of any additional specimen from the present political boundaries of Karnataka, the occurrence of this species in the state is uncertain. Therefore, an extensive field exploration in and around Mysore is essential to confirm its presence in the state.

Remadevi and Binoj Kumar (2001, 2009) reported *L. spinosa* as an addition to the *Flora of Kerala* based on specimen collected from the Pathanamthitta district along with an illustration. A detailed study of the description and illustration revealed that it is not in consensus with the diagnostic characters of *L. spinosa*, *i.e*., leaves lanceolate (ovate to elliptic as shown in the illustration), with entire (hairy as shown in the illustration) margins, mucronate with one spine at the tip and pubescent throughout *versus* oblance-ovate to broadly obovate, margins undulate with minutely serrulate, apex obtuse or rounded with spinose apical process and glabrous throughout. Thus, it is confirmed that the report of this species from the state of Kerala was based on a wrong identification of *L. incurva*.

According to the aforementioned sources, throughout the past 40 years or so, *L. spinosa* has been listed in the checklists of flowering plants from several states, significant phytogeographic regions, and the entire country (Sharma *et al*., 1984; Sasidharan, 2003; Karthikeyan *et al*., 2009; Nayar *et al*., 2006, 2014; Singh *et al*., 2015; Sanjappa & Sringeswara, 2019; Arisdason *et al*., 2020; Narasimhan & Irwin, 2020; Ravikumar *et al*., 2021). Therefore, *L. spinosa*, is considered here a species strictly confined to the state of Tamil Nadu. Likewise, the distribution and threat status of many endemic species need proper identification and reassessment for their effective conservation.

Acknowledgements

The first two authors (GG and AFJK) are thankful to the Science and Engineering Research Board (SERB), Government of India for financial support (File number CRG/2020/001605) and the Principal and Head of the Department of Botany, Madras Christian College (Autonomous), Chennai for facilities. Authors are grateful to the Director, Botanical Survey of India, Kolkata and the Heads of MH and RHT for permission to consult the herbarium and library facilities. They are also thankful to the Curators and Directors of BM, C, E, G and K for sharing the digital images of herbarium specimens. Authors also thank Dr. Kanchi N. Gandhi (HUH), Dr. Henry J. Noltie (E) and Dr. Ian M. Turner (K) for discussions regarding the handwritings on herbarium specimens, authority and nomenclature. The support of Mr. V. Thirumurugan for the field collection is also acknowledged.

Literature Cited

ARISDASON W., LAKSHMINARASIMHAN P., KARTHIGEYAN K., KRISHNA G., ALBERTSON D.W., VENU P., PANJA D., GHOSH T., DEBNATH H.S., GNANASEKARAN G., MURTHY G.V.S. & D.K. ROY 2020. Acanthaceae. *In*: MAO, A.A. & S.S. DASH (eds.), *Flowering plants of India an annotated checklist (Dicotyledons)*. Volume 1. Botanical Survey of India, Kolkata. pp. 270–319.

BACHMAN S., MOAT J., HILLL A.W., DE LA TORRE J. & B. SCOTT 2011. Supporting red list threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117–126. https://doi.org/10.3897/zookeys.150.2109

BIJU P., KUMAR V.N.S.A., ARYA S., JOSEKUTTY E.J. & J. AUGUSTINE 2020. *Lepidagathis ananthapuramensis* (Acanthaceae): a new species from the lateritic plateaus of Kerala, India. *Phytotaxa* 460(4): 269–276. https://doi.org/10.11646/phytotaxa.460.4.4

CHANDORE A., BORUDE D.B., MADHAV N.A. & S.R. YADAV 2020. *Lepidagathis sabui* (Acanthaceae), a new species from the lateritic plateaus of Konkan region of Maharashtra, India. *Phytotaxa* 464(2): 159–166. https://doi.org/10.11646/phytotaxa.464.2.2

CLARKE C.B. 1885. Acanthaceae. *In*: HOOKER, J.D. (ed.), *The flora of British India*. Volume 4. L. Reeve & Co., London. pp. 387–558.

IUCN 2022. *Guidelines for using the IUCN Red List Categories and Criteria. Version 15.1*. Prepared by the Standards and Petitions Committee. Available at: http://www.iucnredlist.org/documents/RedListGuidelines.pdf. (Accessed on 20.09.2022).

KARTHIKEYAN S., SANJAPPA M. & S. MOORTHY 2009. *Flowering plants of India, Dicotyledons, Volume 1 (Acanthaceae – Avicenniaceae)*. Botanical Survey of India, Kolkata.

MORE S., KAMBALE S., SAWANT M., MANE R. & H. BHOSALE 2022. *Lepidagathis mahakassapae* sp. nov. (Acanthaceae: Barlerieae) from the high elevated lateritic plateau of northern Western Ghats of Maharashtra, India. *Nordic Journal of Botany* 2022(7): pe03345. https://doi.org/10.1111/njb.03345

NARASIMHAN D. & S.J. IRWIN 2020. *Flowering plants of Tamil Nadu: a compendium*. Care Earth Trust, Chennai.

NAYAR T.S., RASIYA BEEGAM A., MOHANAN N. & G. RAJKUMAR 2006. *Flowering plants of Kerala: a handbook*. Tropical Botanic Garden and Research Institute, Palode.

NAYAR T.S., RASIYA BEEGAM A. & M. SIBI 2014. *Flowering plants of the Western Ghats, India*. Tropical Botanic Garden and Research Institute, Palode.

NEES VON ESENBECK C.G.D. 1832. Acanthaceae Indiae Orientalis. *In*: WALLICH N. (ed.), *Plantae Asiaticae rariores*. Volume 3. Treuttel, Würtz & Ritter, London. pp. 70–117.

NEES VON ESENBECK C.G.D. 1847. Acanthaceae. *In*: DE CANDOLLE A.P. (ed.), *Prodromus systematis naturalis regni vegetabilis*. Volume 11. Treuttel & Würtz, Paris. pp. 223–247.

NOLTIE H.J. 2005. *The botany of Robert Wight*. A.R.G. Gantner Verlag, Ruggell.

POWO 2022. *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew. Available at: http://www.plantsoftheworldonline.org/ (Accessed on 20.09.2022).

PRASAD K. & A.M. REDDY 2020. *Lepidagathis rajasekharae* (Acanthaceae), a new species from the Seshachalam hills of Eastern Ghats of Andhra Pradesh, India. *Phytotaxa* 470(1): 112–116. https://doi.org/10.11646/phytotaxa.470.1.7

RAVIKUMAR K., TANGAVELOU A.C. & N. PAGE 2021. *Seed plants of Karnataka, India: a concise dictionary*. Foundation for Revitalisation of Local Health Traditions – The University of Trans-Disciplinary Health Sciences and Technology (FRLHT-TDU), Bengaluru and National Biodiversity Authority (NBA), Chennai.

REMADEVI S. & M.S. BINOJ KUMAR 2001. *Lepidagathis spinosa* Wight – an addition to the flora of Kerala. *Journal of Economic and Taxonomic Botany* 25(1): 229–230.

REMADEVI S. & M.S. BINOJ KUMAR 2009. *Contributions to the flora of Kerala: the family Acanthaceae*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

SANJAPPA M. & A.N. SRINGESWARA 2019. *Flora of Karnataka: a checklist*. Volume 2: Gymnosperms & Angiosperms. Karnataka Biodiversity Board, Bengaluru.

SASIDHARAN N. 2003. *Biodiversity documentation for Kerala.* Part 6: Flowering plants. Kerala Forest Research Institute, Peechi.

SHARMA B.D., SINGH N.P., RAGHAVAN R.S. & U.R. DESHPANDE 1984. *Flora of Karnataka – analysis.* Flora of India. Series 2. Botanical Survey of India, Calcutta.

SINGH P., KARTHIGEYAN K., LAKSHMINARA SIMHAN P. & S.S. DASH 2015. *Endemic vascular plants of India*. Botanical Survey of India, Kolkata.

THIERS B.M. updated continuously. Index herbariorum. Available at: http://sweetgum.nybg.org/science/ih/ (Accessed on 10.09.2022).

TURLAND N.J., WIERSEMA J.H., BARRIE F.R., GREUTER W., HAWKSWORTH D.L., HERENDEEN P.S., KNAPP S., KUSBER W.H., LI D.Z., MARHOLD K., MAY T.W., MCNEILL J., MONRO A.M., PRADO J., PRICE M.J. & G.F. SMITH (eds.) 2018. *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile* 159. Koeltz Botanical Books, Glashütten. https://doi.org/10.12705/Code.2018

WALLICH N. 1830. *A numerical list of dried specimens of plants, in the East India Company's museum*, London. Numbers. 2154–2603.

YOGANARASIMHAN S.N., SUBRAMANYAM K. & B.A. RAZI 1981. *Flora of Chikmagalur district, Karnataka, India*. International Book Distributors, Dehra Dun.