RHEEDEA
Journal of the Indian Association for Angiosperm Taxonomy
RESEARCH ARTICLE
Vol. 33(1): 8–16 (2023)
ISSN: 0971-2313 (Print edition)
ISSN: 2582-2438 (Online edition)
https://dx.doi.org/10.22244/rheedea.2023.33.01.02

Extended distribution, typification and modelling of potential areas of *Boehmeria clidemioides* (Urticaceae) in the Western Himalaya, India

Gupta A.[1,3], Adhikari D.[2,3], Hurrah I.A.[1, 3] & V.V. Wagh[1,3]*
[1]Plant Diversity, Systematics and Herbarium Division, CSIR–National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh – 226 001, India
[2]Plant Ecology and Climate Change Division, CSIR–National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh – 226 001, India
[3]Academy of Scientific and Innovative Research (AcSIR), CSIR–HRDC Campus Ghaziabad, Uttar Pradesh – 201 002, India
*E-mail: vijaywagh65@gmail.com

Abstract: *Boehmeria clidemioides* Miq. (Urticaceae) is recorded for the first time in Uttarakhand state of India. The species has so far been known to occur in the eastern Himalayan region of India. A detailed description, illustration, colour photographs and notes on distribution are provided here for its easy identification. The name *Boehmeria clidemioides* is lectotypified and a potential distribution area map is provided for further search for the species in the Western Himalaya.

Keywords: *Boehmeria*, Extended distribution, Himalaya, Potential distribution area, Typification.

Introduction

Boehmeria Jacq. (Urticaceae) is the largest genus in tribe Boehmerieae comprising a number of apomictic species (Yahara, 1990). The genus includes 52 accepted species (POWO, 2023), distributed in tropical to temperate regions of America, Asia and Africa. According to Acharya (2004), 33 species and 12 varieties are found in South Asia. Wilmot-Dear and Friis (1996, 2013) reported a total of 47 species, slightly fewer than POWO (2023), out of which 10–15 species are known from Indian territory (Gaur, 1999).

During field exploration in Bageshwar district of Uttarakhand, a few specimens belonging to *Boehmeria* were collected by the first author. Based on critical examination, review of literature (Miquel, 1851; Hooker, 1888; Hara, 1975; Yahara, 1981, 1990; Chen & Monro, 2003; Wilmot-Dear & Friis, 2013) and study of herbarium specimens in ASSAM, BSD, CAL and DD, as well as of virtual images of specimens in GH, K, L and NHN, the identity of the taxon was confirmed as *Boehmeria clidemioides* Miq. In India, *B. clidemioides* mostly occurs in Eastern Himalaya (Hara, 1975) and most populations in India are confined to the northeastern states (Hara, 1975; Deb, 1981; Nair, 1977; Balakrishnan, 1983; Barooah & Ahmed, 2014). Hence the present report of the species forms an addition to the flora of Western Himalaya. A detailed morphological description, phenology, photographs, illustration, and relevant notes are provided to facilitate its easy identification. A lectotype is designated here according to Shenzhen Code (Turland *et al.,* 2018), and a potential distribution area map is prepared based on Maxent model with the available data.

Received: 20.08.2022; *Revised & Accepted*: 29.03.2023
Published Online: 31.03.2023

Materials and Methods

Collection, processing, and preparation of the herbarium specimens followed Jain and Rao (1977). Voucher specimens were deposited at the Herbarium of National Botanical Research Institute (LWG). Fresh plant materials were examined under a Leica S8APO 170 HD stereomicroscope. The habit, habitat features and the geo-coordinates (latitude/longitude/elevation) were using GPS Garmin Montana 680. Morphological terminology followed Hooker (1888), as updated by Wilmot-Dear and Friis (1996, 2013) and Chen and Monro (2003). The type has been designated based on the protologue (Miquel, 1851) and original material at L and GH, following Art. 9.3 of the ICN (Turland *et. al.,* 2018).

The potential distribution area of *B. clidemioides* in Western Himalaya was modeled using Maxent 3.4.4 (http://biodiversityinformatics.amnh.org/open_source/maxent) (Steven *et. al*., 2021) and the bioclimatic (BIOCLIM) dataset of 30 arc seconds (~1 km) resolution (downloaded from www.worldclim.org). Occurrence data for the species for training the model was collected from India through field surveys and secondary sources in the published literature (Hara, 1975; Deb, 1981; Nair, 1977; Balakrishnan, 1983; Barooah & Ahmed, 2014) and Indian herbaria (BSHC, ARUN, CAL, DAR). The Western Himalayan region was kept as a projection. BIOCLIM data comprising 19 bioclimatic variables for these two regions were clipped using QGIS (http://qgis.osgeo.org) and used to model the potential area. Maxent was run with 10 replications employing the bootstrapping procedure. The other fitting parameters such as convergence threshold (0.00001), regularization multiplier (1), maximum number of iterations (500), and number of background points (10,000) were set to default. The potential distribution area map in the Western Himalayan region was prepared using QGIS.

Taxonomic Treatment

Boehmeria clidemioides Miq., Pl. Jungh. 1: 34. 1851. *Boehmeria platyphylla* D.Don var. *clidemioides* (Miq.) Wedd., Monographie de la famille des Urticacées, [Archives du Museum d'Histoire Naturelle, Paris 9:1–400. 1856. *Lectotype* (designated here): INDONESIA, **Java**, Mount Merapi, April 1851, *F.W. Junghuhn,* "No. 6" (L [L1624156 digital image!]); *isolecto F.W. Junghuhn s.n.* (L [L0836097 digital image!]); *F.W. Junghuhn* "N0. 6" (GH [GH0028623 digital image!]).

Boehmeria platyphylla D.Don var. *cinerascens* Hook.f., Fl. Brit. Ind. 5: 579. 1888. **Figs. 1–3**

Evergreen, perennial, undershrubs, up to 3–4 feet; stems cylindrical, erect, branched, woody at base, sparsely pubescent, indumentum fine, ± adpressed, 0.2–0.65 mm; ultimate stem up to 1.5 cm across. Stipules interpetiolar in a pair on each side of the opposite petioles, ovate–deltoid, narrow, ± asymmetrical at apex, 1.3–6.5 × 0.7–2.35 mm, pubescent on outside at midrib (indumentum 0.12–0.76 mm long), apex acuminate. Leaves opposite to sub-opposite. Petioles 2–6 cm long, densely

Table 1. Bioclimatic dataset used to predict the potential distribution of *Boehmeria clidemioides* in Western Himalaya.

Climatic dataset	Variable code	Variable name
BIOCLIM	Bio 1	Annual mean temperature
	Bio 2	Annual mean diurnal range
	Bio 3	Isothermality
	Bio 4	Temperature seasonality (standard deviation)
	Bio 5	Maximum temperature of warmest month
	Bio 6	Minimum temperature of coldest month
	Bio 7	Annual temperature range
	Bio 8	Mean temperature of wettest quarter
	Bio 9	Mean temperature of driest quarter
	Bio 10	Mean temperature of warmest quarter
	Bio 11	Mean temperature of coldest quarter
	Bio 12	Annual precipitation
	Bio 13	Precipitation of wettest month
	Bio 14	Precipitation of driest month
	Bio 15	Precipitation seasonality (coefficient of variation)
	Bio 16	Precipitation of wettest quarter
	Bio 17	Precipitation of driest quarter
	Bio 18	Precipitation of warmest quarter
	Bio 19	Precipitation of coldest quarter

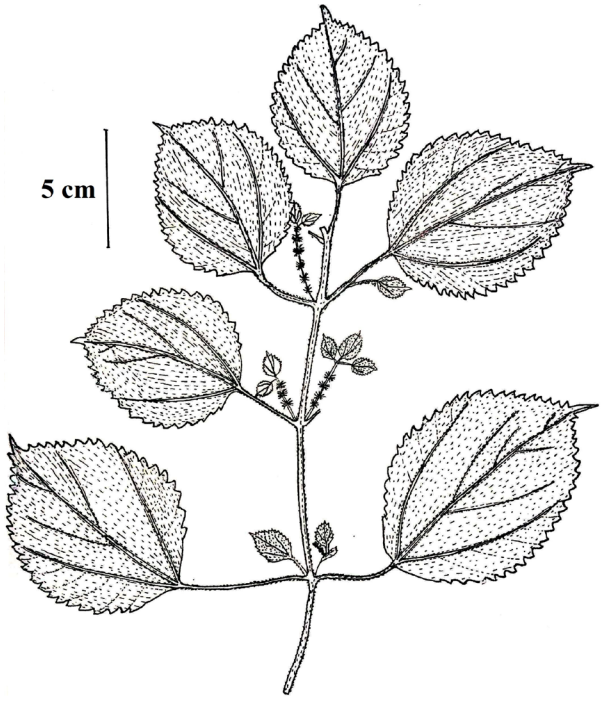

Fig. 1. *Boehmeria clidemioides* Miq. habit (from *Amit Gupta & Imtiyaz A. Hurrah* 326529; drawn by Amit Gupta).

pubescent (hairs 0.2–0.45 mm long); lamina 6–10 × 4–7 cm, slightly asymmetrical, trinerved, base slightly cordate to rounded, nearly oblique, margins serrate, apex acuminate or caudate with single long tooth with 1–2 smaller lateral ones, abaxial surface densely pubescent with short adpressed and fine long hairs, adaxial surface glabrescent, cystoliths dense, round, rough to touch; basal lateral veins extent up to more than half of lamina (1/3 of distal half), upper lateral veins 2–3 either side, arising from mid or below half of lamina or nearly from lamina base. Inflorescences on modified flower-bearing axes, mostly with a tuft of small leaves at its apex; flower-bearing axis unisexual and/or bisexual, floral clusters above on the axes mainly female, unbranched or rarely branched at base. Male floral axes 2–7 cm long, pubescent, with 14–25 floral clusters, 1–2 mm in diam., 8–15 male flowers to a cluster, loosely arranged, distance between clusters 2–3 cm. Bracts deltoid to ovate, 1.44–3.09 × 0.87–1.82 mm, pubescent on midrib dorsally; bracteoles membranous, *c.* 1 mm long. Male flowers tetramerous *c.* 1 mm across, pubescent (hairs 0.25 mm long) near apex of perianth, sessile to pedicellate (1–1.4 mm long), with a rudimentary ovary; perianth lobes elliptic, up to 1.5 × 0.83 mm, fused, valvate. Stamens 4, free, filaments flattened, up to 2 mm long; anthers bilobed, basifixed, 0.57–0.63 × 0.46–0.51 mm. Female floral axes 4–11 cm long, pubescent, 7–30 cluster on each floral axis; each clusters *c.* 50-flowered (some time clusters may be bisexual), lax or condensed. Female flowers sessile, up to 3 mm long, with flowering perianth persisting in fruit; ovary 0.52–0.76 × 0.29–0.61 mm; style up to 1.13 mm long, pilose. Fruiting perianth unwinged and hardening into small achenes with perianth and persisting style. Seeds oval to quadrangular, 0.6–0.7 × 0.3–0.52 mm.

Flowering & Fruiting: Flowering from August to September and fruiting from September to October.

Habitat: Found in open areas, at forest edges, on moist slopes, along roadsides, in ravines, along banks of streams, ponds and rivers, between 600–2200 m elevation.

Distribution: SE Asia (Indonesia, Java, Malaysia, Myanmar, Sumatra, Thailand, Vietnam) Nepal, Bhutan, China, India (Wilmot-Dear & Friis, 2013).

Modelling of potential distribution areas: In India *Boehmeria clidemioides* occurs widely in Sikkim, Assam, Meghalaya and Arunachal Pradesh (Northeast India). In the present study, we used a Maxent model to predict suitable areas for the species in Western Himalaya. The purpose of this modeling was to predict whether suitable areas for the species exist in the Western Himalayas. The new collection record was used as an independent validation data point in the study, which proves that the species does occur in the predicted suitable areas. The Maxent model yielded a mean AUC value of 0.931 showing good fitness and predictive capacity. Annual mean diurnal temperature range (Bio 2) and precipitation of wettest quarter (Bio 16) were identified as the most influential variables that had most effect on the modeled distribution of the species the distribution of the species. The model predicted the occurrence of highly suitable areas in the states of Uttarakhand, Himachal Pradesh and Jammu & Kashmir.

Through ground truthing, we could locate the species in one of these suitable areas near the Bharari village of Bageshwar district of Uttarakhand at an altitude of 2109 m (N 30°03'32" E 79°53'08") (Fig. 3). Nonetheless, we expect that future visits in other predicted suitable areas would result in the discovery of new populations of the species.

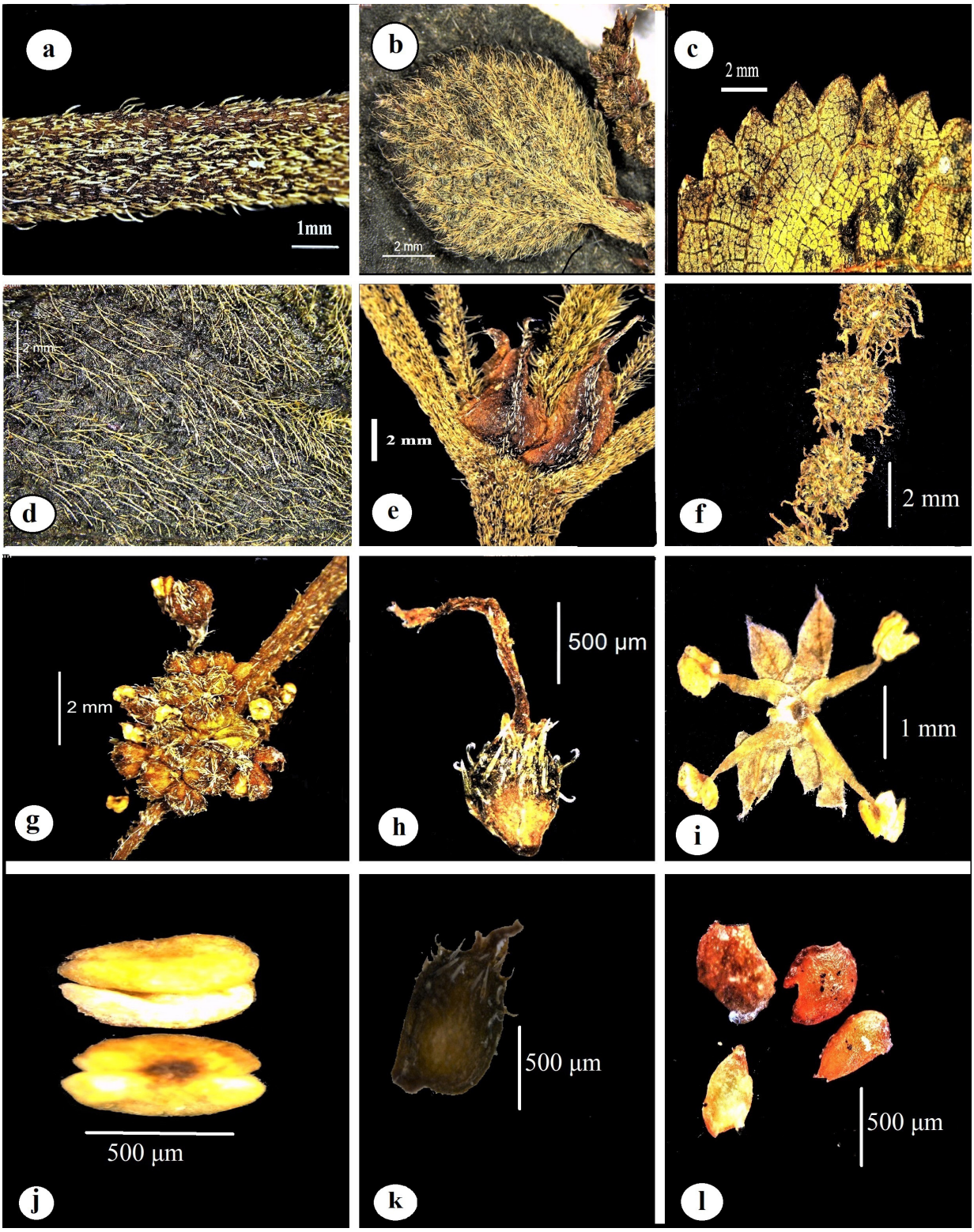

Fig. 2. *Boehmeria clidemioides* Miq.: **a**. Indumentum on stem; **b**. Leaf-abaxial surface; **c**. Leaf margin; **d**. Abaxial leaf surface; **e**. Stipules ; **f**. Female glomerulus; **g**. Male glomerulus; **h**. Female flower; **i**. Male flower; **j**. Anthers; **k**. Achene; **l**. Seed (from *Amit Gupta & Imtiyaz A. Hurrah* 326529; photos by Amit Gupta).

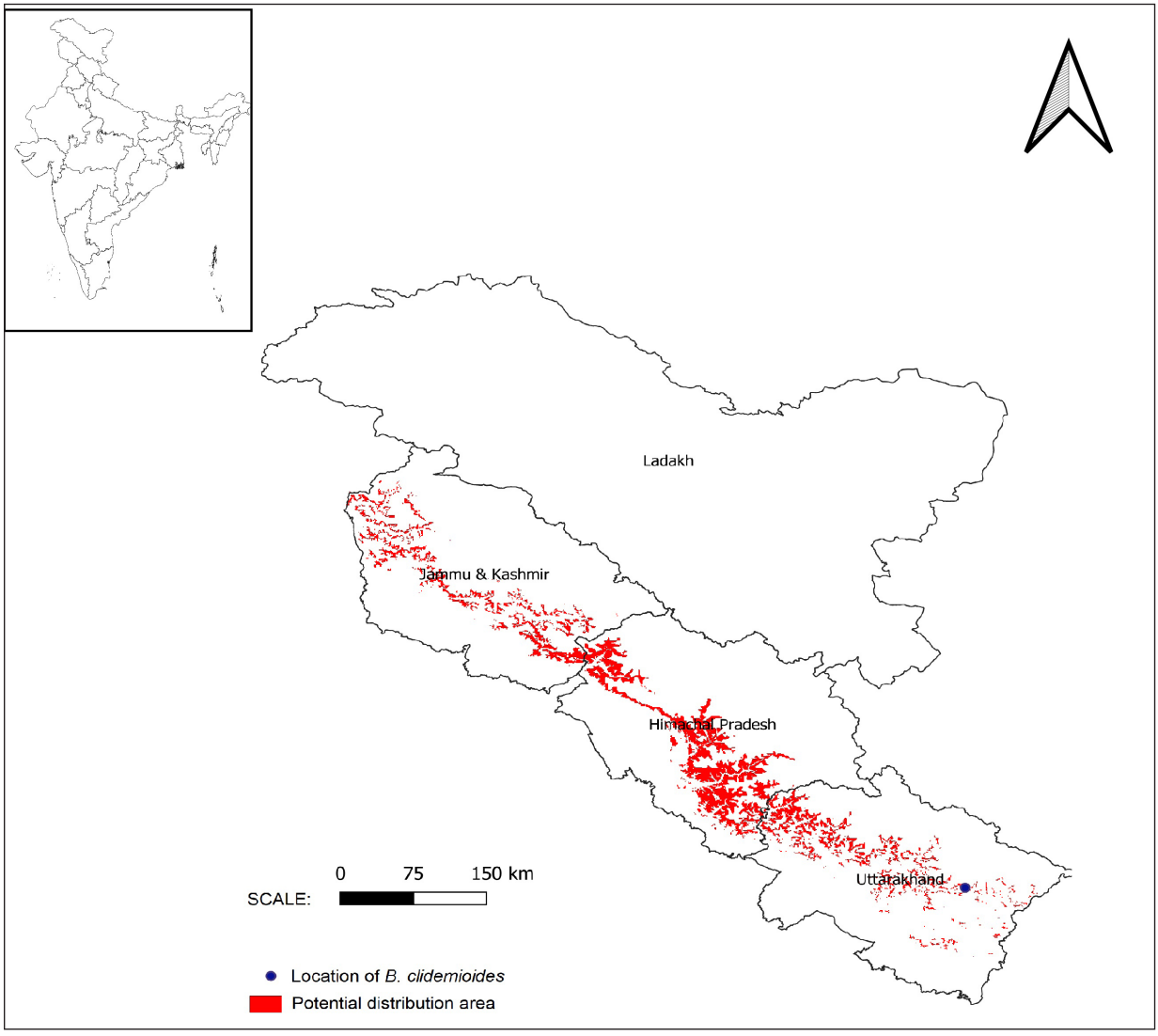

Fig. 3. Observed record in Uttarakhand and predicted potential distribution area of *Boehmeria clidemioides* Mig. in the Western Himalaya using Himalaya based on occurrence points of the species in Northeast India.

Specimens examined: BHUTAN, **Jashigong Hills,** 10.03.1965, *Balakrishnan* 41251 (ASSAM). INDIA, **Arunachal Pradesh**, Changlang district, Jairampur, 1193 m., 11.10.1956, *Rolla S. Rao* 19994 (ASSAM); East Siang district, Pasighat, 02.12.1952, *G.K. Deka* 23320 (ASSAM); Subansiri, New headquarters, 2220 m, *D.B. Deb* 19552 (ASSAM); Tirap district, Khonsa to Kaju, 23.06.1961, *D.B. Deb* 25994 (ASSAM); Tinchha, 1753 m, 24.08.1958, *Panigrahi* 14641 (ASSAM). **Assam**, Kamrup district, Chandmari, 15.09.1950, *B.B. Shyam* 22990 (ASSAM); Khasi and Jaintia Hills, 11.11.1930, *U. Kanjilal* 7626 (ASSAM); *ibid*., 14.09.1942, *G.K. Deb* 21532 (ASSAM). **Meghalaya,** East Khasi Hills district, Shillong, Barapani, 14.09.1930, *P.C. Kanjilal* 8461 (ASSAM); Bidan & Bishop fall, 24.12.1962, *R.H.* 25503 (ASSAM); Khasi Hills, 09.07.1954, *s.coll.* 8145 (ASSAM); Mahadev Khola forest, 21.11.1963, *S. Chowdhary* 25147 (ASSAM); Nongthymai, 11.09.1956, *G. Panigrahi* 3222 (ASSAM); Woodland campus, September 1960, *G.K. Deb* 21779 (ASSAM); Jaintia Hills district, Mynsngat to Nartiang, 1000 m, 27.08.1965, *Balakrishnan* 47143 (ASSAM); *ibid*., 27.08.1965, *Balakrishnan* 47149 (ASSAM); West Jaintia Hills district, Jawai road, 20.09.1930, *P.C. Kanjilal* 8509 (ASSAM). **Mizoram**, Dampa forest reserve, Teirei, 700 m, 21.09.2006, *B.K. Sinha* 112725 (ASSAM). **Sikkim**, *Thomson T.* 747 (ASSAM); **Tripura,** Sekhan, Sermon, 800 m, 03.02.1962, *D.B. Deb* 27444 (ASSAM). **Uttarakhand,** Bageshwar,

Fig. 4. Lectotype of *Boehmeria clidemioides* Miq. (L1624156) © Naturalis, Leiden. Reproduced with permission.

Bharari 2109 m, 18.08.2019, *Amit Gupta & Imtiyaz A. Hurrah* 326529 (LWG). INDONESIA, **Java**, Omgeving Tjibodas Ooatrand van het dal, 07.05.1950, *S.J. Van* 952 (L); G keloet, tuss chen bovenkampen benedenkamp, lang den weg 10.04.1938, *Coert* 1775 (L); Soerakarta, sekardjinggo boven tawangmangoe, 1300 m, 27.07.1936, *R. Brinknaan s.n.* (L); Eiland resid 06.05.1929,1500 m, *Backer* 37221 (L). **Sumatra,** W. Kust Koerintji bt. Tibakar 850 m, 06.02.1920, *Bunnemeijer* 7947 (L). MYANMAR, **Moulmein,** 18.10.1975, *Kuntze* 6273 (NY). THAILAND, **Chiang Mai,** Mae Dtang, Doi sahmg Liang, 1050 m, 07.01.1998, *Maxwell* 98–22 (L); Maung, Doi Suthep Pui National Park, 03.12.1999, *Maxwell* 99–313 (NHN); Payao, muang Doi Luang National Park, 600 m, 09.05.1997, *Maxwell* 97-511 (L); Chiang Dao district, Doi Chiang Dao Animal Sanctuary, 700 m, 30.03.1995, *Maxwell* 95–286 (L). **Chiang Mai Wieng**, near Huay Miang, 925m, 19.04.1995, *Maxwell* 95–345 (L). **Chiang Mai Sahngahmpang**, Mae awn mae Gahm: Bawng village, 1100 m, 17.05.1995, *Maxwell* 95–394 (L). **Lampang,** Muang Bahn, Jae sawn National Park, 575 m, 25.08.1995, *Maxwell* 95–587 (L). **Nan**, ban nan dun: Doi Phu Kha, 1050 m, 11.09.1996, *Larsen s.n.* (NHN). **Nan**, near Doi Phu Kha, 1600 m, 02.09.1999, *D.J. Middleton* 142 (GH). **Siam**, Auerjmai, 20.09.1938, 1200 m, *Garrett* 1091 (L); Mai Hong Son: Huany Yuak village Khoonyauan 13.10.1983, *Hiroshige* 32440 (NHN). VIETNAM, **Da Nang**, Ba Na Nui Chua 22.10.2008, *Du NV* 3271 (L).

Typification

Boehmeria clidemioides was described by Miquel (1851) based on a collection from Java (Indonesia) by the German botanist Friedrich Franz Wilhelm Junghuhn. In the protologue Miquel (*l.c.*) cited "Hab. In sylvis m[onte]. Merapi insulae Java [In forest on Mt. Merapi on the island of Java]" with the month of collection "April" and the collector's name given as "Jungh". The original material was thus collected on the volcano Merapi in the central part of Java. Wilmot-Dear and Friis (2013), in their monograph of *Boehmeria,* cited some of the specimens they had seen of the type material of *B. clidemioides* as "Type: Junghuhn *s.n.* (holo L; iso A, CAL), Indonesia, Jawa [Java], Mt Merapi". In our search we could locate a specimen at L (L0836097), labelled by Wilmot-Dear & Friis "as probable holotype". Another specimen at L (L1624156), apparently originating from the same collection, was named by Wilmot-Dear and Friis on their *determinavit* slip as "*Boehmeria clidemioides* Miq. *sensu lat.*" But for that specimen they mentioned nothing about its possible type-status. The specimen at CAL cited by Wilmot-Dear & Friis (2013) may have been an error; at least we have failed to locate it. However, we have been able to locate the specimen which Wilmot-Dear and Friis stated was kept at A. This must be a specimen at GH (GH00286231), and this specimen was labelled as "probable isotype" by Wilmot-Dear & Friis. The reason for the differences in the Index Herbariorum code between what was stated by Wilmot-Dear & Friis and what appears from the

present barcode (GH00286231) must be due to confusion between the herbarium of the Arnold Arboretum (A) and Gray Herbarium (GH), both integrated in the collections of the Harvard University. However, while most specimens of *B. clidemioides* are marked "Arnold Arboretum" and "A" the specimen GH00286231 is stamped "Gray Herbarium" should be cited as belonging to that. These three sheets, two from L and one from GH, must be part of the original material, but for reason unknown and following the nomenclatural code then in force, Wilmot-Dear & Friis assumed that one of the specimens at L (where Miquel was the Director) was the holotype, and they abstained from further discussion of the typification. Since Wilmot-Dear and Friis failed to designate a lectotype, it is selected from among the specimens deposited at L and GH. One of the specimens at L and the specimen at GH lack a diagnostic feature mentioned in Miquel's protologue "*spicis axillaribus superne femineis, inferne masculis, remote glomeratis, apicesae foliiferis".* These diagnostic features are only observable on the specimen L1624156 (Fig. 4), which thus unequivocally agrees with the protologue, is selected here as the lectoype of *B. clidemioides* and the specimens L0836097 and GH00286231 are here designated as isolectotypes. It's unlikely that the annotation "No. 6" which appears on the labels of L1624156 and on GH00286231, but not on L0836097, represents the collector's original number, as one would assume from analogy with modern herbarium labels; it is more likely that the "6" refers to the fact that the protologue of *B. clidemioides* is the sixth in Miquel's account of the species in the genus *Boehmeria.*

Notes: Taxonomically *B. clidemioides* belongs to tribe Boehmerieae which includes 11 genera and 40 taxa in India (Hooker, 1888; Karthikeyan *et al.,* 2009). Within *Boehmeria*, *B. clidemioides* can be easily identified by its modified inflorescence bearing an axis with a tuft of leaves, but it may be confused with *B. cylindrica* (L.) Sw. which shows a similar character, but that species is only found in the New World. However, other characters of *B. clidemioides* such as leaf shape (narrowly ovate), number of teeth (20–25), leaf base (cuneate) and indumentum are clearly different from those in the New World species.

In India, there are two varieties of *B. clidemioides* (*i.e.*, var. *clidemioides* and var. *diffusa*) which grows sympatrically in northeastern states. *Boehmeria clidemioides* var. *clidemioides* has erect stems; opposite to sub-opposite, narrowly ovate leaves; a flower-bearing axis having a leaf tuft at the apex. It differs from its allied var. *diffusa* in its erect *vs.* diffuse stem, opposite *vs.* alternate leaves, lamina base obtuse or round *vs.* cuneate, more than 25 *vs.* less than 20 marginal teeth, inflorescence bearing axes almost entirely leafless in lower part *vs.* inflorescence bearing axes often with scattered leaves throughout length and fruiting perianth base obovoid *vs.* obtuse. Sometimes, leaf tufts are completely absent in the inflorescence-bearing axes of *B. clidemioides* which can cause confusion with *B. virgata* subsp. *macrophylla* var. *macrostachya* (Wight) Friis & Wilmot-Dear, and *B. virgata* subsp. *macrophylla* var. *rotundifolia* (D.Don) Friis & Wilmot-Dear because of similar leaf shape (broad ovate), texture (thin to thick) and fruiting perianth shape. However, *B. virgata* subsp. *macrophylla* var. *macrostachya* varies from *B. clidemioides* by its narrow or broadly cuneate, slightly asymmetrical leaf base, thin, chartaceous, bullate leaf texture, 20–60 marginal teeth; fruiting perianth narrow ovoid with distinct marginal rim. *Boehmeria virgata* subsp. *macrophylla* var. *rotundifolia* differs by abundant fine hairs on stem, broad elliptical or orbicular leaf shape, marginal teeth 25–30, teeth size increase toward apex; base round without distinct leaf base, small fruiting perianth, ellipsoidal, and fine indumentum throughout. *Boehmeria virgata* subsp. *macrophylla* var. *scabrella* (Roxb.) Friis & Wilmot-Dear differs from *B. clidemioides* by its asymmetrical leaf, broad cuneate, oblique, sub cordate leaf base; margin with 30–40 teeth; fruiting perianths ovoid with minute abrupt beak.

The altitudinal distribution range of *B. clidemioides* varies from 600 m to 2200 m and along this gradient the plants show variation in morphotypes. This indicates that the species is very much adaptable to the wide altitudinal range. Further detailed studies need to be done on the morphological diversity with respect to the different altitudinal gradient along which the species occurs.

In general, the Eastern Himalayan flora is dominated by Malaysian and Sino-Himalayan elements, while the far Western Himalayan flora has more European and Mediterranean elements (Kholia et al., 2013).

The very widespread *B. virgata* subsp. *macrophylla* var. *macrostachya* extends further west in the Himalayas, almost to the border with Pakistan (Wilmot-Dear & Friis, 2013), but then the subspecies also occurs in tropical Africa, where it is represented by other varieties. Records of intermediate forms between several other varieties of *B. virgata* subsp. *macrophylla* have been recorded from as far as northern Pakistan (Wilmot-Dear & Friis, 2013).

Recently many common angiosperms of Eastern Himalaya have been reported by various collectors as occurring in Uttarakhand (Rai *et al.,* 2014, 2015, 2017, 2018). Though *B. clidemioides* is a Southeast Asian species, it also occurs in India, China, and extends up to few parts of South Japan (Wilmot-Dear & Friis, 2013). Occurrence of this species in the western part of the Himalayas provides evidences for east to west distribution of the flora within the Himalayas. According to Kholia *et al*. (2013) occurrence of many eastern Himalayan species (*Anemone demissa* Hook.f. & Thomson, *Scrophularia pauciflora* Benth., *Anthoxanthum flexuosum* (Hook.f.) Veldkamp, *Platanthera pachycaulon* (Hook.f.) Soó, *Platanthera cumminsiana* (King & Pantl.) J. Renz) in the western part of the Himalayas, therefore, indicate that the climate of western regions is becoming conducive for the growth of eastern Himalayan flora there. These species in western Himalayan region could be attributed to their extended range of distribution or restrained botanical excursions in these interior valleys (Kholia *et al.,* 2013).

Acknowledgements

The authors are thankful to the Director CSIR-National Botanical Research Institute, Lucknow for access to their facilities and encouragement. We are very much thankful to one of the reviewer Dr. Ib Friis for his valuable comments and suggestions for the improvement of the manuscript. We are thankful to the curators of various Indian herbaria for allowing us to consult their herbaria and study the specimens (ASSAM, CAL, LWG,). We are grateful to the Curators of BM, G, GH K, KATH, L, MNHN, NY, NHN, and M herbaria for providing access to the specimens online. The first author thanks the University Grant Commission, New Delhi for a Senior Research Fellowship [F.No.16.9(June 2018)/2019(NET/CSIR)].

CSIR-NBRI communication number: CSIR-NBRI_MS/2021/10/03.

Literature Cited

ACHARYA N. 2004. Taxonomy and phylogeny of genus *Boehmeria* Jacq. in South Asia. *Animal Cells and Systems* 8: 62 (Abstact).

BALAKRISHNAN N.P. 1983. Flora of Jowai and vicinity, united Khasi & Jaintia hills district, (Meghalaya), Assam (angiosperms only). Volume 2. Botanical Survey of India, Kolkata.

BAROOAH C. & I. AHMED 2014. *Plant diversity of Assam* (a checklist of angiosperms and gymnosperms), ASTEC. Bigyan Bhawan, Guwahati, Assam.

CHEN C.J. & A.K. MONRO 2003. Urticaceae. *In*: WU Z.Y., RAVEN P.H. & D.Y. HONG (eds.), *Flora of China*. Volume 5. Science Press, Beijing & Missouri Botanical Garden, St. Louis. pp 76–189.

DEB D.B. 1981. *The flora of Tripura state.* Volume I. Today and Tomorrows Printers and Publishers. New Delhi, India.

GAUR R.D. 1999. *Flora of the district Garhwal, North West Himalaya (with ethnobotanical notes)*, Transmedia. Srinagar (Garhwal).

HARA O. 1975. *Flora of eastern Himalaya*. University of Tokyo Press, Tokyo.

HOOKER J.D. 1888. Urticaceae. *In*: HOOKER J.D. (ed.), *The flora of British India*. Volume. 5. L. Reeve & Co., London. pp. 477–594.

JAIN S.K. & R.R. RAO 1977. *A handbook of field and herbarium methods*. Today and Tomorrow Printers and Publishers. New Delhi.

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

KHOLIA B.S., JOSHI R. & R. PUNETHA 2013. Extended distribution of *Cyathea spinulosa* Wall. ex Hook. in Uttarakhand Himalaya with a note on distribution and diversification of Himalayan ferns in relation to recent climate change. *NeBIO* 4(2): 40–50.

MIQUEL F.A.W 1851. *Plantae Junghuhnianae: enumeratio plantarum, quas, in insulis Java et Sumatra.* Part 1. AW Sythoff: [Leiden] & Baillière, Paris.

NAIR N.C. 1977. *Flora of Bashahr Himalayas*. International Bioscience Publishers, Hissar.

POWO 2023. *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew. Available at http://www.plantsoftheworldonline.org/(Accessed on 20.03.2023).

RAI I.D., JALAL J.S., SINGH G. & G.S. RAWAT 2014. *Platanthera pachycaulon* (Orchidaceae): an addition to the orchid flora of western Himalaya, India. *Richardiana* XIV (9): 266–273.

RAI I.D., JALAL J.S., SINGH G. & G.S. RAWAT 2015. Extended distribution of *Platanthera cumminsiana* (King and Pantl.) J. Renz (Orchidaceae) in western Himalaya, India. *Indian Journal of Forestry* 38(1): 95–98. 10.54207/bsmps1000-2015-6D0ZYP

RAI I.D., JALAL J.S., SINGH G. & G.S. RAWAT 2017. Three noteworthy additions to the flora of the western Himalaya, India. *Journal of Threatened Taxa* 9(7): 10421–10425. http://doi.org/10.11609/jott.3371.9.7. 10421-10425

RAI I.D., JALAL J.S., SINGH G. & G.S. RAWAT 2018. *Anemone trullifolia* and *Berberis angulosa* as new records to the flora of the western Himalaya, India. *Journal of Threatened Taxa* 10(5): 11679–11682. http://doi.org/10.11609/jott.3961.10.5.11679-11682.

STEVEN J.P., MIROSLAV D. & E.R. SCHAPIRE 2021. [Internet] Maxent software for modeling species niches and distributions (Version 3.4.1). Available at: http://biodiversityinformatics.amnh.org/open_source/maxent/. (Accessed on 10.07.2022).

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, Volume 38. Koeltz Botanical Books, Glashütten. https://doi.org/10.12705/Code.2018

WILMOT-DEAR C.M. & I. FRIIS 1996. The New World species of *Boehmeria* and *Pouzolzia* (Urticaceae, tribus Boehmerieae). A taxonomic revision. *Opera Botanica* 129: 1–103.

WILMOT-DEAR C.M. & I. FRIIS 2013. The Old-World species of *Boehmeria* (Urticaceae, tribus Boehmerieae). A taxonomic revision. *Blumea* 58(2): 85–216. https://doi.org/10.3767/000651913X674116

YAHARA T. 1981. Taxonomic studies of the Urticaceae: 1. The genus *Boehmeria* in Thailand. *Acta Phytotaxonomica et Geobotanica* 32(1–4): 1–21.

YAHARA T. 1990. Evolution of agamospermous races in *Boehmeria* and *Eupatorium*. *Plant Species Biology* 5(1): 183–196. https://doi.org/10.1111/j.1442-1984.1990.tb00203.x