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Herbertus ramosus (Herbertaceae, Marchantiophyta) – an addition to Indian bryoflora from Arunachal Pradesh with a note on *H. sendtneri*

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Herbertus ramosus (Steph.) H.A.Mill. and *H. sendtneri* (Nees) Lindb. are described and illustrated from West Siang District of Arunachal Pradesh in the eastern Himalaya, India. This constitutes the first record of *H. ramosus* in Indian bryoflora. It is easily distinguished from hitherto known Indian species of the genus by orange brown plants having falcate leaves with acute leaf lobes 23–40 cells wide at base, up to 8 cells uniseriate towards apex, strongly expanded basal leaf lamina on dorsal side, and strong grooved vitta. Identification key to the Indian species of the genus is provided and its distribution in the country is discussed.

The genus *Herbertus* Gray is represented in India by eight species and one subspecies, viz. *H. aduncus* (Dicks.) Gray subsp. *aduncus*, *H. armitanus* (Steph.) H.A.Mill., *H. buchii* Juslén, *H. ceylanicus* (Steph.) Abeyw., *H. dicranus* (Taylor ex Gottsche et al.) Trevis., *H. kurzii* (Steph.) R.S.Chopra, *H. longispinus* J.B.Jack & Steph., *H. sendtneri* (Nees) Lindb. and *H. udarii* Kumar & Manocha (Hattori 1966, Udar and Srivastava 1977, Kumar and Manocha 2000, Juslén 2006, Manju et al. 2008, Dey et al. 2009, Das and Singh 2012). In India the genus is distributed in eastern Himalaya, including the northeastern states, and the Western Ghats only with the former harbouring all the species recorded so far in the country.

The Indian state of Arunachal Pradesh, with varied topography, temperature and rainfall regimes, provides ideal conditions for the luxuriant growth of liverworts in different habitats. Bryologically, however, it remained almost terra incognita until 1982 when Singh (1982) for the first time reported *Blasia pusilla* L., along with a few hornworts from West Kameng District of the state. Though the state has been extensively botanized for liverworts and hornworts since 1981, our knowledge of diversity and distribution of these plants still remains far from complete. Nevertheless, the taxonomic studies carried out on the liverwort flora of the state so far have already revealed the presence of three species and one subspecies of the genus *Herbertus* in Arunachal Pradesh, viz. *H. aduncus* subsp. *aduncus*, *H. armitanus*, *H. buchii* and *H. dicranus* (Das and Singh 2012, Singh Deo and Singh 2013, Singh and Singh Deo 2014, Singh et al. 2015). The present study further revealed the presence of another two species, *H. ramosus* (Steph.) H.A.Mill. and *H. sendtneri* in West Siang district of the state. Of these *H. ramosus*, hitherto known to occur in Indonesia, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam (Miller 1965, So 2003, Juslén 2006, Lai et al. 2008, Söderström et al. 2010), is recorded for the first time from India, whereas *H. sendtneri* is so far known only through the reports of Hattori (1966) and Juslén (2006) from Sikkim and West Bengal with apparently no representation in Indian herbaria.

Herbertus ramosus (Steph.) H.A.Mill. in J. Hattori Bot. Lab. 28: 314. 1965 '*Herberta ramosa*'. *Schisma ramosum* Steph., Sp. hepat. 4: 23. 1909. (Fig. 1: 1–19)

Plants orange brown in herbarium; shoots 4–9 cm long, 1.5–2.5 mm wide including leaves; branches lateral intercalary. Stem oval in outline in transverse section, 275–325 × 387–450 µm, 15–18 cells across diameter; cortical cells in 2–3 layers, 5–15 × 5–20 µm, thick-walled, yellowish brown; medullary cells 7.5–27.5 × 10.0–30.0

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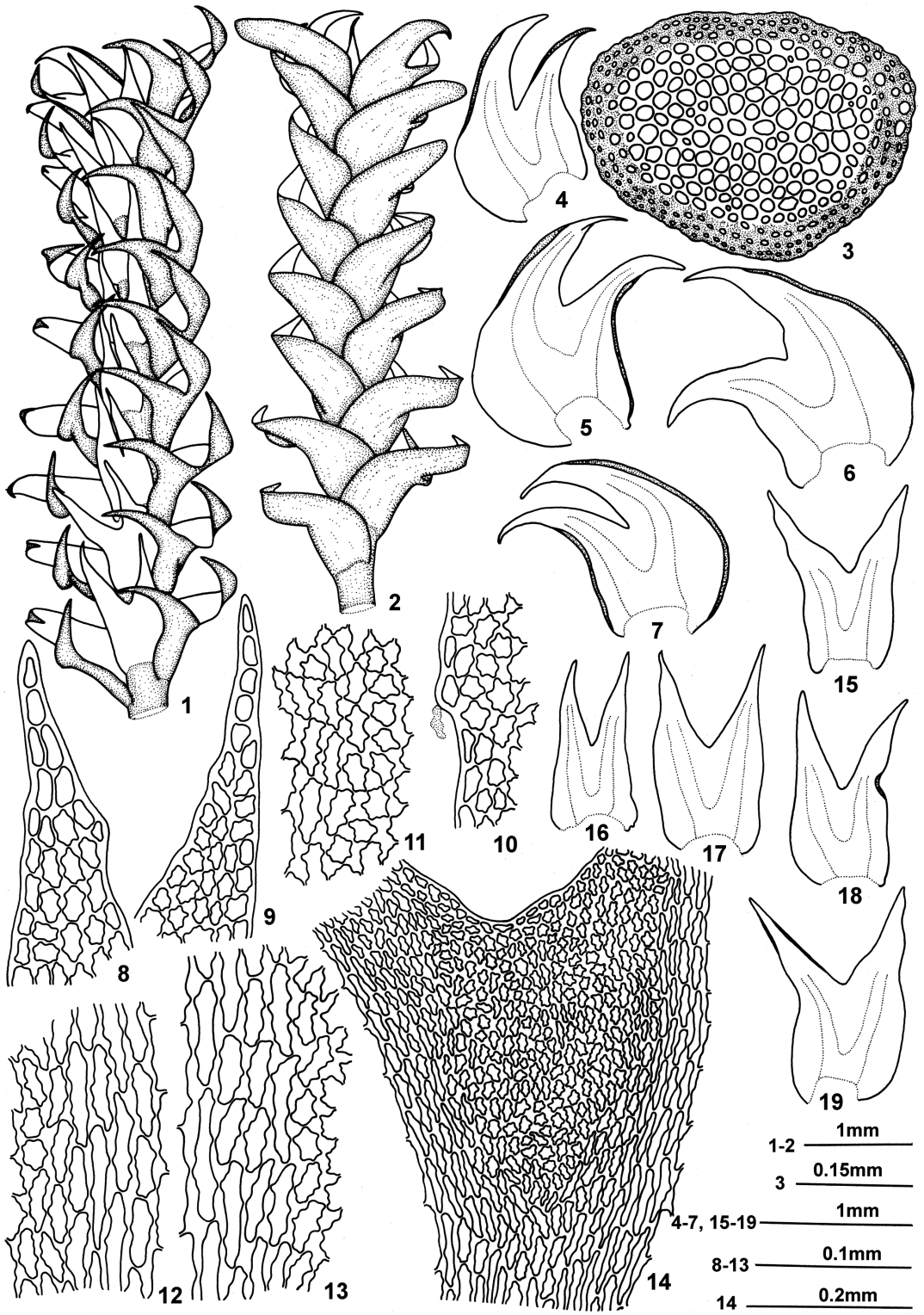


Figure 1. *Herbertus ramosus* (Steph.) H.A.Mill. (1) a portion of plant in ventral view. (2) a portion of plant in dorsal view. (3) transverse section of the stem. (4–7) leaves. (8–9) cells at leaf apex. (10) cells at leaf margin. (11) cells at leaf median. (12) leaf vitta cells (median). (13) leaf vitta cells (basal). (14) vitta bifurcation region. (15–19) underleaves. (All figures drawn by S. Singh Deo from S. Singh Deo 51026A).

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μm, thin – moderately thick-walled, yellowish brown, trigones large, triangular. Rhizoids not seen. Leaves imbricate, transversely – subtransversely inserted, falcate, 1.6–2.0 mm long, 0.85–1.10 mm wide, leaf length–width ratio 1.5–1.9:1, basal lamina strongly expanded, 15–25 cells wide on dorsal side; bilobed to 1/2–2/5 of leaf length; lobes lanceolate, acute, 23–40 cells wide at base,12–24 cells wide in middle, (2–) 4–6 cells uniseriate towards apex, 2–4 cell rows biseriate below apex, apical cells 12.5–20.0 × 7.5–10.0 μm; leaf margins entire, with or without shortly stalked (1–2-celled) slime papillae, marginal cells 7.5–16.0 × 9.0–19.0 μm; vitta distinct, grooved, extending up to middle or sometimes beyond mid leaf lobe, vitta cells 47.5–115.0 × 15.0–20.0 μm in mid basal lamina, bifurcating below mid basal lamina or near base, separated by 15–25 cells between sinus and vitta bifurcation point, 14.0–40.0 × 12.5–19.0 μm; basal lamina cells 16.0–37.5 × 12.5–17.5 μm, trigones large, confluent, bulging; surface smooth. Underleaves imbricate, transversely attached, curving abaxially, shallowly to deeply inserted, covering the entire width of stem, slightly smaller, more symmetrical than leaves, 1.1–1.4 mm long, 0.58–0.72 mm wide, margins entire. Fertile plants not seen.

Habitat. Lignicolous, growing as bright orange patches on fallen logs along water stream in subalpine vegetation in association with *Pleurozia purpurea* Lindb., *Plagiochilion braunianum* (Nees) S.Hatt. and mosses.

Distribution. India [eastern Himalaya (Arunachal Pradesh – present study)], Indonesia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam (Miller 1965, So 2003, Juslén 2006, Lai et al. 2008, Söderström et al. 2010).

Specimens examined. India, eastern Himalaya, Arunachal Pradesh, West Siang District, on way to Tato (Mobu mountain), 94°20'E, 28°25'N, ca 3000 m, 27.08.2011, S. Singh Deo 51026A (CAL).

Note. Indian population of *H. ramosus* have orange brown plants with stem more or less oval in outline in transverse section having 15–18 cells across its diameter (Fig. 1: 3); falcate leaves with strongly expanded basal lamina (Fig. 1: 4–7); apex of leaf lobe (2–) 4–6 cells uniseriate (Fig. 1: 8–9): entire leaf margins occasionally with shortly stalked (1–2-celled) slime papillae (Fig. 1: 10) and distinct, grooved vitta bifurcating below mid basal lamina or near base, separated by 15–25 cells between sinus and vitta bifurcation point (Fig. 1: 4–7, 12–14).

Herbertus sendtneri (Nees) Lindb., in Lindberg & Lackström, Hep. Scand. Exs. 1: [13] No. IV. 1874. *Schisma sendtneri* Nees, Naturgesch. Eur. Leberm. 3: 575. 1838. (Fig. 2: 1–27)

Plants brown–blackish brown in herbarium; shoots 2–4 cm long, 1.5–2.5 mm wide including leaves; branches lateral intercalary. Stem oval – triangular in outline in transverse section, 230–310 × 210–270 μm, 13–16 cells across diameter; cortical cells in 2–3 layers, 5.0–21.0 × 6.5–25.5 μm, thick-walled, yellowish brown; medullary cells 8.0–27.0 × 14.5–45.0 μm, thin-walled, yellowish brown, trigones large triangular. Rhizoids not seen. Leaves imbricate, transversely – subtransversely inserted, falcate, 0.95–1.5 mm long, 0.65–1.0 mm wide, leaf length–width ratio 1.4–1.7:1, basal lamina expanded, 9–18 cells wide on dorsal side; bilobed to 1/2–2/5 of leaf length, lobes lanceolate, 13–26 cells wide at lobe base and 7–18 cells wide at lobe mid region, lobe apex acute – sometimes apiculate, 2–4 cells uniseriate, 2–5 cell rows biseriate below apex, apical cells 15–29 × 6–16 μm; margins with appendages in basal laminar region, 3–4 cells long and 3–4 cells wide at base, slime papillae stalked, 1–2 cells long, 1–2 cells wide at base, marginal cells 12.5–20.0 × 10–21 μm; vitta indistinct, never grooved, extending little above the sinus into the lobe, vitta cells 24.5–62.5 × 12.5–20.0 μm in mid basal lamina, bifurcating in mid basal lamina, separated by 8–11 cells between sinus and vitta bifurcation point, 17.5–37.5 × 15.0–21.0 μm; basal lamina cells 21.0–32.5 × 14.0–20.0 μm, trigones medium – large, confluent, bulging; surface strongly verrucose. Underleaves imbricate, transversely attached, curving abaxially, shallowly – deeply inserted, covering the entire width of stem, slightly smaller, more symmetrical than leaves, 0.90–1.25 mm long, 0.5–0.9 mm wide, laminal margins forming appendages, 3–4 cells long, 3–4 cells wide at base, slime papillae stalked, 1–2 cells long, 1–2 cells wide at base. Fertile plants not seen.

Habitat. Lignicolous, growing in moist and shady conditions in subalpine vegetation in association with *Bazzania tricrenata* (Wahlenb.) Trevis., *Blepharostoma trichophyllum* (L.) Dumort., *Herbertus aduncus* (Dicks.) Gray, *Jungermannia* sp., *Lepidozia stahlii* Steph., *Plagiochila recurvata* Grolle, *Pseudolepicolea trollii* Grolle & Ando.

Distribution. India [eastern Himalaya (Arunachal Pradesh – present study, Sikkim, West Bengal)], Bhutan, China, Nepal, Africa, Europe, Central and South America (Hattori 1966, 1971, 1975, Feldberg et al. 2004, Feldberg and Heinrichs 2005, Juslén 2006, Zhu 2006, Hodgetts 2008, Pradhan and Joshi 2009).

Specimens examined. India, eastern Himalaya, Arunachal Pradesh, West Siang District, on way to Tato (Mobu mountain), 94°18'E, 28°22'N, ca 3600 m, 27.08.2011, S. Singh Deo 51048D (CAL).

Note. H. sendtneri is characterized by oval–triangular outline of the stem in transverse section having 13–16 cells across its diameter (Fig. 2: 3); falcate leaves 1.4–1.7 times

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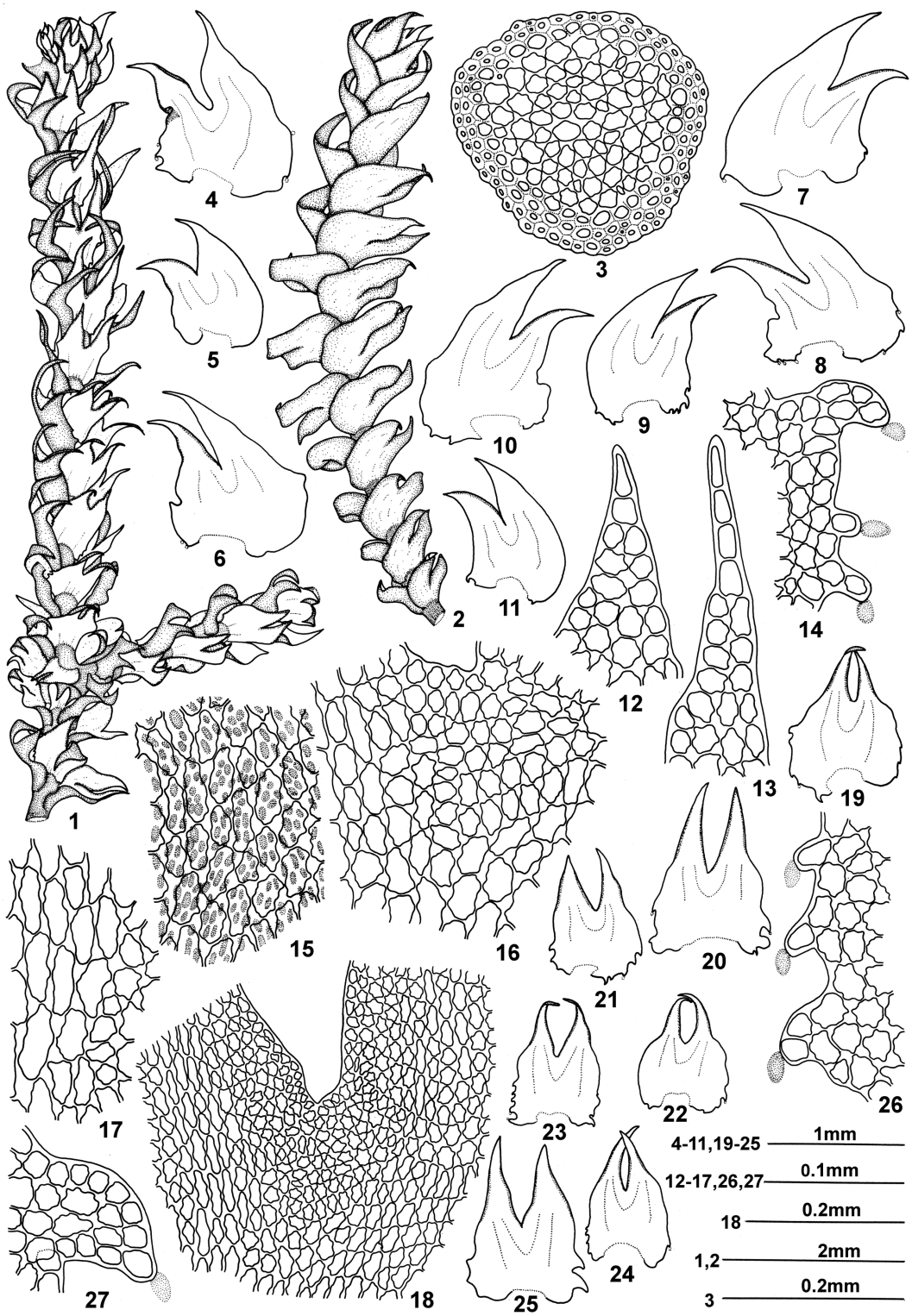


Figure 2. *Herbertus sendtneri* (Nees) Lindb. (1) a portion of plant in ventral view. (2) a portion of plant in dorsal view. (3) transverse section of the stem. (4–11) leaves. (12–13) cells at leaf apex. (14) cells at leaf margin. (15) cells at leaf median (showing surface ornamentations). (16) cells between sinus and vitta bifurcation. (17) cells at leaf base. (18) vitta bifurcation region. (19–25) underleaves. (26, 27) marginal underleaf cells showing appendages/slime papillae (all figures drawn by S. Singh Deo from S. Singh Deo 51048D).

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as long as wide with basal lamina expanded on dorsal side (Fig. 2: 4–11), acute to sometimes apiculate leaf-lobe apex distally 2–4 cells uniseriate (Fig. 2: 12–13) and the margin with appendages in basal laminar region (Fig. 2: 14); indistinct vitta, which is never grooved, bifurcating in mid basal lamina separated by 8–11 cells between sinus and vitta bifurcation point (Fig. 2: 4–11, 18); strongly verrucose leaf surface (Fig. 2: 15) and the laminal margin of underleaf often forming appendages (Fig. 2: 19–27).

Herbertus sendtneri was first recorded from India by Hattori (1966) based on collection made by members of Botanical Expedition of Tokyo University to Nepal and Sikkim in 1960. Recently, Juslén (2006) again described the species from Sikkim and West Bengal based on collections made by D.G. Long and Pradhan Rai in 1992 and 1980 respectively. The plants of *H. sendtneri* from Arunachal Pradesh are morphologically quite identical with those across its range of distribution and the marginal deviations in the dimensions shown by our plants fall well within the range of variations recorded for the species [Miller 1965 (as *H. delavayi* Steph.), Juslén 2006].

Key to the Indian species of *Herbertus*

1a. Leaf lobe apices long, up to 15 cells uniseriate……
……..…….....*H. longispinus*
1b. Leaf lobe apices not long, up to 10 cells uniseriate....2
2a. Vitta not strong, inconspicuous, not grooved…..……3
2b. Vitta strong, conspicuous, grooved……4
3a. Stem 19–23 cells across diameter in transverse section; leaf surface smooth; underleaf margin entire.....……
……..…….....*H. buchii*
3b. Stem (8-) 12–16 cells across diameter in transverse section; leaf surface verruculose – verrucose; underleaves with coarse appendages…
.....*H. sendtneri*
4a. Leaves almost straight/sometimes curved..…….....5
4b. Leaves falcate..…….....7
5a. Vitta bifurcating at mid basal lamina and above..……..
…….....*H. aduncus* subsp. *aduncus*
5b. Vitta bifurcating at mid basal lamina and below……6
6a. Leaf lobe apex 2–3 cells uniseriate, lobes almost straight, symmetrical….....*H. ceylanicus*
6b. Leaf lobe apex 4–7 cells uniseriate, lobes generally straight, asymmetrical.....*H. udarii*
7a. Leaf length width ratio less than 2:1; underleaf margin with tooth/appendages..…….....*H. kurzii*
7b. Leaf length width ratio more than 2:1; underleaf margin entire….....…….....8
8a. Leaf lobe acuminate, basal lamina less expanded on dorsal side…….....*H. armitanus*
8b. Leaf lobe acute, basal lamina strongly expanded on dorsal side…….....9
9a. Plants brown, reddish brown to orange brown, leaf length–width ratio 1.5–2.5 (–3.5), bifid 1/2–3/4 of leaf length, lobe apex with 4–8 uniseriate cells, lobe base 23–40 cells wide, 14–26 cells between sinus and vitta bifurcation point…….....*H. ramosus*
9a. Plants green, olive, brown to reddish, leaf length–width ratio 1.8–3.7, bifid 3/5 of leaf length, lobe apex with 1–5 uniseriate cells, lobe base 7–22 cells wide 8–29 cells between sinus and vitta bifurcation point.....*H. dicranus*

Discussion

In India, the genus *Herbertus* is confined to the eastern Himalaya and the Western Ghats, with all the species, occurring in the former bryogeographical region of the country, while only three taxa, viz. *H. aduncus* subsp. *aduncus*, *H. armitanus* and *H. dicranus*, occur in the latter. Amongst the east Himalayan and northeastern states, Sikkim shows the maximum representation with seven species reported, followed by Arunachal Pradesh (six species), West Bengal and Meghalaya (three species each) and Manipur with two species (Table 1). In Western Ghats, Kerala harbours all the three taxa mentioned above, while Karnataka and Tamil Nadu are represented by *H. dicranus* alone. (Table 1).

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Table 1. Distribution of the genus *Herbertus* Gray in India

Sl.no.	Species	Distribution in India		References
		EH	WG	
1.	*H. aduncus* (Dicks.) Gray subsp. *aduncus*	+	+	Arunachal Pradesh (Singh and Singh Deo 2014), Kerala (Manju et al. 2008), Manipur (Singh et al. 2010), Meghalaya (Singh and Nath 2007 as *H. fragilis* (Steph.) H.A. Mill.), Sikkim (Hattori 1966, Juslén 2006)
2.	*H. armitanus* (Steph.) H.A.Mill.	+	+	Arunachal Pradesh (Singh and Singh Deo 2014), Kerala (Manju et al. 2008), Sikkim (Dey et al. 2009)
3.	*H. buchii* Juslén	+	-	Arunachal Pradesh (Das and Singh 2012)
4.	*H. ceylanicus* (Steph.) Abeyw.	+	-	Meghalaya (Singh and Nath 2007), Sikkim (Hattori 1966)
5.	*H. dicranus* (Taylor ex Gottsche et al.) Trevis.	+	+	Arunachal Pradesh (Singh Deo and Singh 2013), Karnataka [Udar and Srivastava 1977 as *Herberta capense* (Steph.) Sim.; Schwarz 2013], Kerala (Manju et al. 2008), Manipur (Singh et al. 2010), Meghalaya (Hattori 1975, Singh and Nath 2007), Sikkim, Tamil Nadu [Udar and Srivastava 1977 as *Herberta nilgerriensis* (Steph.) H.A.Mill. and *H. pinnata* (Steph.) H.A.Mill.; Hattori 1966, Juslén 2006], West Bengal (Hattori 1966, Juslén 2006)
6.	*H. kurzii* (Steph.) R.S.Chopra	+	-	Sikkim (Juslén 2006)
7.	*H. longispinus* J.B.Jack & Steph.	+	-	Sikkim (Dey et al. 2009)
8.	*H. ramosus* (Steph.) H.A.Mill.	+	-	Arunachal Pradesh (present study)
9.	*H. sendtneri* (Nees) Lindb.	+	-	Arunachal Pradesh (present study), Sikkim, West Bengal (Hattori 1966, Juslén 2006)
10.	*H. udarii* Kumar et Manocha	+	-	West Bengal (Kumar and Manocha 2000)

[EH= eastern Himalaya (including northeastern region); WG= Western Ghats; + = present; - = absent]

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