

## Bryophyte flora of Hunan Province, China. 7. *Herbertus* (Herbertaceae, Hepaticae)

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*Herbertus aduncus* (Dicks.) Gray subsp. *aduncus* and *H. dicranus* (Taylor *ex* Gottsche *et al.*) Trevis. are reported as new to Hunan Province of China. Descriptions and discussion on the extensive variability of the species, illustrations, and distribution maps are provided. *Herbertus lonchobasis* H.A. Mill. and *H. wichurae* Steph. are synonymized with *H. dicranus*. *Herbertus aduncus* subsp. *aduncus* is rare in Hunan and was not present in man-made habitats. *Herbertus dicranus* is rather rare, but in primeval sites it is moderately common. *Herbertus aduncus* subsp. *aduncus* is preferably epilithic, while *H. dicranus* grows on many substrates, which partly explains the difference in their occurrence. In Hunan, both species grow both in warm temperate and orotemperate zones which is in accordance with their global distribution.

Key words: habitat ecology, hepatics, *Herbertus*, Hunan, phytogeography, taxonomy

This paper is a part of a series dealing with the bryophyte flora of Hunan Province, China. The first and third papers (Koponen *et al.* 2000, 2004) explain the methods, the collecting localities, and geographic ranges, here presented in abbreviated form. Other papers of the series are Potemkin (2000), Enroth and Koponen (2003), Potemkin *et al.* (2004), Ignatov *et al.* (2005), and Váňa *et al.* (2005).

### Herbertaceae Müll.Frib. 1954

#### *Herbertus* Gray 1821

The genus *Herbertus* is widely distributed in Asia. Seventeen species have been reported from

China (Piippo 1990), but there are no earlier records for Hunan (Rao *et al.* 1997). There is no worldwide revision of *Herbertus*, and the extreme variability within the genus has led to many new species being described. Currently ca. 100 species are reported (Bonner 1966, Geissler & Bischler 1990), but for instance Gradstein (2001) estimates that there are 25 species worldwide. Knowledge of Asian *Herbertus* is insufficient, except in Japan, where the genus is relatively well known (*see* Hattori 1943, 1947, 1955, 1957, 1958, 1959, Hattori & Inoue 1959, Kitagawa 1962, 1978, Inoue 1974, 1981, Iwatsuki 2001).

Miller (1965) published a review of *Herbertus* (as *Herberta*) in the tropical Pacific area and Asia. He also reviewed the history of research

of the Asian species. Later Miller (1968) added notes on the genus. However, the criteria Miller used in species delimitation have been criticized by Inoue (1977) and Schuster (2000).

Taxonomic characters of special importance within the genus are the number and shape of apical cells in the leaf lobes, the shape of lobes, the point of vitta bifurcation in the basal leaf lamina, and the cell structure. Size and colour vary to a great extent according to ecology and altitude. Several other variable characters exist, such as the shape of the sinus and the bifidness of leaves, but these have hitherto been overemphasized in species delimitation. These characters are mainly useful merely for separating local populations (A. Juslén *et al.* unpubl. data).

As well as the gametophyte characters, Schuster (2000) introduced several sexual characters "as a model for future investigation". They certainly should be studied before discussing the taxonomy of *Herbertus*. However, the plants are so seldom fertile (at least in Asia) that keys are useful only if they are primarily based on gametophyte characters. As no sporophyte material was available from Hunan, descriptions are based on gametophyte characters only.

### Key to *Herbertus* in Hunan

1. Vitta bifurcating in upper part of basal lamina, 1/4–1/2(–3/5) length of basal lamina from the sinus, 3–10 cells between sinus and vitta bifurcation point; basal lamina hardly expanded; leaf lobes ± straight, narrowly acute with 4–7 uniseriate cells at apex ..... 1. *Herbertus aduncus* subsp. *aduncus*
1. Vitta bifurcating in lower part of basal lamina, 1/2–5/6 length of basal lamina from the sinus, 8–29 cells between sinus and vitta bifurcation point; basal lamina ± dorsally expanded; leaf lobes ± falcate, more widely acute, with 1–5(–6) uniseriate cells at apex .... 2. *Herbertus dicranus*

### *Herbertus aduncus* (Dicks.) Gray subsp. *aduncus* (Fig. 1)

Nat. Arr. Brit. Pl. 1: 705. 1821 ('*Herbertia adunca*'). — *Jungermannia adunca* Dicks., Pl. Crypt. Brit. fasc. 3: 12. 1793. — *Schisma aduncum* (Dicks.) Dumort., Syll. Jungerm. Europe: 77. 1831. — *Sendtnera adunca* (Dicks.) Gottsche & Rabenh. Rabenhorst Hep. Eur. Exsicc. 210. 1962. — TYPE: *Dickson* (lectotype BM-000661088! chosen by Proskauer 1962, only the shoot on right with sporophyte).

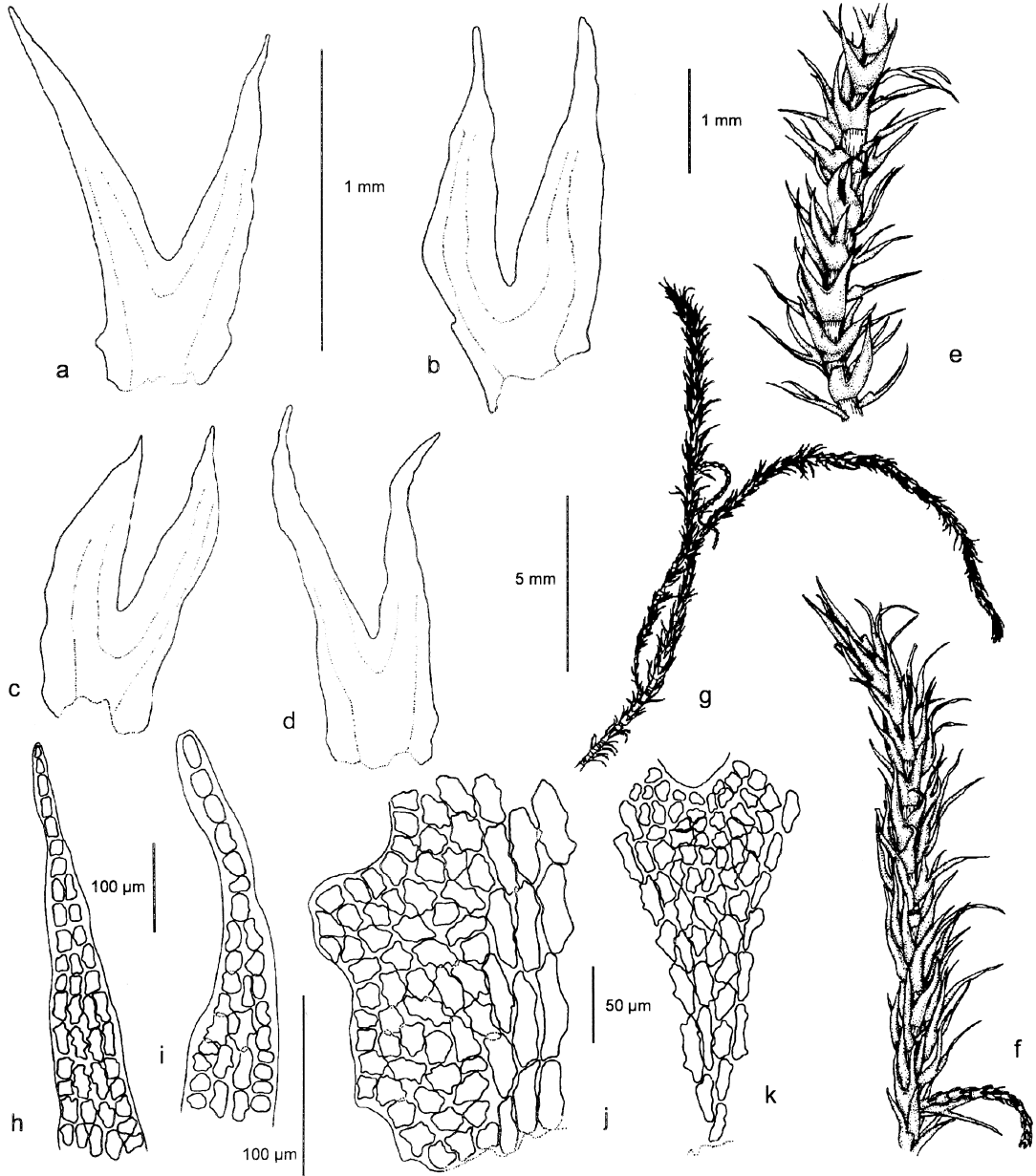
*Schisma pusillum* Steph., Spec. Hep. 6: 361. 1922. — *Herberta pusilla* (Steph.) S. Hatt., Bull. Tokyo Sci. Mus. 11: 8. 1944. — *Herberta sakuraii* fo. *pusilla* (Steph.) S. Hatt., J. Hattori Bot. Lab. 2: 6. 1947. — TYPE: South Korea. Hallaisan, 1906 *Faurie* 86 (isotype BM-000661063!). — Synonymized by Hattori (1947: 6, as *H. sakuraii* (Warnst.) S. Hatt. fo. *pusillum*, 1955: 81, as *H. sakuraii*).

*Herberta minor* Horik., J. Sci. Hiroshima Univ. ser. B., div. 2, 2: 211. 1934. — TYPE: Taiwan. Prov. Taihoku, Mt. Taiheizan (Mururoafu-Kyôgetsu), 1932 *Iwasama* 3472 (herb. Horikawa 11506) (holotype HIRO!). — Synonymized by Hattori (1955: 81, as *H. sakuraii*).

*Herberta remotiusculifolia* Horik., J. Sci. Hiroshima Univ. ser. B., div. 2, 2: 209. 1934. — *Herberta sakuraii* fo. *remotiusculifolia* (Horik.) S. Hatt., J. Hattori Bot. Lab. 2: 6. 1947. — TYPE: Taiwan. Prov. Taihoku, Mt. Taiheizan, Minamoto, Toganooduni-Mururoafu, 1932 *Horikawa* 9405 (holotype HIRO!). — Synonymized by Hattori (1947: 6, as *H. sakuraii* fo. *remotiusculifolia*, 1955: 81, as *H. sakuraii*). — NOTE: In the type specimen of *H. remotiusculifolia* three different kinds of plants are present. One of them was described and illustrated by Horikawa (1934), and it belongs to *H. aduncus* subsp. *aduncus*. But also *H. dicranus* and *H. kurzii* (Steph.) H.A. Mill. can be identified from the same mixed specimen. *Herbertus kurzii* (as *H. imbricata* Horik.) was noted in the specimen by H.A. Miller. The true meaning of this will only be solved in the larger study of Asian *Herbertus*.

*Herberta sakuraii* R.M. Schust. subsp. *sakuraii*, non (Warnst.) S. Hatt., Rev. Bryol. Lichénol. 26: 142. 1957. — *Herberta hutschinsiae* (Gottsche) A. Evans subsp. *schusteri* H.A. Mill. & E.B. Scott, Rev. Bryol. Lichénol. 29: 29. 1960. — *Herberta adunca* (Dicks.) Gray subsp. *schusteri* (H.A. Mill. & E.B. Scott) H.A. Mill., Nova Hedwigia 4: 366. 1962. — TYPE: Japan. Kumamoto, Mt. Ichifusa, ca. 1 700 m, granitic bluffs, 1951 *Mayebar* (holotype, not seen). — Tentatively synonymized by Miller (1965: 314), see also Schuster (1966: 718).

Plants very variable, small to medium-sized, green, brown, yellowish, rarely reddish, often mat-forming or pendulous from cliffs or bark. Shoots sometimes with ventral intercalary branches. Leaves ± imbricate, erect, ± straight and almost symmetrical, the basal lamina hardly or somewhat expanded, 3–7(–8) cells wide on dorsal side, leaf length–width ratio 2.6–4.0; bifid usually to ca. 3/4, lobes long and narrow, 4–8 cells wide at half of the lobe, lobe apex acute, with (2–)4–7 uniseriate cells and below that (2–)4–7 rows two cells wide, apical cells 1–3.3 times longer than wide; leaf margin usually plane, slime papillae few and sessile if present; vitta not very strong, extending to 2/5–4/5 of lobe, vitta cells 10–18 × 28–63 μm in mid basal lamina, bifurcating usually above the mid basal



**Fig. 1.** *Herbertus aduncus* subsp. *aduncus* (all from 51204, H). — **a** and **b**: Leaves. — **c** and **d**: Underleaves. — **e**: Part of shoot, wet. — **f**: Part of shoot, dry. — **g**: Habit. — **h** and **i**: Leaf apices. — **j**: Cells of basal lamina and vitta. — **k**: Cells in sinus, vitta bifurcating point, and the basal most part of leaf. Use the longer 1 mm scale for **a–d**, the shorter 1 mm scale for **e** and **f**, the 5 mm scale for **g**, the shorter 100  $\mu\text{m}$  for **h** and **k**, the longer 100  $\mu\text{m}$  for **i**, and the 50  $\mu\text{m}$  scale for **j**.

lamina, 3–8(–10) cells between sinus and vitta bifurcation point, these cells 10–20  $\times$  12–30  $\mu\text{m}$ ; basal lamina cells 10–12  $\times$  12–23  $\mu\text{m}$ , usually with triangular trigones; underleaves smaller and symmetrical.

SELECTED ILLUSTRATIONS: Stephani 1909 (icones inedit. no. 6734), (icones inedit. no. 6762) as *Schisma pusillum*; Evans 1917: 223 (pl. 8, figs. 3–14) as *Herberta hutchinsiae*; Horikawa 1934: 210 (fig. 36) as *H. remotiusculifolia*; Hattori 1943: 165 (fig. 6) as *H. remotiusculifolia*; Hattori 1947: 5 and 7 (figs. 2–3) as *H. sakuraii* fo. *pusilla* and fo. *typica*;

Schuster 1957: 139 (fig. 4: 3–14) as *H. hutchinsiae* subsp. *sakurarii*; Miller & Scott 1960: 27 (fig. 11–m) as *H. sakurarii* subsp. *schusteri*; Proskauer 1962: 222–223 (figs. 13–25); Miller 1965: 368 (fig. 63), 369 (fig. 65), 372–373 (figs. 72, 73) as *H. aduncus*, 369 (fig. 66), 370 (fig. 68), 374 (fig. 74) as *H. minor*, 370 (fig. 70), 375–376 (figs. 76, 77) as *H. pusilla*; Inoue 1977: 10 (fig. 6), Zhu & So 1996: 77; Zhao & Cao 1998: 21 (fig. 1); Gao & Cao 2000: 16 (fig. 9: 7–13); Iwatsuki 2001: 231 (fig. 83), 125 (figs. 3–4).

There has been a nomenclatural chaos with the type species of the genus (see Miller & Scott 1960, Miller 1962, Proskauer 1962, Schuster 1966), which adds the problems in clarifying the status and the distribution of *Herbertus aduncus*. Proskauer (1962) managed to find Dickson's long lost specimens. He came to the conclusion that the only mounted fertile type specimen of *Jungermannia adunca* was collected from British Columbia, North-Western America. Since all the type specimens of obviously synonymous taxa were not available during this study, the types and earlier synonymizations will be thoroughly discussed in a later paper.

*Herbertus aduncus* is recognized as having three subspecies, subsp. *aduncus* from NW North America and eastern Asia, subsp. *hutchinsiae* (Gottsche) R.M. Schust. from Europe, and subsp. *tenuis* (A. Evans) H.A. Mill. & E.B. Scott from eastern North America (Paton 1999). Schuster compared the subspecies taxonomically in 1957 under the names *H. sakurarii* (Warnst.) S. Hatt. subsp. *sakurarii* (= *H. aduncus* subsp. *aduncus*), *H. sakurarii* subsp. *hutchinsiae* R.M. Schust. (= *H. aduncus* subsp. *hutchinsiae*), and *H. sakurarii* subsp. *tenuis* R.M. Schust. (= *H. aduncus* subsp. *tenuis*), pointing out the differences in numbers of slime papillae, the expansion of basal laminas, and fertility. He agreed that those were not, however, characters of adequate stability to separate species. The new collections of Hunanese *H. aduncus* support Schuster's observations. The basal laminas of leaves are not expanded and the slime papillae are few and sessile. However, the Hunanese plants are infertile. The type and other British Columbian plants studied have somewhat more expanded basal laminas, and sessile or short-stalked slime papillae are more common than in Hunanese plants. The Japanese plants of *H. aduncus* subsp. *aduncus* seen are intermediate in their appearance.

RANGE IN THE HUNAN PROVINCE: **Mangshan**. 6. 51204, 51234, 51235, 51236. **Taoyuandong**. 20a. 57477, 58021, 58026. 21a. 48505, 48517, 54966. 21c. 56052, 56061. **Badagongshan**. 43. 48354. 44b. 48835a, 48938, 50202. 87. 58907. 88b. 58951. Deciduous-evergreen broad-leaved mixed forests and warm temperate secondary forests, road and brook side cliffs, around waterfall and its brook, and in river valley of primeval evergreen forest, in cultivated bamboo forest (*Phyllostachys pubescens*), and along trail in second-growth forest. From dry to wet, open to shaded cliffs (14 collections) and tree trunks (4) at 670–1550 m (Fig. 2). Primevity index 1/7/0. Frequency in Hunan: rare.

TOTAL RANGE: Eur (subsp. *hutchinsiae*); eastern Am 1 (subsp. *tenuis*); subsp. *aduncus*: western Am 1; As 2: Chi, Ja, Ko.

REPRESENTATIVE SPECIMENS EXAMINED: **Am 1: Canada**. British Columbia. W. of Ballard Point, near mouth of Howe Bay, Kunghit I., Queen Charlotte Is., 52°00'N, 131°03'W, near brow of cliff in fen slope, 1971 *Schofield* 44895 (H-3173748), in tree in forest by stream, 1971 *Schofield* 44908 (H-3173750), Popkum, Bridal Falls, Fraser River Valley, over boulders of boulder slope, 1973 *Schofield et al.* 55350 (H-3173766), Stave Lake, ca. 49°15'N, 122°18'W, shaded cliff by streamlet, 1984 *Schofield* 82680 (H-3173755). **U.S.A.** Alaska. Sitka (H-3173771), Near Headwaters of Kurupa River, Endicott Mountains, Brooks Range, ca. 68°24'N, 154°51'W, at ca. 3000 ft., 1952 *Steere* 17779 (H-3173769). **As 2: China**. Taiwan, Chiayi, Mt. Alishan, ca. 2000–2200 m alt., on tree trunk, 1979 *Yamada* 74/a (NICH-426777). **Japan**. Saitama Pref., Mt. Gozen, Mashida-gun, Gifu-ken, on moist rocks, along stream, ca. 1600 m above sea level, 1970 *Yamada* (H-3173782, M-0025118); Nara Pref., Mt. Shiraya, Kawakami-mura, Yoshino-gun, Nara-ken, on rocks, alt. ca. 1000 m, 1972 *Kodama* (H-3173781, M-0025119); Gifu Pref., Mt. Ontake, coniferous forest near Nigorigo Spa, wet vertical cliff face, 1975 *Smith J-449* (NY); Kyushu, Kagoshima-ken, Yakushima I., Mt. Motchomu, alt. 600–900 m, on rocks, 1983 *Mizutani* 10666, 16085 (NY, det. *Mizutani*). **South Korea**. Hallaisan, 1906 *Faurie* 86 (BM-000661063).

### *Herbertus dicranus* (Taylor ex Gottsche et al.) Trevis. (Figs. 3 and 4)

Mem. Real. Ist. Lombardo Sci. Lett. Class. Sci. Mat. Nat., ser. 3, 4: 397. 1877 ('*Herbertia dicrana*'). — *Sendtnera dicrana* Taylor in Gottsche et al., Syn. Hep.: 239. 1845. — *Schisma dicrana* (Taylor) Steph., Spec. Hep. 4: 24. 1909. — TYPE: Nepal. 1820 *Wallich* (lectotype FH! chosen by Miller 1965: 306). There are two *Jungermannia dicrana* specimens collected by Wallich in 1820 in FH. Miller wrote 1964 in hb., that the long "specimens" (= shoots) mounted separately should be considered type and that specimen is therefore the lectotype. The other specimen is an isolectotype.

*Schisma juniperina* Nees var. *sanguinea* Mont., Ann. Sci. Nat. ser. 17, 19: 15. 1842. — *Sendtnera juniperina* var. *sanguinea* (Mont.) Gottsche et al., Syn. Hep.: 239. 1845. — *Herberta sanguinea* (Mont.) Austin, Bull. Torrey Bot. Club 6: 302. 1879. — *Schisma sanguineum* (Mont.) Steph.,

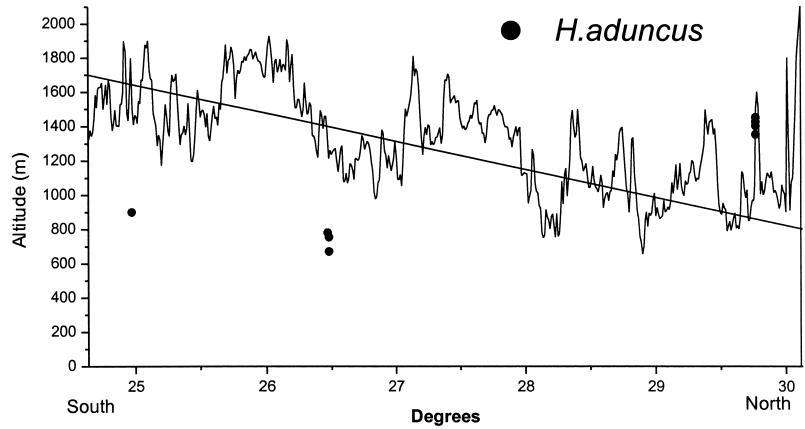


Fig. 2. Localities of *Herbertus aduncus* subsp. *aduncus* in Hunan. Grey line = border of warm temperate and orotemperate zones.

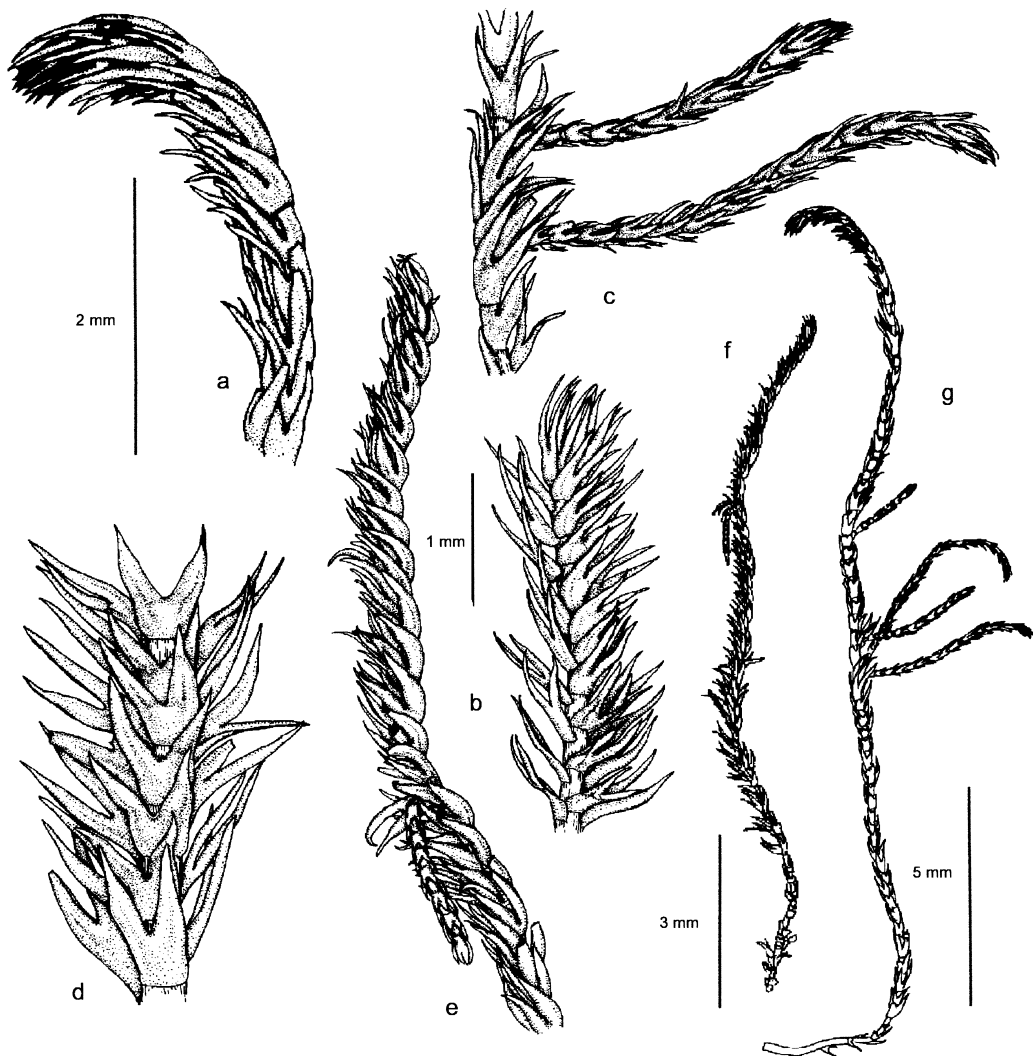
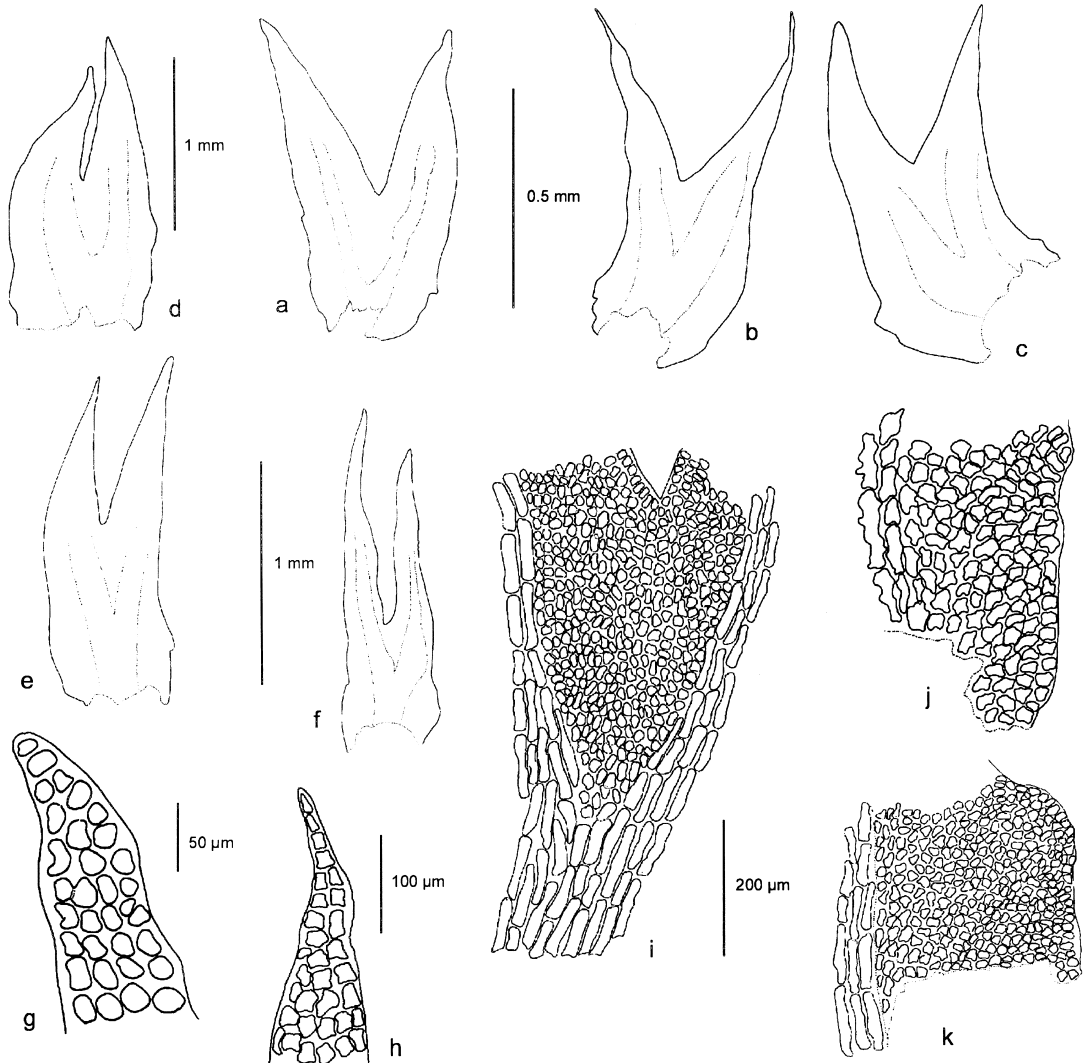


Fig. 3. *Herbertus dicranus* (a, c, d, and g from 49328, H; b, e, and f from 50760, H). — a: Shoot apex, dry. — b: Shoot apex, wet. — c: Branches. — d: Part of shoot, wet. — e: Part of shoot, dry. — f and g: Habits. Use the 3 mm scale for a and d, the 2 mm scale for b, c, and e, the shorter 5 mm scale for f, and the longer 5 mm scale for g.



**Fig. 4.** *Herbertus dicranus* (a, d, h, i, j, and k from 50760, H; b, c, and e from 50758, H; f from 56731, H; g from 51703, H). — a–c: Leaves. — d–f: Underleaves. — g and h: Leaf apices. — i: Cells in sinus, vitta bifurcating point, and the basal most part of leaf. — j and k: Cells of basal lamina and vitta. Use the shorter 1 mm scale for a and d, the 0,5 mm scale for b, c, and e, the longer 1 mm scale for f, the 50 µm scale for g, the 100 µm scale for h and j, and the 200 µm scale for i and k.

Spec. Hep. 4: 27. 1909. — TYPE: India. Neelgherries, *Perrottet*, herb. De Montagne (holotype PC!). — Tentatively synonymized by Miller (1965: 328).

*Herberta chinensis* Steph., *Hedwigia* 34: 43. 1895. — *Schisma chinense* (Steph.) Steph., Spec. Hep. 4: 26. 1909. — TYPE: China. Yunnan, Tsang Yang Tschang, *Delavay* (isotype BM-000661079!). — Synonymized by Inoue (1977: 9).

*Herberta wichurae* Steph., *Hedwigia* 34: 45. 1895, *syn. nov.* — *Schisma wichurae* (Steph.) Steph., Spec. Hep. 4: 25. 1909. — TYPE: China. *Wichura* 2752 (lectotype G! chosen by Miller 1965: 324, erroneously as *Wichura* 2742), *Wichura* 2752 (isolectotype BM-000661065!), *Wichura* 2752/1 (isolectotype G!), *Wichura* 2752/2 (isolectotype G!), *Wichura*

2752/4 (isolectotype M-0025081!).

*Schisma nilgherriense* Steph., Spec. Hep. 4: 28. 1909. — *Herberta nilgherriensis* (Steph.) H.A. Mill., *J. Hattori Bot. Lab.* 28: 308. 1965. — TYPE: India. Hindoustan, Nilgheris, *Perrottet*, ex herb. Cardot 89 (holotype G!). — Synonymized by Miller (1965: 328).

*Schisma sikkimense* Steph., Spec. Hep. 4: 25. 1909. — *Herberta sikkimensis* (Steph.) W.E. Nicholson in *Handel-Mazzetti, Symb. Sin.* 5: 28. 1930. — TYPE: India. Himalaya, Sikkim (isotype BM-000661084!). — Synonymized by Miller (1965: 328).

*Schisma sakuraii* Warnst., *Hedwigia* 57: 69. 1915. — *Herbertus sakuraii* (Warnst.) S. Hatt., *J. Hattori Bot. Lab.*

2: 6. 1947. — *Herberta longifissa* S. Hatt., J. Hattori Bot. Lab. 2: 4. 1947. — TYPE: *Sakurai 152* (lectotype, not seen). — Synonymized by Hodgetts (2003: 140).

*Schisma himalayana* Steph., Spec. Hep. 6: 359. 1922. — *Herberta himalayana* (Steph.) H.A. Mill., J. Hattori Bot. Lab. 28: 319. 1965. — TYPE: Sikkim, Himalaya, Darjeeling, Thareg, alt. 11000 ft (3353 m), "1807" (error for 1907?) *Levier 6145* (holotype G!). — Synonymized with *H. sakuraii* by Inoue (1977: 5), and with *H. dicranus* by Hodgetts (2003: 140).

*Schisma fleischeri* Steph., Spec. Hep. 6: 358. 1922. — *Herberta fleischeri* (Steph.) H.A. Mill., J. Hattori Bot. Lab. 28: 307. 1965. — TYPE: India, Himalaya, Darjeeling, Tigerhill, 2800 m, 1909 *Fleischer* (isotype S-B24656!). — Synonymized by Inoue (1977: 9).

*Herberta longifolia* Horik., J. Sci. Hiroshima Univ. ser. B, div. 2, 2: 208. 1934. — TYPE: Taiwan. Prov. Taihoku, Mt. Taiheizan (Mururoafukyôgetsu), 1932 *Iwamasa 3473* (holotype HIRO!). — Synonymized by Inoue (1977: 9).

*Herberta minima* Horik., J. Sci. Hiroshima Univ. ser. B, div. 2, 2: 208. 1934. — TYPE: Taiwan. Formosa, Mt. Morrison (Top 3900 m), 1932 *Horikawa 9203* (holotype HIRO!).

*Herberta lonchobasis* H.A. Mill., J. Hattori Bot. Lab. 28: 306. 1965, *syn. nov.* — *Herberta lonchobasis* Herzog & W.E. Nicholson in herb. — *Herberta nicholsonii* Herzog in herb. — TYPE: India. Himalaja, Tsomgo Lake zwischen Gangtok und Natu La, 3800 m, 1937 *Troll 17* (holotype JE!, isotype M-0025093!); *Troll 10* (paratypes JE!, MU!).

*Herbertus borealis* Crundw., Trans. Br. Bryol. Soc. 6: 41. 1970. — TYPE: United Kingdom. Scotland, W. Ross, Beinn Eighe, near Kinlochewe, in dwarf shrub heath on quartzite moraine slope facing N.E. at 1500 ft, 1958 *Ratcliffe* (holotype GL, not seen). — Synonymized by Hodgetts (2003: 140).

*Herbertus subdentatus* auct., *non* (Steph.) Fulford — Synonymized by Hodgetts (2003: 140).

*Herbertus subnivalis* S. Winkl., Rev. Bryol. Lichênol. 42(3): 812. 1976. — TYPE: Colombia. Sierra Nevada de Santa Marta, *Winkler C 71* (isotype U, not seen). — Synonymized with *H. subdentatus* by van Reenen (1982: 114) and with *H. dicranus* by Hodgetts (2003: 140).

Plants highly variable, thin and slender to very robust, green, olive, brown or distinctly red to reddish black, growing among other bryophytes or forming large tufts. Shoots often secund, producing frequent flagelliform ventral intercalary branches. Leaves  $\pm$  transversely inserted,  $\pm$  falcate and asymmetrical, with a  $\pm$  strongly expanded dorsal lamina base (4–)6–20 cells wide, leaf length–width ratio 1.8–3.7; bifid usually to ca. 3/5, lobes widely acute, (6–)7–22 cells wide halfway up the lobe, lobe apex with 1–5(–6) uniseriate cells and below that 2–5 rows two cells wide, apical cells 1–2.5 times longer than wide; leaf margin plane, entire or  $\pm$  lobate, with few sessile or shortly-stalked basal slime

papillae; vitta conspicuous, extending to 1/2–4/5 of lobe, vitta cells 12–15  $\times$  30–68  $\mu\text{m}$  in mid basal lamina, bifurcating usually well below or sometimes at mid basal lamina, 8–29 cells between sinus and vitta bifurcation point, these cells 10–20  $\times$  12–30  $\mu\text{m}$ , basal lamina cells 10–13  $\times$  12–25  $\mu\text{m}$ , often with distinct nodulose trigones; underleaves somewhat smaller and  $\pm$  symmetrical.

SELECTED ILLUSTRATIONS: Stephani 1909 (icones inedit. no. 6742), (icones inedit. no. 6740) as *Schisma chinense*, (icones inedit. no. 6744) as *S. fleischeri*, (icones inedit. no. 6756) as *S. nilgherriense*, (icones inedit. no. 6763) as *S. sanguineum*, (icones inedit. no. 6765) as *S. sikkimense*, (icones inedit. no. 6766) as *S. wichurae*; Miller 1965: 335 (fig. 4), 340–341 (figs. 11–12), 343 (fig. 17) as *H. dicranus*, 361 (fig. 52), 365–366 (figs. 58, 59), 368 (fig. 61) as *H. chinensis*, 342 (fig. 14), 343 (fig. 19), 345 (fig. 21) as *H. fleischeri*, 335 (fig. 3), 338–339 (figs. 9, 10) as *H. lonchobasis*, 361 (fig. 51), 362 (fig. 55), 364 (fig. 57) as *H. longifolia*, 348–349 (figs. 26, 27), 350 (fig. 31) as *H. nilgherriensis*, 381 (fig. 90), 386 (fig. 97), 388 (fig. 103) as *H. sakuraii*, 342 (fig. 16), 347 (fig. 23), 348 (fig. 25) as *H. sanguinea*, 342 (fig. 13), 343 (fig. 18), 344 (fig. 20) as *H. sikkimense*, 394 (fig. 115), 396 (fig. 118), 399 (fig. 122) as *H. wichurae*; Hattori 1971: 222 (fig. 18) as *H. chinensis*; Inoue 1977: 8 (fig. 5); Hu & Wang 1985: 467 (fig. 201: 15–20), 466 (fig. 200: 3–5) as *H. fleischeri*, 466 (fig. 200: 8–12) as *H. sikkimense*; Zhao & Cao 1998: 22 (fig. 2); Bapna & Kachroo 2000: 250 (fig. 78); Wu & Wang 2000: 14 (fig. 3: 9–12).

Hattori (1955: p. 81) synonymized *Herbertus minima* with *H. sakuraii* (= *H. aduncus* subsp. *aduncus*), but Miller (1965: p. 316) stated that it belonged to the real *H. sakuraii*. Also Inoue (1977: p. 7) studied the type specimen and agrees it to be *H. sakuraii*. *Herbertus sakuraii* was synonymized with *H. dicranus* by Hodgetts (2003: p. 140).

A large number of types and other specimens were studied in order to place the Hunanese plants under the correct name among Asian *Herbertus*. The examination revealed the tremendous morphological plasticity of *H. dicranus*, also shown in the list of synonyms. Especially noteworthy among the characters are the size and colour of the plants, the degree of leaf bifidness, the angle of the lobes in the sinus, the falcateness of leaves, and differences in the lobing of the leaf margins, which characters are also clearly visible in African *Herbertus dicranus* (N. Hodgetts, pers. comm.). Both Evans (1917)

and Schuster (1957) commented that *Herbertus dicranus* is very closely related to *H. aduncus*. However, they had seen only limited numbers of Himalayan specimens of the highly variable and widely distributed *H. dicranus*. Among Hunanese *H. dicranus*, small green plants probably growing in unfavourable conditions form one extreme. Another form are robust plants with dark green colour and exceedingly expanded laminas, which refer e.g. to the type of *H. chinensis* Steph., and typical Taiwanese plants (see Inoue 1977). Another extreme are the plants from Mangshan Mountain, Mengkengshi Peak at 1750–1900 m altitude and humid climate with 1400–2000 mm annual precipitation. The basal laminas of plants from this area are not largely expanded. The most striking characters of those plants are the large trigones and red colour, especially bright in cell walls. Also the colour of the entire shoot is reddish. Schuster (1957) noticed that *H. aduncus* subsp. *tenuis* showed great differences in pigmentation of cell walls in its two principal habitats in the Appalachian Mountains. There, plants growing in areas with exceedingly high rainfall invade tree bark. They have a tendency to develop supplementary red pigmentation to cell walls, have a robust habit, and produce sex organs. On the contrary, plants from areas with relatively low precipitation grow in most shaded places, have no rosy colour, are small, and produce no sex organs. The similarity in growing conditions and morphological adaptations between *H. dicranus* from Mengkengshi Peak, and the first mentioned Appalachian race of *H. aduncus*, are remarkable. However, there are no holding arguments to describe any new species either in the Appalachian or Mengkengshi areas since the characters are so variable.

During the course of study I noticed that *Herbertus lonchobasis* and *H. wichurae* clearly belong to *H. dicranus*. The type of *H. lonchobasis* was collected from the Himalayas in 1937 by Troll. *Herbertus lonchobasis* is separated in the key by Miller (1965) on the basis of such underleaf characters, which are by no means adequate for species delimitation within the genus. The lanceolate underleaves and narrow sinus can be found in several populations. Stephani's species, *H. wichurae* was placed by Miller (1965) in the section *Piloherberta* H.A. Mill., the status

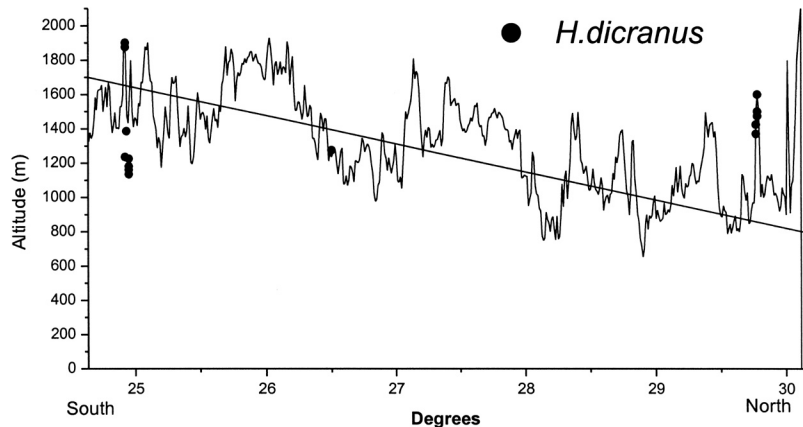
of which is in any case critical. The section is separated from the section *Herberta* H.A. Mill., where *H. dicranus* belongs, by the extension of the vitta to the leaf tip, the deep obtuse sinus, and a straight somewhat reduced antical segment. These all have proven to be more or less unstable characters (A. Juslén *et al.* unpubl. data). Furthermore, the essential characters of *H. dicranus* fit both *H. lonchobasis* and *H. wichurae*.

RANGE IN THE HUNAN PROVINCE: **Mangshan**. 7a. 50920, 51057. 7b. 50731, 50733a. 7c. 50757, 50758, 50760, 50770, 50771, 51073. 7e. 50641a. 9a. 49076, 49431. 11c. 51187, 51189a, 51339a. 13. 50988a, 50997. 14a. 49126, 49457a. 14b. 49272, 49284, 49285a, 49287a, 49288, 49289a, 49293, 49295, 49296, 49297a, 49302a, 49303a, 49305, 49306a, 49309a, 49311, 49312a, 49313a, 49328, 49329, 49336a, 49612a, 49617a, 49618a, 49624a. **Taoyuandong**. 37. 56726, 56731. **Badagongshan**. 42. 55714. 44a. 48179a. 50. 48767. 55b. 48022, 48036, 48046, 48049. 55c. 58825. Deciduous–evergreen forests, broad-leaved mixed forests, primeval and evergreen forests, and warm temperate secondary forest, in elfin forest on mountain top, and on rocky mountain top with *Fokienia hodginsii*, *Pinus kwantungensis* and *Tsuga longibracteata*, along roads and in *Magnolia* and *Tapiscia* plantation. Substrates were dry to moist, open to shaded cliffs (13 collections), outcrops (2), boulder (1), tree trunks (12), tree bases (3), dead trees (11), bushes (10), rotten stump (1), decorticated tree (1), and twig (1), often with *Plagiochila* or *Bazzania* at 1135–1900 m (Fig. 5). Primevity index 10/2/3. Frequency in Hunan: rather rare.

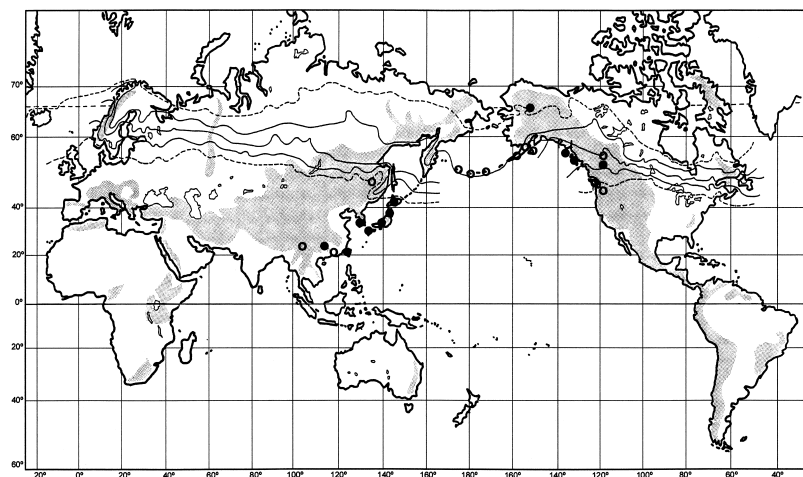
TOTAL RANGE: Eur (Paton 1999); Afr 2 (Wiggington & Grolle 1996); Afr 3 (Grolle 1995); Am 1 (Hong *et al.* 1993); Am 2, Am 4, Am 5 (Fulford 1963); Oc (Miller *et al.* 1983); As 2: Chi, Ja; As 3: Bhu, In, Ne, Sri, Tha.

REPRESENTATIVE SPECIMENS EXAMINED: **Afr 2: Rwanda**. Préfecture de Ruhengeri, gahinga, versant interne du cratère, alt. env. 3450 m, sur rocher ensoleillé, 1974 *De Sloover 19404* (H-3173906). **Am 4: Colombia**. Meta, Páramo de Sumapaz, Hoya de la Quebrada Sitiales, Vallecito pantanoso entre morrenas 0,5 km al SW de la Laguna La Primavera, Vegetación muy húmedo con *Diplostophium revolutum*, *Chusquea* sp., *Sphagnum* spp. Hepática terrícola por debajo de *Chusquea* sp., alt. 3550 m, 1972, *Cleef 1053* (U, det. Reenen as *H. subdentatus*). **As 2: China**. Yunnan. *Delavay* (BM-000661077, as *H. chinensis*), Fang Yang Tchang, *Delavay* (BM-000661079, as *H. chinensis*), Auf dem Passe Dsuningkou ober Dienso zwischen Dali und Hodjing, an lebenden *Rhododendron*-Stämmen, temp. Region, ca. 3400 m, 1915 *Handel-Mazzetti* (BM-000661076, M-0025115, NICH-218885, det. *Nicholson* as *H. chinensis*), In jugo Tschiangschel, 27°52', inter fluvios Lu-djiang et Djiou-djiang, in pluviisilva mixta, ad truncos, 2800–3400 m, 1916 *Handel-Mazzetti* (BM-000661072, G, M-0025110, NICH-218887, Z, det. *Nicholson*), Lijiang Co., Mt. Yu-Lung 25 km NNW of Lijiang near Gan-He-Ba, *Pinus densata*–*Larix*–*Abies*–*Rhododendron* forest at foot of the mountain sloping gently E, alt. 3020–3050 m, 27°06'N, 100°14'E, on trunk in partial





**Fig. 5.** Localities of *Herbertus dicranus* in Hunan. Grey line = border of warm temperate and orotemperate zones.



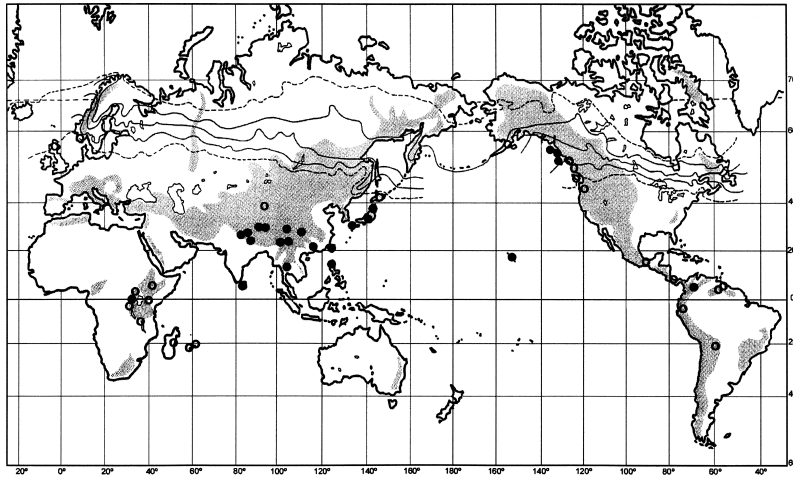
**Fig. 6.** Distribution of *Herbertus aduncus* subsp. *aduncus*. Solid circles = checked localities, open circles = localities in the literature.

shade, coll. site 9a, 1985 *Koponen 42104* (NY). Sichuan. In montium trans flumen Yalung ad septentr. oppidi Yenyüen ca.  $28^{\circ}10'$  sitorum regione frigide temp., ad arb. diversas, alt. 3600–3900 m, 1914 *Handel-Mazzetti 497* (JE, NY, det. *Nicholson* as *H. sikkimensis*), Mt. Emei, 1982 *Ratcliffe* (BM-000661083, as *H. aff. chinensis*). Guangdong. Ding-Hu-Shan, on rock, 1957 *Han Wu B270* (NY, det. *Wu 1975* as *H. chinensis*). **Japan.** Kyushu, Kagoshima-ken, Yakushima Isl., near Yodogawa Hut, alt. 1400 m, on tree trunk, 1985 *Furuki* (GOET, as *H. aduncus*), Honshu, Nagano-ken (Prov. Shinano), Mt. Yatsugatake, Iohdake–Yoko-dake, 1932 *Horikawa 8723* (HIRO). **As 3: Bhutan.** Bumthang district, between Resang La and Kertshog,  $27^{\circ}25'N$ ,  $90^{\circ}44'E$ , *Abies/Rhododendron* forest, on twigs of small tree, alt. 3770 m, 1999 *Long 28650* (H). **India.** Sikkim, Himalaya, Darjeeling distr., Sandakphu, 11 930 ft (3636 m), 1908 *Rhomoo 108* (BM-000661084, det. *Stephani n. 6147* as *Schisma sikkimense*), Darjeeling, Tigerhill, alt. 2800 m, 18.III.1909 *Fleischer* (JE); Sikkim, Himalaja, Tsomgo Lake, alt. 3600–3900 m, 1937 *Troll 18* (JE as *H. lonchobasis*); Darjeeling district, 1 km S of Lebung,  $27^{\circ}02'21''N$ ,  $88^{\circ}17'20''E$ , dense shady evergreen *Castanopsis* forest, on tree trunk, alt c. 1990 m, 1992 *Long 22400* (H). **Nepal.** Summit ridge, Tamo La  $27^{\circ}38'N$ ,

$87^{\circ}57'E$ , open rocky slopes with dwarf *Rhododendron*, on bank, alt. c. 3980 m, 1989 *Long 16954* (H). **Sri Lanka.** Ceylon centr., Horton Plains, 6500 ft., 1898 *Fleischer* (M-0025174, det. *Stephani n. 2111* as *Schisma wichurae*). **Thailand.** Prachinburi, Khao Khieo, evergreen forest, alt. 1300 m, 1963 *Larsen 10178* (C). **Oc: U.S.A.** Hawaii, Maui, Puu Kukui summit bog, Metro, ruta 1., 1938 *Cranwell* and *Skottberg 5293* (H, det. *Evans, Miller*, as *H. sanguinea*).

## Discussion

*Herbertus aduncus* is a northern hemisphere species of temperate climates (Fig. 6). Its main area of the distribution is in the cool temperate zone. In Hunan, subsp. *aduncus* was collected both in warm temperate (meridional) and cool temperate (orotemperate) zones (Fig. 2) (see *Koponen et al. 2004*). *Herbertus aduncus* belongs to the holarctic, continuously or discontinuously cir-



**Fig. 7.** Distribution of *Herbertus dicranus*. Solid circles = checked localities, open circles = localities in the literature.

cumpolar, boreal to temperate element, to which the majority of the bryophytes occurring in the arctic, boreal and temperate zones of the northern hemisphere belong (Koponen *et al.* 2004). Based on the total distribution of *H. aduncus* it can be assumed that it is an ancient polymorphous species from the early Tertiary, or even earlier times. It is now more or less restricted to disjunct populations in areas, which have not been glaciated or submerged since the Pleistocene.

Inoue (1977) stated that *Herbertus aduncus* is rare in Taiwan, and restricted to the central mountains at altitudes of 2000–2500 m. In this study the species could be confirmed with only one specimen from Taiwan (Yamada 74/a, NICH-426777). Zhu and So (1996) reported *H. aduncus* from Hong Kong. *Herbertus aduncus* has been reported several times from continental China, from the provinces of Anhui, Xijiang, and Heilongjiang (Piippo 1990). Thus, the discovery of *H. aduncus* in Hunan was to be expected. Temperate to boreal bryophytes commonly have disjunct localities at high elevations in the central Chinese “second step” mountainous areas (Koponen *et al.* 2004, Potemkin *et al.* 2004, Ignatov *et al.* 2005).

*Herbertus dicranus* has one of the largest distributions within the genus (Fig. 7). The synonymizations of *H. borealis*, *H. sakuraii*, and *H. subdentatus* auct., non (Steph.) Fulford with *H. dicranus* made by Hodgetts (2003) enlarged the distribution to cover, in addition to Africa and Asia, Europe and North and South America. In subtropical and tropical Asia, South America,

and Africa the species grows at high altitudes. This is in accordance with its Hunanese range, which is mainly in the orotemperate zone (see Koponen *et al.* 2004).

In China *Herbertus dicranus* occurs in eight provinces (Piippo 1990). In Europe and North America it is present in oceanic regions. When describing *H. borealis* Crundwell (1970) pondered whether it really is a new species, even though not recognized in Europe before. He placed *H. borealis* (= *H. dicranus*) in the group of “oceanic-montane” liverworts, mentioning as other examples *Mastigophora woodsii* and *Pleurozia purpurea*. Paton (1999) recorded that *H. borealis* occurs in Scotland in “subalpine” zone, at 380–550 m, and rarely in the lowlands. However, considering the whole distribution of the species I would place *H. dicranus* in pansubtropical-temperate element (see Koponen *et al.* 2004). Other examples of species that occur in southeast Asia, North America and at the high elevations in the tropics are *Herpetineuron tocoae* and *Palamocladium leskeoides* (Ignatov *et al.* 2005).

*Herbertus dicranus* is more common in Hunan than *H. aduncus*. *Herbertus dicranus* seems indifferent in its substrate selection, while *H. aduncus* subsp. *aduncus* prefers stone substrates. This might partly explain the difference in their frequency. Even though *Herbertus* species are able to grow also in disturbed habitats, they are classified as rare (*H. aduncus*), and rather rare (*H. dicranus*), using Norrlin’s frequency scale (Table 1; see also Koponen *et*

al. 2004). Infertility may be one reason. Løe and Söderström (2001) stated that local growth of Norwegian *Herbertus* populations seems to depend mostly on regeneration from shoot fragments and branches.

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## Index of scientific names

This index contains the names formally treated in this paper. Names accepted and treated in detail are given in **boldface**.

<i>Herberta</i>	<i>sakuraii</i>	<i>lonchobasis</i>
<i>adunca</i>	fo. <i>pusilla</i>	<i>sakuraii</i>
fo. <i>minor</i>	fo. <i>remotiusculifolia</i>	<i>wichurae</i>
subsp. <i>schusteri</i>	fo. <i>typical</i>	<i>Schisma</i>
<i>ceylanica</i>	subsp. <i>hutchinsiae</i>	<i>aduncum</i>
<i>chinensis</i>	subsp. <i>sakuraii</i>	<i>chinense</i>
<i>dicrana</i>	subsp. <i>tenuis</i>	<i>dicrana</i>
<i>fleischeri</i>	<i>sanguinea</i>	<i>fleischeri</i>
<i>hutchinsiae</i>	<i>sendtneri</i>	<i>juniperina</i>
subsp. <i>sakuraii</i>	<i>sikkimensis</i>	var. <i>sanguinea</i>
subsp. <i>schusteri</i>	<i>wichurae</i>	<i>nilgherriense</i>
<i>lonchobasis</i>	<i>Herbertia</i>	<i>pusillum</i>
<i>longifolia</i>	<i>adunca</i>	<i>sanguineum</i>
<i>longispinus</i>	<i>dicrana</i>	<i>sikkimense</i>
<i>minima</i>	<b><i>Herbertus</i></b>	<i>wichurae</i>
<i>minor</i>	<b><i>aduncus</i></b>	<i>Sendtnera</i>
<i>nicholsonii</i>	subsp. <b><i>aduncus</i></b>	<i>adunca</i>
<i>nilgherriensis</i>	subsp. <i>hutchinsiae</i>	<i>dicrana</i>
<i>pusilla</i>	subsp. <i>tenuis</i>	<i>juniperina</i>
<i>remotiusculifolia</i>	<b><i>dicranus</i></b>	var. <i>sanguinea</i>