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

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Received 11 Nov. 2003, revised version received 22 Nov. 2003, accepted 2 Dec. 2003


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)


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
lamina, 3–8(–10) cells between sinus and vitta bifurcation point, these cells 10–20 × 12–30 µm; basal lamina cells 10–12 × 12–23 µm, 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;
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. *hutchiniae* (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. sakuraii* (Warnst.) S. Hatt. subsp. *sakuraii* (= *H. aduncus* subsp. *aduncus*), *H. sakuraii* subsp. *hutchiniae* R.M. Schust. (= *H. aduncus* subsp. *hutchiniae*), and *H. sakuraii* 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 Columbia 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, *Taoyuangong*. 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 1/70. Frequency in Hunan: rare.**

**Total range:** Eur (subsp. *hutchiniae*); eastern Am 1 (subsp. *tenuis*); subsp. *aduncus*: western Am 1; As 2: Chi, Ja, Ko.


**As 2: China.** Taiwan, Chiai, Mt. Alishan, ca. 2000–2200 m alt., on tree trunk, 1979 *Yamada* 74/a (NICH-42677).

**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 *Steere* 17779 (H-3173769).

**As 2: China.** Taiwan, Chiai, Mt. Alishan, ca. 2000–2200 m alt., on tree trunk, 1979 *Yamada* 74/a (NICH-42677).

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


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, i, j, and k from 50780, 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 l and k.
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 ± transversely inserted, ± falcate and asymmetrical, with a ± 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 ± lobate, with few sessile or shortly-stalked basal slime papillae; vitta conspicuous, extending to 1/2–4/5 of lobe, vitta cells 12–15 × 30–68 μm 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 × 12–30 μm, basal lamina cells 10–13 × 12–25 μm, often with distinct nodulose trigones; underleaves somewhat smaller and ± symmetrical.

**Selected illustrations:** Stephani 1909 (icones ined. no. 6742), (icones ined. no. 6740) as *Schisma chinense*, (icones ined. no. 6744) as *S. fleischeri*, (icones ined. no. 6756) as *S. nilgerriense*, (icones ined. no. 6763) as *S. sikkimense*, (icones ined. no. 6766) as *H. 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. longobasis*, 361 (fig. 51), 362 (fig. 55), 364 (fig. 57) as *H. longifolia*, 348–349 (figs. 26, 27), 350 (fig. 31) as *H. nilgerriensis*, 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. Hodggets, 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. chinesis* 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 Menkengshi areas since the characters are so variable.

During the course of study I noticed that *Herbertus lonchobasis* and *H. wichuriae* 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 under-leaf 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. wichuriae* 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 obute 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. wichuriae*.

**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. Taoyuangdong. 37. 57672, 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 elin forest on mountain top, and on rocky mountain top with *Fokienia hodginsii*, *Pinus kwantungensis* and *Tsuga longibracteata*, along roads and in *Magnolia* and *Taxispis* 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 (Fullford 1963); Oc (Miller et al. 1983); As 2; Chi, Ja; As 3: Bhu, In, Ne, Sri, Tha.


**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-
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, Xijang, 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. sakuraitai*, 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 tecoae* 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

![Fig. 7. Distribution of *Herbertus dicranus*. Solid circles = checked localities, open circles = localities in the literature.](image-url)
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.

Acknowledgements

I thank my supervisors Prof. Sinikka Piippo and Prof. Jaakko Hyvönen for valuable advice and for critical comments on the manuscript. Prof. Timo Koponen is thanked for commenting on the manuscript and for supplying rare literature. Thanks are due to Nick Hodgetts and Dr. Fred Rumsey for the possibility of seeing his manuscripts on the genus Herbertus and reviewing the English. Dr. Elena A. Ignatova from Moscow State University illustrated the habits of Herbertus. Prof. Pekka Isovitoh helped with the nomenclature and Prof. Teuvo Ahti with nomenclature and Latin. Dr. Xiao-Lan He-Nygrén with Chinese, Erkki Reimikka with Korean, and Laura Salminen with German language. Dr. Tuomo Niemelä kindly gave distribution map basis for my use. I thank the staff of Botanical library of University of Helsinki for locating books and papers. The curators of BM, C, G, GOET, FH, H, HIRO, JE, M, MU, NICH, NY, S, U, and Z are thanked for the loans of specimens. The study was financed by the Academy of Finland projects 50620 and 39482 led by Prof. Jaakko Hyvönen, Research Foundation of the University of Helsinki, and Oskar Öflund Foundation.

References


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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**.

**Herberta**

- *adunca*
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  - subsp. *schusteri*
  - ceylanica
  - chinensis
  - dicrana
  - fleischeri
  - hutchinsiae
    - subsp. *sakuraii*
  - subsp. *schusteri*
  - longobasis
  - longifolia
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  - minima
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  - pusilla
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- *sakuraii*
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  - *juniperina*
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  - *pusillum*
  - *sanguineum*
  - *sikkimense*
  - *wichurae*

- *Sendtnera*
  - *adunca*
  - *dicrana*
  - *juniperina*
    - var. *sanguinea*