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Bryophyte flora of Hunan Province, China. 25. Neckera- ceae and Miyabeaceae (Musci)

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In Hunan Province of China, the moss family Neckera- ceae has 24 species in eight genera, namely *Circulifolium* S. Olsson, Enroth & D. Quandt (with 1 species), *Forsstroemia* Lindb. (3), *Homalia* Brid. (1), *Homaliodendron* M. Fleisch. (7), *Neckera* Hedw. (5), *Neckeropsis* Reichardt (2), *Pinnatella* M. Fleisch. (2), *Taiwanobryum* Nog. (2) and *Thamnobryum* Nieuwl. (1). The family Miyabeaceae contains one genus, *Homaliadelphus* Dixon & P. de la Varde with one species. *Forsstroemia noguchii* L.R. Stark, *Neckera setschwanica* Broth., and *N. konoii* Broth. ex Cardot are new records for Hunan. The presence of *Taiwanobryum speciosum* Nog. in Hunan is confirmed and *Pinnatella taiwanensis* Nog. is new to mainland China. *Forsstroemia cryphaeoides* Cardot is excluded from the Hunan flora. *Neckera decurrens* Broth. is reported for the first time from Vietnam. A key to the species is provided and their habitats, substrates and taxonomy are discussed. The taxa are divided into floristic elements on the basis of their total range and range in Hunan. Altitudinal ranges of 11 taxa are mapped.

Key words: China, floristic elements, habitats, Hunan, Miyabeaceae, Neckera- ceae, nomenclature, substrates, ranges, taxonomy

CONTENTS

1. Introduction, material and methods	149
2. Neckeraceae Schimp. 1855	149
Key to the taxa of Miyabeaceae and Neckeraceae reported from Hunan	150
2.1 <i>Circulifolium</i> S. Olsson, Enroth & D. Quandt	152
1. <i>Circulifolium exiguum</i> (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt ..	152
2.2. <i>Forsstroemia</i> Lindb.	152
2. <i>Forsstroemia noguchii</i> L.R. Stark	152
3. <i>Forsstroemia trichomitria</i> (Hedw.) Lindb.	153
4. <i>Forsstroemia yezoana</i> (Besch.) S. Olsson, Enroth & D. Quandt	153
2.3 <i>Homalia</i> Brid.	154
5. <i>Homalia trichomanoides</i> (Hedw.) Brid.	154
2.4. <i>Homali dendron</i> M. Fleisch.	154
6. <i>Homali dendron flabellatum</i> (Sm.) M. Fleisch.	155
7. <i>Homali dendron</i> cf. <i>ligulaefolium</i> (Mitt.) M. Fleisch.	156
8. <i>Homali dendron montagneanum</i> (Müll.Hal.) M. Fleisch.	156
9. <i>Homali dendron neckeroides</i> Broth. in Hand.-Mazz.	157
10. <i>Homali dendron papillosum</i> Broth.	157
11. <i>Homali dendron pulchrum</i> L.Y. Pei & Y. Jia	158
12. <i>Homali dendron</i> cf. <i>scalpellifolium</i> (Mitt.) M. Fleisch.	159
2.5. <i>Neckera</i> Hedw.	159
13. <i>Neckera decurrens</i> Broth.	160
14. <i>Neckera flexiramea</i> Cardot	160
15. <i>Neckera inopinata</i> Enroth & M. Ji	161
16. <i>Neckera konoii</i> Broth. ex Cardot	161
17. <i>Neckera setschwanica</i> Broth.	162
2.6. <i>Neckeropsis</i> Reichardt	162
18. <i>Neckeropsis calcicola</i> Nog.	162
19. <i>Neckeropsis nitidula</i> (Mitt.) M. Fleisch.	163
2.7. <i>Pinnatella</i> M. Fleisch.	163
20. <i>Pinnatella makinoides</i> (Broth.) Broth.	163
21. <i>Pinnatella taiwanensis</i> Nog.	164
2.8. <i>Taiwanobryum</i> Nog.	164
22. <i>Taiwanobryum guangdongense</i> (Enroth) S. Olsson, Enroth & D. Quandt	164
23. <i>Taiwanobryum speciosum</i> Nog.	165
2.9. <i>Thamnobryum</i> Nieuwl.	165
24. <i>Thamnobryum subserratum</i> (Hook.) Nog. & Z. Iwats.	165
3. Miyabeaceae Enroth, S. Olsson, Buchbender, Hedenäs, Huttunen & D. Quandt	166
3.1. <i>Homaliadelphus</i> Dixon & P. de la Varde	166
25. <i>Homaliadelphus targionianus</i> (Mitt.) Dixon & P. de la Varde	166
4. Doubtful and excluded records	167
5. Discussion	167
5.1. Range extensions	167
5.2. Phytogeography; floristic elements	167
5.2.1. Taxa ranging only in SE Asia	170
5.2.2. Taxa ranging also outside SE Asia	170
5.3. Conservation	171

Acknowledgements	171
References	171
Index to names	175

1. Introduction, material and methods

This paper belongs to a series dealing with the bryophyte flora of Hunan Province in China. The series is mainly based on the authors' excursions and collections. Essential background information of the material and methods, and abbreviations of the collecting localities of the three first excursions (to Mangshan, Wulingyuan, Taoyuandong, Yuankou, Badagongshan and Hupingshan) and geographical areas used in this study are given in parts 1 and 3 (Koponen *et al.* 2000, 2004). The collecting localities of the two later excursions, in 2000 and 2001 (to Badagongshan, Daweishan, Shunhuangshan and Yunshan) were described by Koponen *et al.* (2014, see also below). The preceding part in the series, treating the Pottiaceae is that by Sollman and Koponen (2017).

In this paper, we cite the nomenclature including the basionyms of taxa and the synonymous names previously reported or used for Hunan bryophytes. The specific taxonomy is discussed when necessary and illustrations useful in the identification are referred to. In "Habitat and substrates in Hunan" we collect information from the labels of our specimens. If specimens from only four collecting sites are present in the material, we repeat the label details in full. In case of more specimens, a summary of habitats and substrates is given. For each species the frequency in the province is estimated and the ranges in Hunan, China and total worldwide ranges are summarized.

We add two collecting localities absent from the list published in 2014.

Badagongshan National Nature Reserve

Collecting locality 92. Sangzhi Co. (Badagongshan – Tianpingshan). Miao-Wan-Kou. Subtropical (warm temperate) zone. Secondary evergreen broadleaf forest with e.g. *Fagus*, *Acer*, *Camellia* and *Symplocos* species, 29°46'N, 110°04'E, alt. 1350–1370 m, 19.IX.2000 Viivi Virtanen.

Daweishan National Forest Park

Collecting locality Daw27. Liu Yang County. Chuang-Di-Wo. Subtropical (meridional) zone. Secondary, mixed evergreen/deciduous broadleaf forest with e.g. *Betula luminifera*, *Carpinus viminea*, *Castanea mollissima*, *Cyclobalanopsis ningangensis*, *Dendrobenthamia hongkongensis*, *Eurya myricata* f. *glaberrima*, *Ilex pernyi*, *Pinus taiwanensis*, *Sorbus folgnerii*, *Symplocos paniculata* and *Rhododendron* species, 28°25'N, 114°06' E, alt. 1350–1430 m, 28.9.2000 Viivi Virtanen.

2. Neckeraceae Schimp. 1855

The present paper reports the species of the moss families Neckeraceae and Miyabeaceae found in Hunan. The circumscription of the Neckeraceae applied here follows the one established by Olsson *et al.* (2009a) and further elaborated by Olsson *et al.* (2010, 2011). In that circumscription the Neckeraceae contains the genera *Leptodon* Mohr, *Forsstroemia* Lindb. and *Taiwanobryum* Nog., the latter two newly defined. The family has three main clades called *Neckera* clade, *Thamnobryum* clade, and *Pinnettella* clade (Olsson *et al.* 2009a, 2010, 2011). The last-mentioned clade is essentially, if not exclusively, tropical and Asian.

Key to the taxa of Miyabeaceae and Neckeraceae reported from Hunan

1. Plants small, complanate, “leafy liverwort-like”; leaves ecostate, asymmetric, nearly rounded to obovate or spatulate, often with a distinct basal lobe *Homaliadelphus targionianus* (Miyabeaceae)
– Plants different 2
2. Plants to c. 1 (–1.5) cm high, stipitate-frondose; distal or most branch leaves caducous
..... *Taiwanobryum guangdongense*
– Different combination of characters 3
3. At least upper (or all) leaves distinctly undulate 4
– Leaves not distinctly undulate 10
4. Leaf apex mostly truncate; costa weak, reaching to midleaf at most *Neckeropsis calcicola*
– Leaf apex acute; costa weak and short or strong and reaching to above midleaf 5
5. Paraphyllia present *Neckera setschwanica*
– Paraphyllia absent 5
6. Plants strongly glossy; leaves complanate, distinctly asymmetric 7
– Plants dull or slightly glossy; leaves not complanate, symmetric or slightly asymmetric 8
7. Upper part of leaf decurrencies to 6–7(–9) cells wide *Neckera decurrens*
– Upper part of leaf decurrencies to 3–4(–5) cells wide *Neckera flexiramea*
8. Apical and laminal cells with solid or weakly porose walls *Neckera inopinata*
– Apical and laminal cells with strongly incrassate, distinctly porose walls 9
9. Plants autoicous; branch tips often attenuate; capsules immersed *Forsstroemia yezoana*
– Plants dioicous; branch tips not attenuate; capsules exerted *Neckera konoii*
10. Plants not or only indistinctly stipitate-frondose; leaves strongly complanate; leaf apices rounded to obtuse 11
– Plants distinctly stipitate-frondose; leaves complanate or not; leaf apices obtuse to acute .. 13
11. Plants slender; stems with leaves to 2 mm wide; flagelliform, microphyllous branches common *Circulifolium exiguum*
– Plants more robust; stems with leaves more than 2 mm wide; flagelliform, microphyllous branches infrequent 12
12. Plants distinctly glossy; costa reaching to ½ of leaf length at most; capsules immersed
..... *Neckeropsis nitidula*
– Plants slightly glossy; costa usually to ½ or ¾ of leaf length, occasionally shorter; capsules exerted *Homalia trichomanoides*
13. Stipe leaves spreading to squarrose 14
– Stipe leaves appressed 15

14. Plants mostly between 2 and 6 cm long; stem leaves to c. 2 mm long; apical and median laminal cells with strongly incrassate and more or less porose walls *Pinnatella makinoi*
 – Plants commonly to over 10 cm long; stem leaves to c. 2.8 mm long; apical and median laminal cells with fairly thin, solid walls *Pinnatella taiwanensis*
15. Leaf apices narrowly acute to acuminate; leaf margins nearly entire or faintly serrulate near apex 16
 – Leaf apices acute to obtuse; leaf margins near apex distinctly serrate by uni- or (mostly) multicellular teeth 17
16. Plants autoicous, sporophytes common; branches not attenuate or filiform *Forsstroemia trichomitria*
 – Plants dioicous, sporophytes rare; branches often attenuate or filiform *Forsstroemia noguchii*
17. Leaves with a long, linear-lanceolate acumen *Taiwanobryum speciosum*
 – Leaves different 18
18. Costa strong, forming a distinct abaxial keel in dry leaves, ending near leaf apex; leaf apex moderately serrate by uni- or multicellular teeth *Thamnobryum subserratum*
 – Costa weaker, not forming a keel in leaves, reaching to c. 3/4 at most; leaf apex very strongly serrate to incised by multicellular teeth 19
19. Plants strongly glossy and complanate; costa absent or reaching 1/5(–1/4) of leaf length at most *Homaliodendron pulchrum*
 – Plants dull or glossy, complanate or not; costa reaching to 1/3 or 3/4 of leaf length 20
20. Laminal cells especially in branch leaves and near leaf apices distinctly mammillose *Homaliodendron papillosum*
 – Laminal cells smooth or very slightly bulging 21
21. Capsules immersed *Homaliodendron neckeroides*
 – Capsules exserted 22
22. Plants remotely and irregularly branched; stipe leaves ovate, apex obtuse *Homaliodendron montagneanum*
 – Plants often densely and ± regularly branched; stipe leaves ovate to triangular, apex acute ...
 23
23. Branch leaves broadly spathulate or obovate *Homaliodendron flabellatum*
 – Branch leaves narrower 24
24. Branch leaves nearly symmetric, lingulate *Homaliodendron cf. ligulaefolium*
 – Branch leaves asymmetric, mostly ovate to spathulate ... *Homaliodendron cf. scalpellifolium*

2.1 *Circulifolium* S. Olsson, Enroth & D. Quandt

Circulifolium is a genus of two species, both distributed in China. It was segregated from *Homali dendron* M. Fleisch. by Olsson *et al.* (2010). Ninh (1984) treated it as *Homali dendron* sect. *Circulifolia*, but it is more closely related to *Neckeropsis s.l.*, *Caduciella* Enroth and *Himantocladium* (Mitt.) M. Fleisch. than to *Homali dendron* M. Fleisch. *s.str.* *Circulifolium* differs from the latter genus by having more or less spatulate leaves with rounded, entire or slightly dentate apices, and filiform instead of leaf-like pseudoparaphyllia.

One species is known from Hunan. Brotherus (1929) cited also *Circulifolium microdendron* (Mont.) S. Olsson, Enroth & D. Quandt (as *Homali dendron microdendron* (Mont.) M. Fleisch.) from the province, but that specimen (*Handel-Mazzetti* 2293, H-BR11493) represents a small, glossy form of *H. flabellatum* (Sm.) M. Fleisch.

1. *Circulifolium exiguum* (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt

Org. Divers. Evol. 10(2): 120. 2010. – *Homalia exigua* Bosch & Sande Lac., Bryol. Jav. 2: 55, pl. 175. 1862. – *Homali dendron exiguum* (Bosch & Sande Lac.) M. Fleisch., Musci Fl. Buitenzorg 3: 897. 1908.

TAXONOMY. *Circulifolium exiguum* is characterized by very slender, irregularly branched plants with strongly complanate leaves.

ILLUSTRATIONS (all as *Homali dendron exiguum*). Fleischer 1908: 899 (fig. 157, “156”); Ninh 1984: 13 (fig. 5); Enroth 1989: 59 (fig. 7); Noguchi 1989: 715 (fig. 315A).

HABITATS, SUBSTRATES AND RANGE IN HUNAN (Fig. 2). *Circulifolium exiguum* was first reported from Hunan by Koponen *et al.* (2000, as *Homali dendron exiguum*, not cited in Jia & He 2013). **Hupingshan**. 59. 53328, mixed with

Pinnatella makinoi, primary evergreen broad-leaf forest, 550–700 m, on stump. **Mangshan**. 4b. 51441, 51442, mixed with *Hypopterygium* sp., meridional mixed forest, on tree trunks at 640 m (Koponen *et al.* 2000, as *Homali dendron exiguum*). **Taoyuandong**. 20a. 57249, Zhulian waterfall, 670 m. **Yuankou**. 74b. 59911, at trail side along river, on tree base at 330–400 m. 78c. 59685, bamboo forest with remnant trees of original evergreen broadleaf forest and *Pinus massoniana* on steep slope at 700–870 m. 79b. 59611, mixed with *Homali dendron* cf. *scalpellifolium*, primary broadleaf evergreen and deciduous forest, 950–1000 m, on outcrop. – Frequency in Hunan: Rare.

RANGE IN CHINA. *Circulifolium exiguum* is a tropical-subtropical species, in China known from most of the southern provinces, the northernmost localities being in Xizang and Jiangsu (Redfearn *et al.* 1996, Wu 2011a). According to Wu (2011a), it grows between 160–1850 m on trees and shaded rock surfaces.

TOTAL RANGE (Ninh 1984, Enroth 1989). Afr 3; As 2: Chi Ja Tai, As 3: Bu In Ne Sri Tha Vi, As 4: Ind Ma Phi PNG; Austr 1; Oc: Fij.

2.2. *Forsstroemia* Lindb.

Forsstroemia was revised by Stark (1987) who recognized 10 species. Olsson *et al.* (2011) determined that the genus belongs in the Neckeraceae and more specifically in the *Neckera* clade and transferred two species from *Neckera* to *Forsstroemia*. According to Zhang and He (2011), six species were known from China but Jia and He (2013) added two species. The latter authors cite *Forsstroemia cryphaeoides* Cardot from Hunan, based on the report by Koponen *et al.* (2004). However, that species does not occur in Hunan (see Doubtful and excluded records, below). Three species of *Forsstroemia* are known from Hunan.

2. *Forsstroemia noguchii* L.R. Stark

Misc. Bryol. Lichenol. 9: 182. 1983.

TAXONOMY. The specimen of *Forsstroemia noguchii* (below), which consists of only two shoots, is typical of the species, having irregularly branched, slender, attenuate stems and flexuose branches (Stark 1987).

ILLUSTRATIONS. Stark 1987: 189 (fig. 30); Zhang & He 2011: 141 (pl. 301: 1–4).

HABITAT, SUBSTRATE AND RANGE IN HUNAN. *Forsstroemia noguchii* has not previously been recorded to Hunan (Jia & He 2013). **Badagongshan.** 40a. 50438, mixed with *Homaliiodendron* cf. *ligulaefolium*, primary, dry deciduous-evergreen forest, at c. 1300 m, tree trunk. – Frequency in Hunan: Very rare.

RANGE IN CHINA. Zhang and He (2013) cited specimens of *Forsstroemia noguchii* from Shaanxi and Sichuan, but the species has been recorded also from Hubei (Redfearn *et al.* 1996, Jia & He 2013). It grows on tree trunks and rocks between 1300 and 4200 m (Zhang & He 2011). – New to Hunan.

TOTAL RANGE (Stark 1987, Zhang & He 2011). As 1: Ru, As 2: Chi Ja.

3. *Forsstroemia trichomitria* (Hedw.) Lindb.

Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 19: 605. 1863. – *Pterigynandrum trichomitrium* Hedw., Sp. Musc. Frond. 82, pl. 16, fig. 1–6. 1801.

TAXONOMY. *Forsstroemia trichomitria* can be distinguished from *F. noguchii* by autoicous sexual condition and hence frequent presence of sporophytes, and by the lack of slender, flexuose branches. It lacks the turgid appearance typical of *F. yezoana*; the latter also has much more deeply immersed capsules.

ILLUSTRATIONS. Stark 1987: 193 (fig. 32 A–D), 194 (fig. 32 E–T), 195 (fig. 33A & B); Noguchi 1989: 631 (fig. 280B); Sharp *et al.* 1994: 679 (fig. 507); Buck 1998: 156 (pl. 63, figs. 1–8); Zhang & He 2011: 144 (pl. 302).

HABITATS, SUBSTRATES AND RANGE IN HUNAN. Reported from **Badagongshan.** 42a. 64784, 64851, 64985, trunk of *Tapiscia sinensis* at 1370 m (Enroth & Koponen 2003). **Hupingshan.** 58. 53606, river valley in primary evergreen broadleaf forest, tree trunk at 550 m. – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Forsstroemia trichomitria* is known from 11 provinces in China (Jia & He 2013). According to Zhang and He (2011), it grows on tree trunks and rocks between 850 and 2400 m.

TOTAL RANGE (Stark 1987, Zhang & He 2011). Am 1, Am 5, Am 6, As 1 (Russian Far East), As 2: Chi Ja Kor, As 3: Ne.

4. *Forsstroemia yezoana* (Besch.) S. Olsson, Enroth & D. Quandt

Taxon 60: 45. 2011. – *Neckera yezoana* Besch., Ann. Sci. Nat., Bot., sér. 7, 17: 358. 1893.

TAXONOMY. *Forsstroemia yezoana* has long been recognized as *Neckera yezoana*, probably due to the undulate leaves and relatively weak costa, thought to be typical of most species of *Neckera*. It can usually be recognized by the somewhat turgid habit (because the leaves are not complanate) and narrowly ovate to lanceolate leaves with thick-walled cells. Especially distal branch leaves are often somewhat homomallous.

ILLUSTRATIONS (as *Neckera yezoana*). Noguchi 1989: 703 (fig. 310B); Wu 2011a: 357 (pl. 382, figs. 1–12).

HABITATS AND SUBSTRATES IN HUNAN. A remarkable part (nine sites) of the habitats of *Forsstroemia yezoana* were described as high elevation (950–2099 m) primary evergreen broadleaf forests, mixed evergreen and deciduous forests or deciduous forests. At lower elevations it was taken from secondary forests, in bamboo, *Phellodendron sinense* and *Cunninghamia lanceolata* plantations, in grazed open or semi-open secondary forests and along trail in orchards at

430–1550 m (Fig. 1). It is mainly epiphytic as the statistics for the specimens reported here shows: Tree trunk (25), tree base (1), log (1), bush (1), rock (3), cliff (1) and litter (1). Eight of the specimens from tree trunks were collected on *Tapiscia sinensis*. – Frequency in Hunan: Rather rare.

RANGE IN HUNAN. *Forsstroemia yezoana* was first reported from Hunan by Wu *et al.* (2011b). **Badagongshan.** Sang-zhi Co. (Wu *et al.* 2011b). 42a. 61368, 64778, 64830, 64852, 64993, 64997, 65001. 45. 55526. 48. 48687. 52. 54649. 54. 54645. 88b. 59017. **Daweishan.** DAW16. 63277. DAW18. 63301. **Hupingshan.** 58. 53603, 53609. 69. 54078, 54081. 72. 49831, 49885, 49917, 52195, 53551, 53580. **Shunhuangshan.** S8. 70675. S16. 71066 (mixed with *Homaliodendron* cf. *scalpellifolium*). **Taoyuandong.** 25a. 56869. 28. 55298. 33. 56762. 34. 57071. **Wulingyuan.** Da-yong City (Wu *et al.* 2011b). 18a. 58588. **Yunankou.** 76b. 60984. **Yunshan.** Y2. 70023.

RANGE IN CHINA. Redfearn *et al.* (1996, as *Neckera yezoana*) and Jia and He (2013) listed *Forsstroemia yezoana* from 10 Chinese provinces, and Wu (2011a) cited specimens from nine provinces. Wu (2011a) gives the altitudinal range of 1000–2900 m, and states that it grows on trees, rotten logs and rock surfaces.

TOTAL RANGE (Noguchi 1989, Wu 2011a). As 1 (Russia, Sakhalin), As 2: Chi Ja Kor.

2.3. *Homalia* Brid.

He (1997) recognized five species in *Homalia*. Of those, the South and Central American *H. glabella* (Hedw.) Schimp. was transferred to *Thamnalia* S. Olsson, Enroth & D. Quandt by Olsson *et al.* (2010) and *Homalia pennatula* (Mitt. ex Dixon) S. He & Enroth actually belongs in *Symphyodon* Mont. (Olsson *et al.* 2009a) and should be recognized as *S. pennatulus* (Mitt. ex Dixon) Dixon. One species of *Homalia* is known from China.

5. *Homalia trichomanoides* (Hedw.) Brid. var. *trichomanoides*

Bryol. Eur. 5: 55. 1850 (fasc. 44–45. Monogr. 3). – *Leskea trichomanoides* Hedw., Sp. Musc. Frond. 231. 1801.

TAXONOMY. *Homalia trichomanoides* var. *trichomanoides* is a well-known taxon in the temperate regions of the northern hemisphere (see the Illustrations). *H. trichomanoides* var. *japonica* (Besch.) S. He is smaller than var. *trichomanoides*, and also differs from it by being dioicous (He 1997, Wu 2011a). The variety *japonica* is much rarer in China than var. *trichomanoides* (Wu 2011a).

ILLUSTRATIONS. In many North American, European and East Asiatic flora works, e.g. Brotherus 1923, Lawton 1971, Smith 1978, 2004, Crum & Anderson 1981, Noguchi 1989, Ignatov & Ignatova 2003, Hallingbäck 2014, Wu 2011a: 325 (pl. 370, figs. 1–6).

HABITAT, SUBSTRATE AND RANGE IN HUNAN. **Changsha City.** 1. 48982, 49386, meridional evergreen forest on tree bases in shadow at 50 m (Koponen *et al.* 2000). – Frequency in Hunan: Very rare.

RANGE IN CHINA. In China *Homalia trichomanoides* var. *trichomanoides* was previously known from several provinces mainly in the central and northern parts of the country (Redfearn *et al.* 1996, Wu 2011a, Jia & He 2013).

TOTAL RANGE. According to He (1997), *H. trichomanoides* var. *trichomanoides* is widely distributed mainly in the temperate regions of the northern hemisphere. Am 1; Am 2 (Mexico); Eur; As 1, As 2: Chi Ja Kor, As 3: Bhu In.

2.4. *Homaliodendron* M. Fleisch.

Homaliodendron s.str. (*Circulifolium* excluded) contains distinctly stipitate, frondose and mostly medium-sized to robust plants with very coarsely serrate leaf apices (Olsson *et al.* 2010), corresponding to Ninh's (1984) *Homaliodendron* sect. *Homaliodendron*.

There are nine species of *Homaliodendron s.str.* reported from China. That number includes

H. neckeroides Broth. which was treated in *Nec-keria* by Wu (2011a), *H. fruticosum* (Mitt.) S. Olsson, Enroth & D. Quandt, known from Yun-nan but absent from Wu (2011a), and *Homalio-dendron pulchrum* L.Y. Pei & Y. Jia, which was described too recently (Pei *et al.* 2011) to be included in Wu's account.

Of the nine Chinese species, *Homalioden-dron montagneanum* (Müll. Hal.) M. Fleisch., *H. neckeroides* and *H. pulchrum* are distinct and mostly easily identified, with the reservation that *H. neckeroides* is difficult to distinguish, if sporo-phytes are not present. In principle also *H. papillosum* is distinct, if one assigns all speci-mens with more or less distinctly mammillose leaf cells to it. However, the variability in plant stature, leaf shape, strength of costa, and leaf areolation in such material is inconveniently wide.

Jia and He (2013) cite also *Homaliodendron opacum* Nog. and *H. undulatum* Nog. from Chi-na. However, both names were treated as taxo-nomic synonyms of *H. papillosum* Broth. by Su (1988; not seen by us but cited by Wu 2011a).

Enroth (1989) adopted a very wide concept of *H. flabellatum* based on New Guinea material, encompassing also expressions that Wu (2011a) treated as *H. ligulaefolium* and *H. scalpellifolium*. That wide concept was followed by Koponen *et al.* (2000). It seems that the variabil-ity in China is not quite as continuous as in New Guinea, and therefore we here recognize *H. cf. ligulaefolium* and *H. cf. scalpellifolium*. We also re-examined the specimens reported as *H. fla-bellatum* from Mangshan and Wulingyan by Ko-ponen *et al.* (2000) and list them here according to the present narrower species concept. Wu (2011a) published some of our collection as *H. flabellatum*; these are here re-identified. The main distinctions reside in the shape of the branch leaves, and they are not clear-cut. It seems that the specific boundaries in this assem-blage can hardly be worked out without system-atic studies based on molecular data and a geo-graphically wide sampling of specimens. The ranges of these three taxa in Hunan (Figs. 1 and 2) do not support the separation to different speci-es. All of them have been collected in both

orotemperate and meridional zones, and from the same or nearby localities.

Six to eight species of *Homaliodendron s.str.* are known from Hunan, depending on whether one recognizes *H. ligulaefolium* and *H. scalpellifolium* as distinct species.

6. *Homaliodendron flabellatum* (Sm.) M. Fleisch.

Hedwigia 45: 74. 1906. – *Hookeria flabellata* Sm., Trans. Linn. Soc. London 9: 280, 23, fig. 2. 1808.

Homaliodendron microphyllum C. Gao, Acta Phytotax. Sin. 17: 117. 1979. – Synonymized by Wu (2011a).

TAXONOMY. The specimens *Koponen et al.* 55098, 55142 and 55144 (also in Wu 2011a), all from Taoyuandong from between 745 and 800 m, represent a very distinctive expression. They are strongly glossy and strongly complanate, resemb-ling *H. pulchrum* in those characters. One would be tempted to formally recognize them at least at the subspecific level, but given the great intraspe-cific variability of *H. flabellatum*, such a conclu-sion would need support from molecular data.

ILLUSTRATIONS. Ninh 1984: 34–36 (figs. 17–19); Enroth 1989: 62–63 (figs. 8–9); Wu 2011a: 332 (pl. 372, figs. 1–9).

HABITATS AND SUBSTRATES IN HUNAN. Most of the collections were taken in either primary or second growth meridional evergreen broadleaf forests, and some specimens from sites disturbed by grazing or from bamboo groves at 400–1350 m (Fig. 1). One specimen was taken at 1500 m in mixed primary deciduous – evergreen forest. Substrates: Tree trunk (6 specimens), dead tree (1), twig (1), cliff (4) and top of outcrop (2). – Frequency in Hunan: Rather rare.

RANGE IN HUNAN. Rao *et al.* (1997, Note 10) gave two references, as *Homaliodendron squar-rosulum* M. Fleisch. and *H. ligulaefolium* (Mitt.) Fleisch. in which no voucher specimens were

cited. It was recorded from **Changsha City** by Brotherus (1929, as *H. microdendron*, see Chapter 2.1.). **Badagongshan**. 50. 50109. 92. 61178. **Daweishan**. DAW18. 61841. DAW27. 61883. **Mangshan**. 9a. 49081. 11c. 51329. **Shunhuangshan**. S8. 70680. S9. 70694. **Taoyuandong**. 21a. 55098. 21c. 55142, 55144. 28. 56554. 31. 55424. **Wulingyuan**. 16a. 52872. **Yunshan**. Y6a. 70087.

RANGE IN CHINA. *Homaliodendron flabellatum* is widely distributed in central and southern China (Redfearn *et al.* 1996, Wu 2011a, Jia & He 2013). It grows on tree trunks and rocks at 250–2800 m (Wu 2011a).

TOTAL RANGE (Enroth 1989, Buck 1998). Afr 3; Am 2, Am 3, As 2: Chi Ja Ta, As 3: Bhu Bu In La Ne Sri Tha Vi, As 4: Ind Ma Phi PNG; Austr 1 (Queensland); Oc: Haw NC.

7. *Homaliodendron cf. ligulaefolium* (Mitt.) M. Fleisch.

Hedwigia 45: 77. 1906. – *Neckera ligulaefolia* Mitt., J. Proc. Linn. Soc. Bot. Suppl. 1: 119. 1859.

TAXONOMY. If one compares the illustrations of *H. flabellatum* and *H. ligulaefolium* in Ninh (1984) and Wu (2011a), the distinction between those two appears to be clear, especially in the leaf shape. In fact there is almost a morphological continuum from the narrow-leaved plants (“*H. ligulaefolium*”) to the wide-leaved ones (“*H. flabellatum*”), and “*H. scalpellifolium*” is somewhere in between these two extremes.

ILLUSTRATIONS. Ninh 1984: 22 (fig. 10); Wu 2011a: 332 (pl. 372, figs. 10–19).

HABITATS AND SUBSTRATES IN HUNAN. Most of the collections came from primary forests. In the meridional zone it grows in both primary and second growth broadleaf evergreen forests at 640–1250 m (Fig. 2). The disturbed sites were such as *Metasequoia glyptostroboides* plantation, cut *Cunninghamia lanceolata* – *Pinus massoniana* forest on ridge and mature secondary

evergreen forest. The localities in evergreen – deciduous mixed forests, pure deciduous forests and mixed evergreen – deciduous bushes at 1240–1860 m were all primary. *Homaliodendron ligulaefolium* is rather obligatory epiphyte. Substrate statistics: On tree or trunk (15 specimens), rotten bark (1), base of tree (2), fallen log or tree (2), rotten twig (1), climber (1), bush (1) and rock outcrop (2). – Frequency in Hunan: Rather rare.

RANGE IN HUNAN. The specimens from Mangshan reported as *H. flabellatum* by Koponen *et al.* (2000) are *Homaliodendron cf. ligulaefolium*. P.-C. Wu (2011a) reported one collection of *H. ligulaefolium* from Hunan, Mt. Hengshan. **Badagongshan**. 40a. 50438 (mixed with *Forsstroemia noguchii*), 55620. 45. 55527. 47. 48946. 50. 48757, 50102. 55a. 47910 (Wu 2011a, as *H. flabellatum*), 47914, 54257. 55b. 54372. 86b. 58680 (mixed with *H. papillosum*). **Hupingshan**. 69. 54098. 70. 54069 (Wu 2011a, as *H. flabellatum*). **Mangshan**. 4b. 51217, 51391, 51401, 51679. 7a. 50929. 7c. 50883. 7d. 51054. 7e. 50642. 9a. 49429, 49517. 10c. 51031, 51265. 12b. 50575. **Taoyuandong**. 27. 56524. 31. 57366, 57411. 33. 56739. **Yunshan**. Y7a. 70135.

RANGE IN CHINA. Wu (2011a) listed specimens from Guangdong, Hunan, Jiangxi, Taiwan, and Yunnan; Jia and He (2013) added Anhui, Henan, Chongquin, Guizhou and Zhejiang provinces. Wu (2011a) lists rock surfaces and trees at 1300 m as the substrate.

TOTAL RANGE (Ninh 1984, Wu 2011a). As 2: Chi, As 3: Sri Vi, As 4: Ind Phi PNG; Oc: NC.

8. *Homaliodendron montagneanum* (Müll. Hal.) M. Fleisch.

Hedwigia 45: 74. 1906. – *Neckera montagneana* Müll. Hal., Bot. Zeit. (Berlin) 14: 436. 1856.

TAXONOMY. *Homaliodendron montagneanum* can be distinguished by the remote and irregular mode of branching and by the obtuse apices of stipe leaves.

ILLUSTRATIONS. Ninh 1984: 18–20 (figs. 7–9); Wu 2011a: 335 (pl. 373, figs. 7–13).

RANGE IN HUNAN. Wu (2011a) cited *Homaliiodendron montagneanum* from E Hunan (Mt. Hengshan), but we have not seen any specimens from the province.

RANGE IN CHINA (Wu 2011a, Jia & He 2013). Fujian, Guangdong, Guangxi, Hubei, Hunan, Sichuan, Taiwan, Xizang, Yunnan. According to our experience, it is relatively common in SW China, especially in Yunnan. According to Wu (2011a), it grows on rocks and trees between 2200 and 3500 m.

TOTAL RANGE (Ninh 1984, Long 1994). As 2: Chi, As 3: Bhu Bu In Ne Tha, As 4: Ind.

9. *Homaliiodendron neckeroides* Broth. in Hand.-Mazz.

Symb. Sin. 4: 88. 1929. – *Neckera neckeroides* (Broth.) Enroth & B.C. Tan, Ann. Bot. Fennici 31: 53. 1994. – Holotype: China. Hunan. An lebenden Stämmen von *Fagus longipetiolata* in der wpt. St. im Hochwalde des Yünschan bei Wukang, 1250 m, 14.VI.1918 *H. Handel-Mazzetti 12115* (H-BR2002001).

TAXONOMY. Due to the immersed sporophyte, *Homaliiodendron neckeroides* was treated as *Neckera neckeroides* by Enroth and Tan (1994) and Wu (2011a), but it belongs in *Homaliiodendron* after all (Olsson *et al.* 2010), as the gametophyte morphology indeed would suggest. When sporophytes are absent, it is difficult to distinguish it from some expressions of *H. flabellatum*.

ILLUSTRATIONS. Enroth and Tan 1994: 54 (fig. 1); Wu 2011a: 349 (pl. 379, figs. 14–25).

HABITATS, SUBSTRATES AND RANGE IN HUNAN. *Homaliiodendron neckeroides* was reported first from Hunan by Brotherus (1929, see above). **Badagongshan.** 50. 48749, deciduous – evergreen mixed forest at brook side in full shade, at c. 1475 m, on tree trunk. **Yunshan.**

Brotherus (1929, Rao *et al.* 1997, Wu 2011, Koponen *et al.* 2014). – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Homaliiodendron neckeroides* is a central Chinese endemic, confirmed from Guizhou, Hunan and Shaanxi (Wu 2011a, Jia & He 2013). Redfearn *et al.* (1996) cited it also for Zhejiang. According to Wu (2011a), it grows “often on tree trunks” at 1000 m.

TOTAL RANGE (Ninh 1984, Long 1994, Wu 2011a). As 2: Chi, As 3: Bhu In Ne Tha, As 4: Ind.

10. *Homaliiodendron papillosum* Broth.

Akad. Wiss. Wien Sitzungsber., Math.-Naturwiss. Kl., Abt. 1, 131: 216. 1922 (preprint), 1923 (journal). – Holotype: China. Hunan. An feuchten Tonschieferfelsen im Hochwalde des Yün-schan bei Wukang, warmtemperierte Stufe, 1150 m, 25.VI. *H. Handel-Mazzetti 12219* (H-BR2002021).

Homaliiodendron handelii Broth. in Hand.-Mazz., Symb. Sin. 4: 88. 1929. – Synonymized by Wu (2010).

Porotrichum perplexans Dixon, Hong Kong Nat. Suppl. 2: 21. 1933. – Synonymized by Enroth (1992).

Homaliiodendron crassinervium Thér. var. *bacvietensis* Tixier, Rev. Bryol. Lichénol. 34: 146. 1966.

TAXONOMY. *Homaliiodendron papillosum* is very variable, and it should be studied whether there in fact are more than just one species of *Homaliiodendron* with distinctly mammillose leaf cells. The mammillosity is usually more pronounced in branch leaves than in stem leaves, and around midleaf rather than in the basal or apical parts of leaves. Sometimes the stem leaves can have smooth cells, while the branch leaves from the same frond have distinctly mammillose cells. The juxtacostal cells are often smooth. According to Ninh (1984), the laminal cells can be “papillose” or smooth, and he emphasized “irregularly and strongly plicate” dry leaves as a good distinguishing character of *H. papillosum*.

The first author did not find that character consistent or reliable in species identification.

ILLUSTRATIONS. Ninh 1984: 26 (fig. 12), 28 (fig. 13); Wu 2010: 122 (fig. 2); Wu 2011a: 337 (pl. 374, figs. 1–6).

HABITATS AND SUBSTRATES IN HUNAN. Most collections of *Homaliodendron papillosum* were taken in meridional zone at 550–1380 m (Fig. 1) both in primary and secondary forests. The localities with heavy human impact were described as hotel garden and forest edge, young *Cunninghamia lanceolata* and palm plantation, semi-open grazed secondary forest, bamboo forest with remnant trees of original broadleaf evergreen forest, trail-side in orchards and road-side. The high elevation deciduous forest and mixed forest of evergreen and deciduous trees at 900–1580 m were primary. It is mainly epiphytic on tree trunks and secondly grows on cliffs, especially vertical ones. The many kinds of substrates and habitats may explain why it is the most common species of the Neckeraceae in Hunan. Substrate statistics: Tree trunks (44 specimens), tree base (4), branch (4), tree root (1), stump (2), rotten trunk (1), bush (2), fallen branch (2), log (2), rotten twig (1), cliff (7), rock outcrop (9) and bolder (4). – Frequency in Hunan: Moderately common.

RANGE IN HUNAN. *Homaliodendron papillosum* was previously reported from Hunan by Brotherus (1922, 1929, see above), Wu (2011a) and Jia and He (2013). **Badagongshan.** 41. 54851, 54863. 42b. 64869 (mixed with *Taiwanobryum speciosum*). 43. 54753, 54756, 54762. 44a. 54404, 54422, 54423. 44b. 48806, 48846, 50239. 45. 55503, 55556. 48. 48638 (Wu 2011a, as *H. flabellatum*), 48644, 48664. 51. 50378. 52. 48274, 54659, 54668, 54724. 55a. 54225 (mixed with *Neckera decurrens* and several other bryophytes), 54226, 54227, 54232, 54236, 54248, 54277. 55c. 58773, 58810. 86b. 58680 (mixed with *Homaliodendron* cf. *ligulaefolium*), 58689 (mixed with *Neckera decurrens*). 87. 58895. 88b. 59010. 92. 61171, 61189, 61201, 61210. 95. 64593. **Daweishan.** DAW4. 62396. DAW15. 63461.

DAW17. 61772. DAW26a. 63175, on base of *Viburnum cylindricum*. **Hupingshan.** 58. 53621 (mixed with *Homaliadelphus targionianus*). **Mangshan.** 3b. 51561. 11c. 51324. **Shunhuangshan.** S5. 70537. S7. 70630. S9. 70772. S12a. 70855, 70925. S12b. 70943. S16. 71067. **Taoyuandong.** 20a. 56788, 57220, 57221, 57242, 57471. 21a. 55058, 55078. 21c. 56096. 21d. 55962. 23a. 55916. 27. 55049, 56480, 56529. 28. 55275, 55278. 33. 56748, 56750. 34. 56993. 36. 57119. **Wulingyuan.** Da-yong Co. (Wu 2011a). 19c. 51810. **Yuankou.** 76b. 59939. 78c. 59698, 59720. 79a. 59488, 59506. 79b. 59527, 59579, 59603. **Yunshan.** Brotherus (1922, 1929). Y3. 70042. Y6a. 70065. Y7a. 70104. Y13a. 70224.

RANGE IN CHINA. *Homaliodendron papillosum* has been recorded from western, central and southern China (10 provinces in Wu 2011a, 9 provinces in Jia & He 2013) and collected between 680 and 2200 m on rocks, tree trunks and rotten logs (Wu 2011a).

TOTAL RANGE (Ninh 1984, Wu 2011a). As 2: Chi; As 3: Bhu Ne Vi.

11. *Homaliodendron pulchrum* L.Y. Pei & Y. Jia
J. Bryol. 33(2): 136. 2011.

TAXONOMY. *Homaliodendron pulchrum* has strongly glossy and strongly complanate fronds and the costa is almost absent or reaching to c. 1/4 of leaf length at most, being usually much shorter than that.

ILLUSTRATIONS. Pei *et al.* 2011: 138 (fig. 2).

HABITATS, SUBSTRATES AND RANGE IN HUNAN (Fig. 1). **Mangshan.** 4b. 51443, 51517, along river shores and in meridional evergreen mixed forest at 800 m, on tree trunk. These specimens were reported as *H. flabellatum* by Koponen *et al.* (2000). **Hupingshan.** 58. 53719, evergreen broadleaf forest on tree trunk at 550 m. 59. 53271, evergreen broadleaf forest on tree trunk at c. 640 m. **Wulingyuan.** Zhangjiajie (Pei *et al.* 2011). – Frequency in Hunan: Very rare.

RANGE IN CHINA. This very distinctive Chi-

nese endemic is known from Sichuan, Guangxi and Hunan (Pei *et al.* 2011, Jia & He 2013) from between 450 and 1200 m.

TOTAL RANGE (Pei *et al.* 2011). As 2: Chi.

12. *Homaliodendron cf. scalpellifolium* (Mitt.) M. Fleisch.

Hedwigia 45: 75. 1906. – *Neckera scalpellifolia* Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2: 119. 1859.

TAXONOMY. The plants we treat as *Homaliodendron cf. scalpellifolium* are more or less intermediate between the narrow-leaved *H. cf. ligulaefolium* and the wide-leaved *H. flabellatum*. The costa tends to be somewhat shorter than in the other Chinese species of *Homaliodendron* (excluding *H. pulchrum*), but even that is not a clear-cut distinction.

ILLUSTRATIONS. Noguchi 1989: 717 (fig. 316); Wu 2011a: 337 (pl. 374, figs. 7–14).

HABITATS AND SUBSTRATES IN HUNAN. All collections of *Homaliodendron cf. scalpellifolium* were obtained in forests, often along brook sides or creeks, either in primary or in second growth broadleaf evergreen forests at 400–1500 m (Fig. 2), or in primary mixed evergreen and deciduous forests at higher elevations, at 1200–1580 m. Only a few specimens came from sites heavily disturbed by human activities such as forest grazing or bamboo cultivations. Substrates: Tree trunk or bark (7 specimens), tree base (1), rotten twig or log (2), stump (1), cliff (7), rock outcrop (1), humus (1) and gravel (1). – Frequency in Hunan: Rather rare.

RANGE IN HUNAN. *Homaliodendron scalpellifolium* was recorded for Hunan by Wu (2011a). Most of the specimens from Mangshan were reported as *H. flabellatum* by Koponen *et al.* (2000). **Badagongshan.** 40b. 50451. 44a. 54507. 50. 50110. 52. 54702. 55a. 54332. 88b. 59005. **Daweishan.** DAW17. 61964 (Wu 2011a, as *H. fla-*

bellatum). DAW27. 61873, 61950. **Mangshan.** 3b. 51736. 4b. 51134, 51509. 7a. 50955. 9a. 49162. 12a. 49579. **Shunhuangshan.** S9. 70785. S12a. 70832 (mixed with *Thamnobryum subserratum*). S16. 71048, 71066 (mixed with *Forsstroemia yezoana*). **Taoyuandong.** 21a. 54957. 21d. 55928. 24. 56952. 32. 57200. 34. 57059 (Wu 2011a, as *H. flabellatum*). **Yuankou.** 75b. 59452 (Wu 2011a, as *H. flabellatum*), 59453. 79b. 59611 (mixed with *Circulifolium exiguum*).

RANGE IN CHINA. If one follows Wu's (2011a) concept, this is the most common species of *Homaliodendron* in China. Wu (and Jia & He 2013) cited specimens from 17 provinces and said it grows on shaded and wet rocks and trees at 500–3600 m.

TOTAL RANGE (Ninh 1984, Wu 2011a). Afr 3: (Mauritius); As 2: Chi Ja, As 3: In La Ne Sri Vi, As 4: Ind Ma Phi PNG; Oc: NC.

2.5. *Neckera* Hedw.

The genus *Neckera* in its traditional circumscription has been shown to be an unnatural assemblage of species (Olsson *et al.* 2011) sharing some superficial resemblance, often expressed as glossy, undulate, asymmetric and acute-tipped leaves and immersed capsules.

Wu (2011a) treated a total of 17 species in *Neckera*. Of those, *N. crenulata* Harv. has been transferred to *Taiwanobryum* (Olsson *et al.* 2010), *N. yezoana* and *N. goughiana* Mitt. to *Forsstroemia* (Olsson *et al.* 2011), and *N. neckeroides* belongs into *Homaliodendron* (see above). Wu (2011a) did not treat several species reported from China before 2011, including *N. enrothiana* M.C. Ji (Ji & Miao 2009), *N. xizangensis* Enroth (Enroth & Ji 2010), *N. bhutanensis* Nog., *N. pusilla* Mitt. and *N. denigricans* Enroth (Ji & Enroth 2010). Therefore, the identification key in Wu (2011a) is inadequate, and an updated key was published by Enroth (2017).

Five species of *Neckera s.str.* are known from Hunan.

13. *Neckera decurrens* Broth.

Akad. Wiss. Wien Sitzungsber., Math.-Naturwiss. Kl., Abt. 1, 131: 215. 1922 (preprint), 1923 (journal). – Holotype: China. Hunan. An lebenden Stämmen von *Liquidambar formosana* in der str. St. im Walde des Yolu-schan bei Tschangschu, subtropische Stufe, 150 m, c. sp., 16.II.1918 H. *Handel-Mazzetti* 11449 (H-BR2892020).

Neckera decurrens var. *rupicola* Broth., Akad. Wiss. Wien Sitzungsber., Math.-Naturwiss. Kl., Abt. 1, 131: 215. 1922 (preprint), 1923 (journal). – Lectotype (designated by Enroth 1996): China. Hunan. Bei Hsikwangschan nächst Hsingwa, Kalkfelsen der subtropische Stufe, 550–700 m, 20.–25.V.1918 H. *Handel-Mazzetti* 11937 (H-BR2892024). – Synonymized by Enroth (1996).

TAXONOMY. *Neckera decurrens*, originally described from Hunan (see above), appears to be close to *N. flexiramea*, and the best distinction is in the width of the upper parts of the decurrencies (see the key). There is no consistent difference in the length of the costa, although the descriptions and illustrations in Wu (2011a) would seem to suggest so. Indeed, in the holotype of *N. decurrens* the costae are mostly very short, just as in *N. flexiramea*. That species is more slender than *N. decurrens*, and often has more or less arcuate branches (hence the specific epithet). If sporophytes are present, distinguishing the two species is easy, as *N. decurrens* has an immersed capsule, whereas that of *N. flexiramea* is exserted on a 3–4 mm long seta (Wu 2011a).

ILLUSTRATIONS. Wu 2011a: 344 (pl. 377, figs. 1–11).

HABITATS AND SUBSTRATES IN HUNAN. *Neckera decurrens* was collected in the meridional primary and disturbed evergreen broadleaf and in primary orotemperate deciduous forests at 550–1860 m (Fig. 1). Man-made habitats were such as *Metasequoia glyptostroboides*, *Magnolia officinalis* subsp. *biloba* and *Tapiscia sinensis* plantations. The present specimens were col-

lected from tree trunk (4), climber (2), tree base (1), decaying stump (1), fallen twig (1) and stone (1). The following trees were identified: *Prunus grayana*, *Fagus longipetiolata*, *Symplocos* sp. – Frequency in Hunan: Rare.

RANGE IN HUNAN. **Changsha City** (Brotherus 1922, 1929, Rao *et al.* 1997, Wu 2011a). **Badagongshan**. 42b. 64872 (mixed with *Neckera inopinata* and *Homaliodendron* sp.). 55a. 54225 (mixed with *H. papillosum* and several other bryophytes). 86b. 58689 (mixed with *H. papillosum*). 92. 61157. **Daweishan**. DAW18. 63302, 63303. DAW26b. 63208. DAW27. 61877. **Hupingshan**. 58. 53623. 70. 54072.

RANGE IN CHINA. *Neckera decurrens* was previously known from China and is here reported for the first time from Vietnam (see below). Wu (2011a) cited specimens from Guizhou, Hubei, Hunan and Yunnan, but according to Redfearn *et al.* (1996) and Jia and He (2013), it has also been reported from Guangxi. It has been recorded at 150–2000 m from tree trunks and shaded rocks (Wu 2011a).

TOTAL RANGE (Wu 2011a). As 2: Chi, As 3: “Vietnam boreo-occ. Montes Hoang-Lien-Son. Ad truncos prope opp. Sapa in prov. Lao-Cai”, 1650 m, 17.XII.1960 A. *Bartke s.n.*, Herbarium Academiae Paedagogicae Agriensis, Flora Vietnamica No. 197” (EGR). – New to Vietnam.

14. *Neckera flexiramea* Cardot

Bull. Soc. Bot. Genève 3: 277. 1911.

TAXONOMY. For the differences between *Neckera flexiramea* and *N. decurrens*, see discussion under the latter. These two species appear to be the most common ones of *Neckera s.str.* in Hunan.

ILLUSTRATIONS. Noguchi 1989: 701 (fig. 309A); Wu 2011a: 344 (pl. 377, figs. 12–23).

HABITATS AND SUBSTRATES IN HUNAN. Most of the collections were collected in primary or secondary evergreen broadleaf forests at

550–1350 m (Fig. 1). One collection was taken in primary dry mixed evergreen and deciduous forest at c. 1300 m and one from plantation of *Phellodendron chinense* and other trees. Substrate statistics for the present specimens: Tree trunk (10), tree branch (2), fallen branch (2), climber (1) and cliff (1). The identified trees were *Tapiscia sinensis* (2 records) and *Eurya* sp. (1 record). – Frequency in Hunan: Rare.

RANGE IN HUNAN. Wu (2011a) recorded *Neckera flexiramea* based on our collections. **Badagongshan**. 40a. 50398. 42a. 64778 (mixed with *Forsstroemia yezoana*), 64782. 92. Sangzhi Co. (Wu 2011a, 61157), 61160. **Daweishan**. DAW16. 63278. DAW18. 63300, 63308, 63310. DAW27. 61884. **Hupingshan**. 58. 53626. 72. Shimen Co. (Wu 2011a, *Koponen et al.* 49877). **Taoyuandong**. 20a. 57494, 57552, 57575. 21a. 54992, 55093. 23b. 55814. 28. 55330.

RANGE IN CHINA. Wu (2011a) and Jia and He (2013) cited specimens of *Neckera flexiramea* from Anhui, Chongqing, Guangxi, Hunan and Taiwan, but Redfearn *et al.* (1996) mentioned it also from Sichuan and Zhejiang. According to Wu (2011a), it grows on tree trunks and rock surfaces at 960–1150 m.

TOTAL RANGE (Noguchi 1989, Wu 2011a). As 2: Chi Ja Kor.

15. *Neckera inopinata* Enroth & M.C. Ji

Polish Bot. J. 57(1): 64. 2012. – Holotype: China. Hunan. Wulingyuan World Heritage Area, Zhangjiajie, Pipajie meridional zone, on roadside bushes, 687 m, on *Liquidambar formosana*, collection site 80, 15.IX.1999 P. Rao 58379 (H). – The paratype from Zhejiang (*T. Simon* 39 in EGR) was collected in *Cryptomeria japonica* forest at 1000 m.

TAXONOMY. *Neckera inopinata* resembles especially *N. konoii* Broth. ex Cardot, *N. coreana* Cardot (which was excluded from the Chinese flora by Wu 2011a), *N. humilis* Mitt. and *N. setschwanica* Broth. (Enroth & Ji 2012). From the first two it can be distinguished by the less

strongly asymmetric leaves and by the shorter apical and median laminal cells which also have much less distinctly porose walls. From the latter two *N. inopinata* differs especially by the absence of paraphyllia, which are consistently present in *N. humilis* and *N. setschwanica* (cf. Wu 2011a). The leaf shape variability, from ovate-lingulate to ovate, in the Badagongshan specimen reported here is just as clear as in the type material, and such variability is not present in any of the other species of comparison. The leaf margins of *N. inopinata* are sharply serrulate almost to the base, which is a further distinctive character.

ILLUSTRATIONS. Enroth & Ji 2012: 65–66 (figs. 1–2).

HABITATS, SUBSTRATES AND RANGE IN HUNAN. *Neckera inopinata* was in the protologue reported from Wulingyan in Hunan, and here we report a new locality in **Badagongshan**. 42b. 64872, only few small shoots mixed with *N. decurrens* and *Homali dendron* sp., meridional forest on cliffs, trunk of *Prunus grayana* at 1400 m. **Wulingyuan**. 80. 58379, see above. – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Neckera inopinata* is endemic to China, known from Hunan and Zhejiang (Enroth 2012). Not mentioned in Jia and He (2013).

TOTAL RANGE. As 2: Chi.

16. *Neckera konoii* Broth. ex Cardot

Bull. Soc. Bot. Genève, Ser. 2(3): 277. 1911.

TAXONOMY. The present plants of *Neckera konoii* are quite small, but the other characters match the published descriptions and illustrations (Noguchi 1989, Wu 2011a).

ILLUSTRATIONS. Noguchi 1989: 705 (fig. 311B).

HABITAT, SUBSTRATE AND RANGE IN HUNAN.

Neckera kono has not previously been recorded to Hunan (Jia & He 2013). **Hupingshan**. 72. 49877, Hupingshan Peak area, lower part of deciduous forest, at c. 2000 m on tree trunk. – Frequency in Hunan: Very rare.

RANGE IN CHINA. In China *Neckera kono* was previously known from Anhui and Sichuan (Wu 2011a, Jia & He 2013), growing on tree bark at 1600 m (Wu 2011a). – New to Hunan.

TOTAL RANGE (Wu 2011a). As 2: Chi Ja Kor.

17. *Neckera setschwanica* Broth.

Akad. Wiss. Wien Sitzungsber., Math.-Naturwiss. Kl., Abt. 1, 131: 215. 1922 (preprint), 1923 (journal).

TAXONOMY. *Neckera setschwanica* is distinctive by the following combination of characters: proximal leaf margins that are often recurved in the basal part of leaves; costa that reaches from 1/2 to c. 2/3 of leaf length; elongate apical leaf cells; thick and porose walls of apical and laminal cells; and by the presence of paraphyllia. In the Chinese flora *N. setschwanica* resembles especially *N. humilis* Mitt., but that species has more concave leaves and shorter leaf cells (Wu 2011a).

ILLUSTRATIONS. Wu 2011a: 355 (pl. 381, figs. 1–13).

HABITAT, SUBSTRATE AND RANGE IN HUNAN. *Neckera setschwanica* has not previously been recorded to Hunan (Jia & He 2013). **Hupingshan**. 58. 53639, primary evergreen broadleaf forest in river valley, moist, partially shaded cliff at 550 m, mixed with *Homaliadelphus targionianus* and several other non-neckeraeous mosses. – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Neckera setschwanica* was long considered as a Chinese endemic, but it was recently reported from Bhutan (Enroth 2017). In China it was previously known from Sichuan, Xizang and Yunnan (Wu 2011a, Jia & He 2013). According to Wu (2011a), *N. setschwanica* grows on tree trunks and rock surfaces between

1500 and 3950 m, but based on the present specimen it can grow in suitable microhabitats at considerably lower altitudes. New to Hunan.

TOTAL RANGE (Wu 2011a, Enroth 2017). As 2: Chi, As 3: Bhu.

2.6. *Neckeropsis* Reichardt

Neckeropsis s.lat. is an essentially tropical genus with 29 species, of which two occur in Hunan. The genus is currently under study by the first author and his colleagues and it will be divided into several smaller genera based on molecular evidence. *Neckeropsis s.lat.* is quite a heterogeneous grouping, but it has traditionally been recognized by irregular, sparse mode of branching, non-stipitate shoots and a complanate leaf arrangement termed “pseudotetrastichous” by Touw (1962).

18. *Neckeropsis calcicola* Nog.

J. Hattori Bot. Lab. 16: 124, fig. 1. 1956.

TAXONOMY. *Neckeropsis calcicola* resembles the widely distributed tropical *N. lepinea* (Mont.) M. Fleisch. so much that in the absence of sporophytes the two cannot always be reliably distinguished from each other (Touw 1962, 1972). *N. calcicola* tends to have a longer costa, often reaching to midleaf, and slightly longer leaf cells with more porose walls.

ILLUSTRATIONS. Noguchi 1989: 713 (fig. 314); Wu 2011a: 360 (pl. 383, figs. 8–14).

HABITATS AND SUBSTRATES IN HUNAN. All collections of *Neckeropsis calcicola* came from rather low elevation in meridional zone at 350–600 m (Fig. 1). It grows both in primary evergreen broadleaf forests and in secondary forests, and was ones taken from rocks along river in valley surrounded by arable land. It favours rock as substrate but grows also on rotten wood and tree trunks. Substrate statistics: Cliff (5 specimens), stone or rock (4), stump (1), rotten

tree trunk (1), tree trunk (1) and bush (1). – Frequency in Hunan: Very rare.

RANGE IN HUNAN. *Neckeropsis calcicola* was recorded from Hunan by Enroth and Koponen (2003), Wu (2011a) and Jia and He (2013). **Badagongshan.** 39d. 64632 (Enroth & Koponen 2003), on vertical cliff by road over river, open. **Hupingshan.** 56b. 53941. 57. 48632. 58. 53622, 53638, 53675, 53724, 53725, 53790. 59. 53302 (= Shi-men Co., Wu 2011a), 53324. 60. 53886, 53888, 53923. **Wulingyuan.** Da-yong Co. (Wu 2011a).

RANGE IN CHINA. *Neckeropsis calcicola* is known from eight provinces in China (cf. Redfearn *et al.* 1996, Wu 2011a, Jia & He 2013) and grows on rocks and tree trunks at 290–3600 m (Wu 2011a).

TOTAL RANGE (Noguchi 1989, Wu 2011a). As 2: Chi Ja.

19. *Neckeropsis nitidula* (Mitt.) M. Fleisch.

Musci Fl. Buitenzorg 3: 882. 1908. – *Homalia nitidula* Mitt., J. Linn. Soc., Bot. 8: 155. 1865.

TAXONOMY. This species is fairly easy to recognize, as the plants are strongly complanate and very glossy. It resembles *Homalia trichomanoides*, but is glossier and has more distinctly apiculate leaves and immersed capsules.

ILLUSTRATIONS. Touw 1962: 415 (pl. 19); Noguchi 1989: 709 (fig. 312); Wu 2011a: 365 (pl. 385, figs. 6–14).

RANGE IN HUNAN. Wu (2011a) cited *Neckeropsis nitidula* from E Hunan, Mt. Hengshan. It was not collected in any of the Helsinki University excursions in the province.

RANGE IN CHINA. *Neckeropsis nitidula* is known from six provinces in China, including Hunan, and grows on tree trunks, rocks and soil walls at 120–2000 m (Wu 2011a).

TOTAL RANGE (Noguchi 1989, Wu 2011a). As2: Chi Ja Kor.

2.7. *Pinnatella* M. Fleisch.

The tropical genus *Pinnatella* was monographed by Enroth (1994a), who recognized 15 species. Olsson *et al.* (2010) transferred two of the species to *Taiwanobryum* and one to *Neckeropsis*, and shortly afterwards Enroth *et al.* (2010) described *P. homaliadelphoides* Enroth *et al.* from India and China. Thus there are currently 13 species placed in *Pinnatella*. The genus can be characterized by distinctly stipitate-frondose plants with recurved to squarrose stipe leaves and a strong costa in the leaves (except in *P. homaliadelphoides* Enroth *et al.*, see above under *Homaliadelphus*). There are usually in the leaves more or less distinct inframarginal borders consisting of elongate cells. The capsules are exserted and the setae rather distinctly mammillose in the upper part. Nine species are known from China (Wu 2011b) and two from Hunan.

20. *Pinnatella makinoi* (Broth.) Broth.

Nat. Pflanzenfam. I(3): 858. 1906. – *Porotrichum makinoi* Broth., Hedwigia 38: 227. 1899.

TAXONOMY. *Pinnatella makinoi* has broadly ovate-lanceolate leaves which resemble those of *P. ambigua* (Bosch & Sande Lac.) M. Fleisch., a species also known from China. However, *P. makinoi* can be distinguished by the only few well-differentiated stipe leaves, absence of a central strand in the stem, and the strongly incrassate and porose walls of laminal cells.

ILLUSTRATIONS. Noguchi 1989: 723 (fig. 319A); Enroth 1994a: 6 (fig. 3c), 45 (fig. 17); Wu 2011b: 376 (pl. 389, figs. 8–17).

HABITATS, SUBSTRATES AND RANGE IN HUNAN. *Pinnatella makinoi* was reported by Enroth and Koponen (2003) and Wu *et al.* (2011b) from **Hupingshan.** 58. Shi-men Co. (Wu 2011b, Koponen *et al.* 53726). 59. 53328, mixed with *Circulifolium exiguum*, primary evergreen broad-leaf forest at c. 600 m, on stump. – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Pinnatella makinoi* is known from six to seven Chinese provinces (Redfearn *et al.* 1996, Wu 2011b, Jia & He 2013). It favors (calcareous) rocks as substrate (Enroth 1994a), but grows also on tree trunks and is found between 600 and 3600 m (Wu 2011b).

TOTAL RANGE (Enroth 1994a, Wu 2011b). As 2: Chi Ja, As 3: Vi, As 4: Phi.

21. *Pinnatella taiwanensis* Nog.

J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 3: 218, fig. 3. 1939.

TAXONOMY. This large, shaggy species is relatively easy to identify. The fronds are elongate and up to about 20 cm long. The laminal cells are also much longer than in *P. makinoi* and *P. ambigua*, with which it could be confused (Enroth 1994a).

ILLUSTRATIONS. Enroth 1994a: 5 (fig. 1c), 23 (fig. 10).

HABITAT, SUBSTRATE AND RANGE IN HUNAN. *Pinnatella taiwanensis* was reported from Hunan by Enroth and Koponen (2003, included in Jia & He 2013) from **Hupingshan**. 63. 54169, second growth forest, at c. 900 m, on cliff. – Frequency in Hunan: Very rare.

RANGE IN CHINA. Wu (2011b) cited specimens only from Taiwan. According to Enroth (1994a), *Pinnatella taiwanensis* grows on tree trunks and rocks. – New to mainland China.

TOTAL RANGE (Enroth 1994a, Wu 2011b). As 2: Chi, As 3: Vi.

2.8. *Taiwanobryum* Nog.

This genus has traditionally been considered unispecific and placed in the Prionodontaceae, but it belongs in the Asian *Pinnatella* clade of the Neckeraceae and is closely related to *Shevockia* Enroth & M.C. Ji and *Pinnatella* (Olsson *et al.* 2010). In the current circumscription it contains five species and is morphologically heterogeneous.

Two species, strikingly different from each other, of *Taiwanobryum* are known from Hunan. Two of the remaining three species now placed in this genus were in the *Moss Flora of China* treated as *Neckera crenulata* Harv. (Wu 2011a) and *Pinnatella anacamptolepis* (Müll.Hal.) M. Fleisch. (Wu 2011b). The third is *Taiwanobryum mucronatum* (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt [= *Pinnatella mucronata* (Bosch & Sande Lac.) M. Fleisch.], which is not known from China (Enroth 1994a).

22. *Taiwanobryum guangdongense* (Enroth) S. Olsson, Enroth & D. Quandt

Org. Divers. Evol. 10(2): 121. 2010. – *Caduciella guangdongensis* Enroth, Bryologist 96(3): 471, figs. 1–7. 1993.

TAXONOMY. The best distinguishing characters of this species are the miniature fronds usually with caducous branch leaves. It could be confused with *Taiwanobryum mucronatum* (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt and *T. anacamptolepis* (Müll. Hal.) S. Olsson, Enroth & D. Quandt, but they are somewhat more robust and have distinctly squarrose stipe leaves; those of *T. guangdongense* are appressed.

ILLUSTRATIONS. Enroth 1993: 472 (Fig. 1–7).

RANGE IN HUNAN. *Taiwanobryum guangdongense* was reported from Hunan (erroneously from Hupingshan) by Enroth and Koponen (2003, Jia & He 2013, as *Caduciella guangdongensis* Enroth). **Taoyuandong**. 20a. 57217, 57241, on tree trunk at 670 m. – Frequency in Hunan: Very rare.

RANGE IN CHINA. *Taiwanobryum guangdongense* was originally described from Guangdong (Enroth 1993, as *Caduciella guangdongensis*). Wu (2011c) mapped *Taiwanobryum guangdongense* from Guangdong and Taiwan, but it is also known from Hong Kong (So 1995) and Hainan (Zhang 1994; see also Akiyama & Enroth 2016).

TOTAL RANGE. *Taiwanobryum guangdong-*

gense is a SE Asian endemic (Wu 2011c, Akiyama & Enroth 2016): As 2: Chi, As 3: Vi.

23. *Taiwanobryum speciosum* Nog.

Trans. Nat. Hist. Soc. Taiwan 26: 143, 1 fig. 2. 1936.

TAXONOMY. *Taiwanobryum speciosum* is a robust species and easy to identify by its 4–5 mm long leaves, which are long-lanceolate from an ovate base and have a strong, single costa. The cells have very strongly incrassate and porose walls nearly throughout the leaves.

ILLUSTRATIONS. Noguchi 1989: 645 (fig. 286); Wu 2011b: 183 (pl. 324, figs. 9–14).

HABITATS, SUBSTRATES AND RANGE IN HUNAN. *Taiwanobryum speciosum* is here confirmed for Hunan. Previously Wu (1992) cited it from Hunan without citing voucher specimens, and Redfearn *et al.* 1996 and Rao *et al.* 1997 cited Wu). **Badagongshan.** 42b. 64877, meridional secondary forest, 1400 m, on cliff in partial shade, 64869 (mixed with *Homali dendron papillosum*). **Yunshan.** Y7a. 70120, mature secondary evergreen broadleaf forest on steep N-facing mountain slope, 1120 m, on fallen trunk, by trail in partial shade. – Frequency in Hunan: Very rare.

RANGE IN CHINA. Redfearn *et al.* (1996) listed *Taiwanobryum speciosum* from Fujian, Guizhou, Guangxi, Hunan and Taiwan. Wu (2011b) cited specimens from Fujian, Taiwan and Yunnan and Jia and He (2013) added Zhejiang. The records from Guangxi and Hunan by Redfearn *et al.* (1996) are obviously based on literature without voucher citations. – Here confirmed for Hunan.

TOTAL RANGE (Noguchi 1989, Wu 2011). As 2: Chi Ja.

2.9. *Thamnobryum* Nieuwl.

Thamnobryum is a predominantly temperate ge-

nus of the Northern Hemisphere. Two SE Asian rheophytic species previously placed here are currently placed in *Touwia* Ochyra (Olsson *et al.* 2010). In the neckeraceous context *Thamnobryum* can be recognized by the often dull, dark-green, frondose or dendroid plants with closely appressed stipe leaves and a very strong, sometimes abaxially toothed, costa reaching near leaf apex. The seta is long and the peristome is of the unreduced hypnoid type. The closest relatives of the (still partly polyphyletic) *Thamnobryum* are *Homalia*, *Chileobryon* Enroth, *Pendulothecium* Enroth & S. He, *Echinodopsis* S. Olsson, Enroth & D. Quandt, and the, as yet poorly defined, “Poro-clade” in the Neckeraceae (Olsson *et al.* 2011).

Wu (2011b) recognized three species of *Thamnobryum* in China. He did not consider *T. neckeroides* (Hook.) E. Lawton, which is known from the country (Mastracci 2003). The revision of the Russian species by Ignatova and Ignatov (2011) is very useful when identifying Chinese specimens.

One, very variable and rather common, species of *Thamnobryum* is known from Hunan.

24. *Thamnobryum subserratum* (Hook.) Nog. & Z. Iwats.

J. Hattori Bot. Lab. 36: 470. 1973 (“1972”). – *Neckera subserrata* Hook., Icon. Plant. 1: pl. 21, f. 7. 1836.

TAXONOMY. In Hunan, *Thamnobryum subserratum* can be recognized by its generic characters mentioned above.

ILLUSTRATIONS. Ignatova and Ignatov 2011: 149 (fig. 6); Wu 2011b: 384 (pl. 391, figs. 1–9).

HABITATS AND SUBSTRATES IN HUNAN. Most of the collections of *Thamnobryum subserratum* were taken in the meridional zone at 550–1400 m (Fig. 2) both in primary and second growth evergreen broadleaf forests. At that elevations it occurs also in bamboo and *Cunninghamia lanceolata* plantations. Above 1400 m up to 1580 m

it was collected in primary mixed evergreen and deciduous and in pure deciduous forests. It favors moist or wet, shady habitats and grows most commonly on rocks, but also on tree bases, stumps and sometimes on tree trunks. The present specimens were growing on rock, stone, or outcrop (43), cliff (12), tree base (4), tree trunk (3), underhang (3), soil (2), rotten stump (2) and log (1). – Frequency in Hunan: Moderately common.

RANGE IN HUNAN. *Thamnobryum subserratum* was previously reported from Hunan by Tan *et al.* (1994), but not cited for the province by Redfearn *et al.* (1996). **Badagongshan.** 39a. 64539. 40a. 50441. 40b. 55653. 41. 54872. 43. 54755, 54758. 44a. 54407, 54469. 44b. 48879, 48902, 50251. 45. 50277, 55460, 55473. 48. 48680. 50. 48738, 50121. 52. 54667, 54688. 55a. 54231, 54261, 54275. 87. 58935, 58938. 88b. 58998. 92. 61188, 61216. 95. 61534, 64595. **Da-weishan.** DAW15. 63463. DAW24b. 62237. DAW25. 63420. **Hupingshan.** 58. 53705, 53706. 59. 49657, 49665, 53291, 53424. 60. 54191. **Shunhuangshan.** S7. 70652. S9. 70774. S12a. 70832, 70856, 70864, 70867. S12b. 70929. S17. 71103. **Taoyuandong.** 20a. 57232, 57246. 21c. 55194. 31. 55447, 57370. 32. 57170. 34. 57069. **Wulingyuan.** 17b, 18a, 18b, 18c, 19a. (Koponen *et al.* 2000). **Yuankou.** 79b. 59556. **Yunshan.** Y2. 70013. Y4. 70055. Y7a. 70117, 70121.

RANGE IN CHINA. *Thamnobryum subserratum* is known in China from eight provinces (Jia & He 2013). Wu (2011b) gives an altitudinal range of 650–1800 m.

TOTAL RANGE (Tan 1989, Tan & Iwatsuki 1993, Ignatova & Ignatov 2011): As 2: Chi Ja, As 3: Bhu "Himalayas" In Sri Tha Vi, As 4: Ind Phi.

3. Miyabeaceae Enroth, S. Olsson, Buchbender, Hedenäs, Huttunen & D. Quandt 2009

Miyabeaceae was first recognized as a distinct family by Olsson *et al.* (2009b) and it contains the genera *Homaliadelphus*, *Miyabea* Broth. and *Bissetia* Broth. ex M. Fleisch., of which only *Homaliadelphus* is known from Hunan. That ge-

nus and the unispecific *Bissetia* have earlier been placed in the Neckeraceae, but the resemblance is only superficial. One distinction between the Neckeraceae and the Miyabeaceae is the frequent presence of dwarf males in the latter family; they have not been found in the Neckeraceae.

3.1. *Homaliadelphus* Dixon & P. de la Varde

Two species are generally recognized in *Homaliadelphus*: *H. sharpii* (R.S. Williams) Sharp and *H. targionianus* (Mitt.) Dixon & P. de la Varde. Both have been reported from China and several varieties have been described in both. The Hunanese material has larger leaves typical of *H. targionianus* (cf. Wu 2011a).

25. *Homaliadelphus targionianus* (Mitt.) Dixon & P. de la Varde

Rev. Bryol. Lichénol. 4(3): 142. 1932 ("1931"). – *Neckera targioniana* Mitt., Rev. Bryol. Lichénol. 4(3): 142. 1932 ("1931"). – *Homaliopsis targioniana* (Gough) Dixon & P. de la Varde, Ann. Bryol. 1: 48. 1928.

TAXONOMY. Due to the small, complanate and irregularly branched plants and fairly similar leaf shape, *Homaliadelphus targionianus* can be confused with *Circulifolium exiguum*, which, however, has lobeless leaves with a distinct costa.

ILLUSTRATIONS. Noguchi 1989: 719 (fig. 317A); Wu 2011a: 327 (pl. 371, figs. 1–8)

HABITATS, SUBSTRATES AND RANGE IN HUNAN. *Homaliadelphus targionianus* was first reported from Hunan by Brotherus (1929) from **Changsha City** (*Handel-Mazzetti 11448*, H-BR 1991020) and Xinhua ("Hsinhwa", *Handel-Mazzetti 11870* and *11871*, H-BR 1991021 and H-BR 191022, respectively, as *Homaliopsis targioniana*). **Badagongshan.** Sang-zhi Co. (Wu 2011b). **Hupingshan.** 58. 53621, mixed with

Homali dendron papillosum, in primary evergreen broadleaf forest in river valley at 550 m, on climber, 53639, mixed with *Neckera setschwani-ca* and other mosses. **Shunhuangshan**. S9. 70695, secondary evergreen broadleaf forest, at c. 850 m, on tree trunk. **Taoyuandong**. 20a. 57219, mixed with *Homali dendron papillosum* and *Fissidens dubius*, around Zhu-lian waterfall and its brook, at 670 m. 21a. Yan-ling Co. (Wu 2011b, *Koponen et al.* 55000). 21c. 55007, 55009, bamboo forest, at c. 670 m, both on trunk of *Tilia*. **Wulingyuan**. 16c, 17a, 18e, 19b, 19c (*Koponen et al.* 2000). – Frequency in Hunan: Rare.

RANGE IN CHINA. *Homaliadelphus targionianus* is widely distributed in southern China and up to Shaanxi and Shandong provinces (Redfearn *et al.* 1996, Wu 2011b). Jia and He (2013) list it from 12 provinces. According to Wu (2011a), it is encountered at 450–3600 m and grows on trees, rotten logs and rocks.

TOTAL DISTRIBUTION (Noguchi 1989, Tan & Iwatsuki 1993): As 2: Chi Ja Kor, As 3: Bhū (cf. Long 1994) In Ne (Enroth 1994b) Tha Vi.

4. Doubtful and excluded records

Forsstroemia cryphaeoides Cardot

Bull. Soc. Bot. Genève ser. 2, 1: 132. 1909.

This species was reported from Hunan by *Koponen et al.* (2004) based on one specimen from Changsha (*Koponen et al.* 48965) and one from Badagongshan (*Koponen et al.* 48750). The first author of the present paper re-examined the specimens and they represent *Pseudoleskeella* sp.; we cannot verify their specific identity at this time. *Forsstroemia cryphaeoides* is thus excluded from Hunan flora.

Neckeropsis lepinea (Mont.) M. Fleisch.

Musci Fl. Buitenzorg 3: 879, fig. 155. 1908. – *Neckera lepinea* Mont., Ann. Sci. Nat., Bot. sér. 3, 10: 107. 1848.

Jia and He (2013) listed *Neckeropsis lepinea-*

ana from Hunan. It is not listed from Hunan by Wu (2011a) and was not found in our collections.

Pinnatella alopecuroides (Mitt.) M. Fleisch.

Hedwigia 45: 84. 1906. – *Porotrichum alopecuroides* (Mitt.) Besch., Boll. Soc. Bot. France 34: 96. 1887.

Jia and He (2013) listed *Pinnatella alopecuroides* from Hunan. It is not reported from Hunan by Wu (2011a) and was not found in our collections.

5. Discussion

5.1. Range extensions

New to mainland China and Hunan

Pinnatella taiwanensis

New to Hunan

Forsstroemia noguchii

Neckera konoii

N. setschwani

Taiwanobryum speciosum (confirmed)

New to Vietnam

Neckera decurrens

5.2. Phytogeography; floristic elements

Koponen and Piippo (2004) reviewed the previous literature of the floristic elements in East and Southeast Asia. Since then, the geographical distribution of the Hunanese bryoflora has been discussed and taxa of several families or genera have been grouped to floristic elements by various authors: species of several genera (*Koponen et al.* 2004), Brachytheciaceae (*Ignatov et al.* 2005), Jungermanniaceae (*Váňa et al.* 2005), Othotrichaceae (*Guo et al.* 2007). *Koponen and Piippo* (2007) summarized those studies and

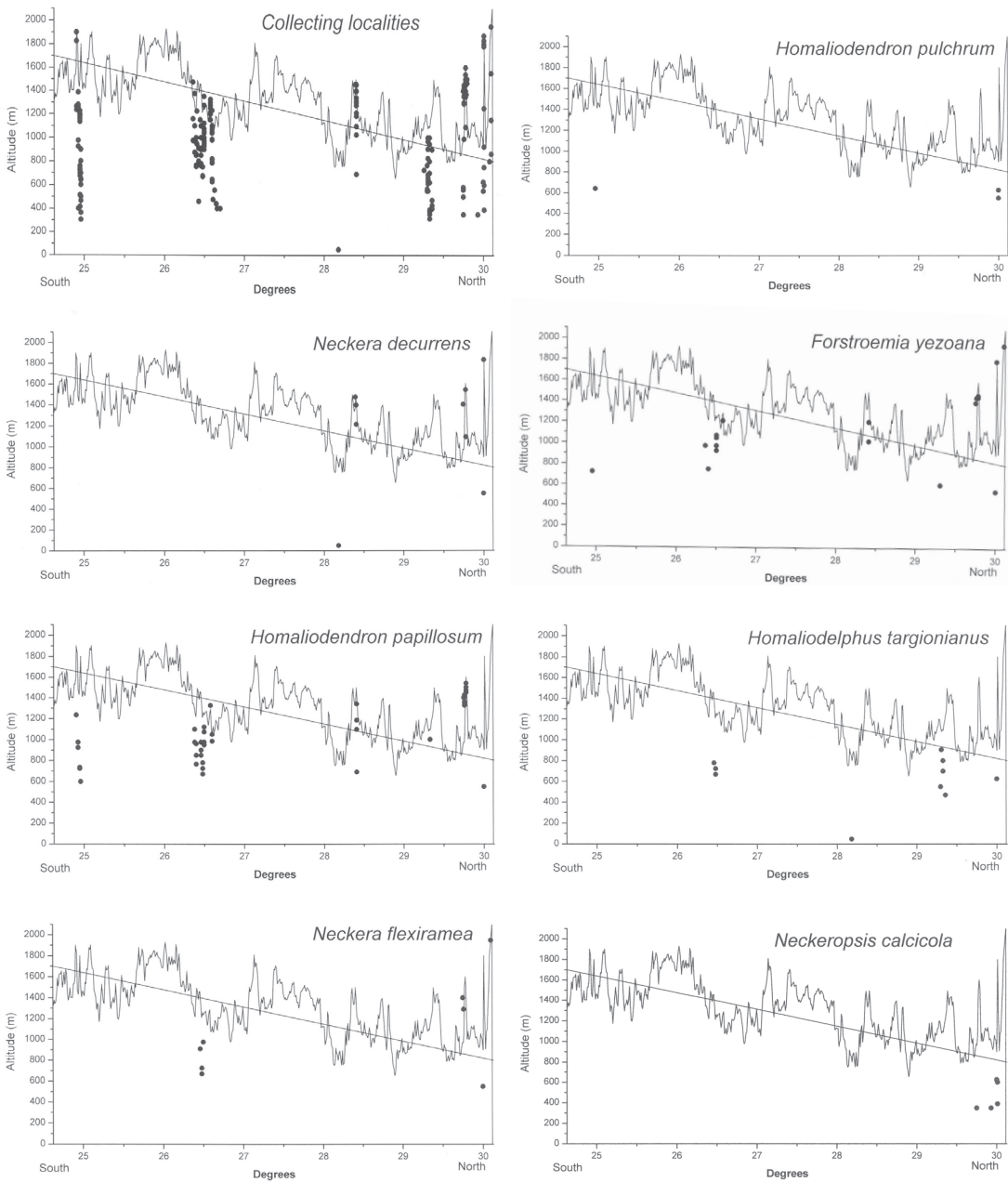


Fig. 1. Altitudinal ranges in Hunan. – The altitudinal distribution of collecting localities. The diagonal line marks the appropriate upper border of the meridional zone and, at the same time, the lower border of the orotemperate zone. – Species endemic to China: *Homali dendron pulchrum* L.Y. Pei & Y. Jia and *Neckera decurrens* Broth. – Southeast Asiatic temperate to meridional species: *Forstroemia yezoana* (Besch.) S. Olsson, Enroth & D. Quandt, *Homali dendron papillosum* Broth., *Homaliadelphus targionianus* (Mitt.) Dixon & P. de la Varde, *Neckera flexiramea* Cardot. and *Neckeropsis calcicola* Nog.

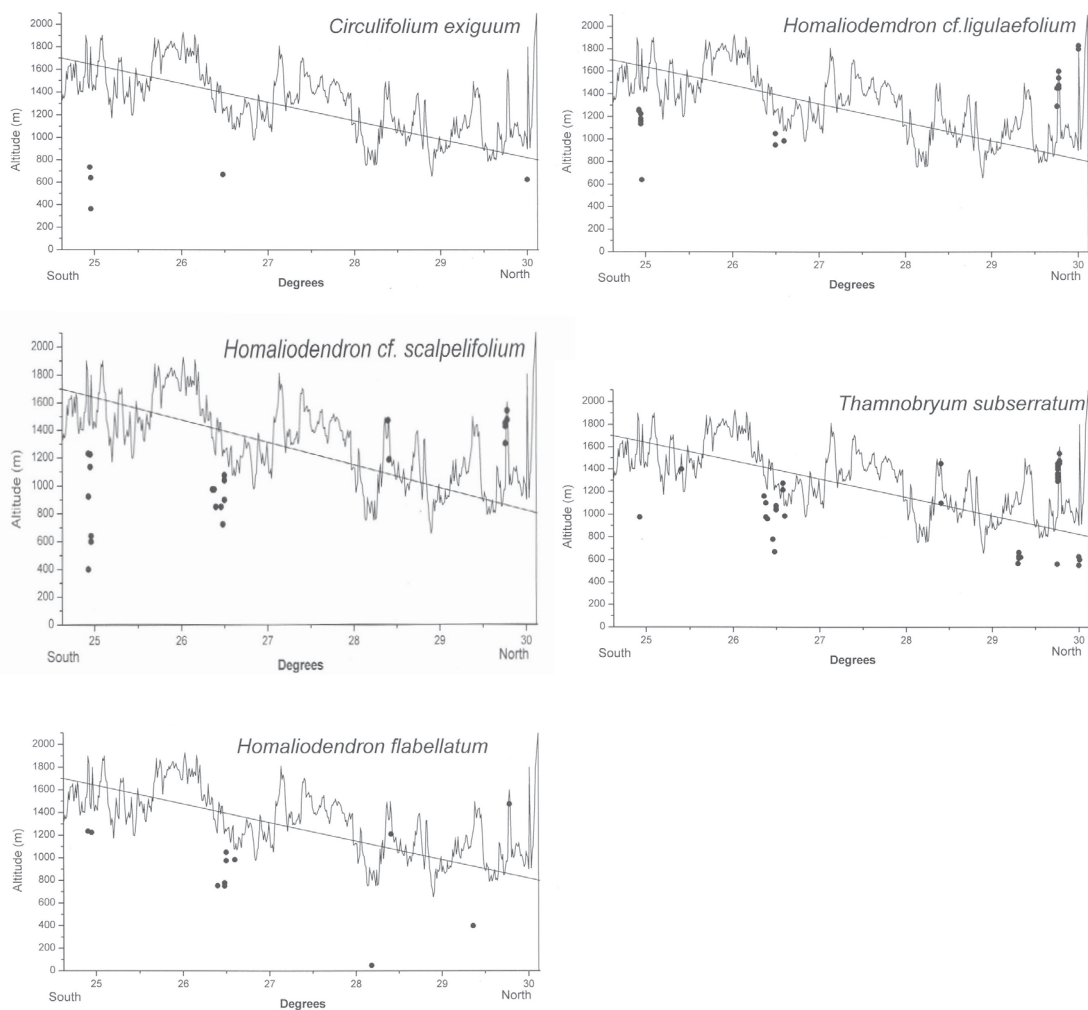


Fig. 2. Altitudinal ranges in Hunan. – Southeast Asiatic meridional to subtropical taxa: *Circulifolium exiguum* (Bosch & Sande Lac.) S. Olsson, Enroth & D. Quandt, *Homaliodendron* cf. *ligulaefolium* (Mitt.) M. Fleisch., *H.* cf. *scalpellifolium* (Mitt.) M. Fleisch. and *Thamnobryum subserratum* (Hook.) Nog. & Z. Iwats. – Pansubtropical species: *Homaliodendron flabellatum* (Sm.) M. Fleisch.

recognized eight floristic elements in the Hunanese bryoflora. Koponen (2014) added discussion of the elements in the Mniaceae, Sollman and Koponen (2017) in the Pottiaceae and Tan and Koponen (2017) in the Sematophyllaceae.

The taxa in the Neckeraceae are divided into floristic elements here.

The basis of these floristic elements lies in

the bioclimatic vegetation zones as defined by Ahti *et al.* (1974). That system regards disjunct occurrences of a species in southern mountainous areas as occurring in the same corresponding vegetation zone as the northern occurrences, in “oro”zones (e.g., oroboreal, orotemperate etc.). For instance in Hunan the sea level vegetation zone is meridional (subtropical) and on the

mountainous areas the orotemperate zone corresponds to the temperate zone at sea level.

Homaliodendron montagneanum
H. papillosum
Neckera setschwanica

5.2.1. Taxa ranging only in SE Asia

1. Endemic to China

Homaliodendron neckeroides
H. pulchrum
Neckera decurrens (also in Vietnam)
N. inopinata
Pinnatella taiwanensis
Taiwanobryum guangdongense (also in Vietnam)

2. Southeast Asiatic temperate to meridional element

The species of Southeast Asiatic temperate floristic element have their distribution within the temperate and meridional zones in China, Japan and Korea. Some of them extend their range to Russian Far East or to the Himalaya and they may have disjunct localities in the mountains of the Philippines, Vietnam, or Thailand. This element can be divided into three subelements (Koponen 2014).

1. Widely ranging from Japan to Himalaya

Forsstroemia yezoana
Homaliodelphus targionianus

2. Bryophytes occurring in Japan and central China but absent in the Himalayan region

Forsstroemia noguchii
Neckera flexiramea
N. konoii
Neckeropsis calcicola
N. nitidula
Taiwanobryum speciosum

3. Species occurring in central China and ranging to the Himalayas

3. Southeast Asiatic meridional to subtropical element

Taxa belonging to this floristic element are rather widely distributed in the meridional to subtropical parts of Southeast Asia from China or Japan to New Guinea, and some of them occur in the Pacific area. In Hunan their main distribution is within the meridional zone. In more southern areas, such as New Guinea, their distribution is either at higher elevations, in “montane rainforest zones”, or in lowland rain forest, extending from the sea level to c. 1000 m.

1. Absent in New Guinea (Malesian element *s. str.*)

Pinnatella makinoi
Thamnobryum subserratum

2. Present in New Guinea

Circulifolium exiguum (disjunction in Africa) PNG 100 m
Homaliodendron scalpellifolium (disjunction in Africa) PNG (incl. *H. flabellatum* and *H. ligulaefolium*) 600–3350 m

5.2.2. Taxa ranging also outside SE Asia

1. Holarctic, continuously or discontinuously circumpolar, boreal to temperate element

The majority of the bryophytes occurring in the arctic, boreal and temperate zones of the northern hemisphere belong to this group. Of the species of the Neckeraceae occurring in Hunan only one belongs to this floristic element.

Homalia trichomanoides

2. *Pansubtropical–temperate element*

These species occur in meridional southeast Asia and North America and in tropical continents at high elevations: the only species of this element is:

Forsstroemia trichomitria

3. *Pansubtropical element*

Homaliodendron flabellatum

5.3. Conservation

The conservation of the bryoflora of Hunan has been discussed in several of our papers (Koponen *et al.* 2002, Koponen & Piippo 2004, 2007), and in connection with the Brachytheciaceae (Ignatov *et al.* 2004), Jungermanniaceae (Vana *et al.* 2004), Othotrichaceae (Guo *et al.* 2007), Mniaceae (Koponen 2014), Pottiaceae (Sollman & Koponen 2017) and Sematophyllaceae (Tan & Koponen 2017).

Koponen (2014) discussed the obvious rarity of the taxa in the Mniaceae in Hunan, Sollman and Koponen (2017) on the rarity of the Pottiaceae and Tan and Koponen (2017) on the rarity of the Sematophyllaceae. The Neckeraceae shows a similar tendency. Of the total of 25 taxa, 13 were estimated as very rare (collected by us

on 1–4 localities), three taxa as rare (5–15 localities) and four as rather rare (16–40) localities. This is easily understood: the habitats of the species of Neckeraceae are forests and most of them are epiphytic on old tree stems and branches. The taxa were often collected in primary forests but some of them inhabit second growth forests as well, but only rarely were obtained in more open habitats such as gardens. Only two species, *Homaliodendron papillosum* (48 localities) and *Thamnobryum subserratum* (41 localities) are moderately common. *Homaliodendron papillosum* thrives in addition to tree trunks on rock faces and other substrates, and *Thamnobryum subserratum* was mostly collected from rock outcrops and cliffs, and thus they have different substrate prerequisites than the other species. However, they also favor shady habitats, as do the forest-dwelling epiphytes.

Conclusion

The species in the Neckeraceae are so rare since they prefer shady forest habitats. The conclusion as to the conservation is the same as for the other moss families: the species of the Neckeraceae in Hunan benefit of, or survive best, in conserved primary forest sites.

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Index of names

The names accepted for Hunan are **in bold**.

Caduciella 152
guangdongensis 164
Chileobryon 165
Circulifolium 152
exiguum 152
Echinodiopsis 165
Forsstroemia 152
cryphaeoides 167
noguchii 152
trichomitria 153
yezoana 153
Himantocladium 152
Homalia 154
exigua 152
glabella 154
nitidula 163
pennatula 154
trichomanoides 154
var. trichomanoides 154
var. japonica 154
Homaliadelphus 166
targionianus 166
Homaliodendron 154
crassinervium 157
var. bacvietensis 157
exiguum 152
flabellatum 155
fruticosum 155
handelii 157
cf. ligulaefolium 156
microphyllum 156
montagneanum 157
neckeroides 157
papillosum 158
pulchrum 159
cf. scalpellifolium 159
squarrosulum 155
Homaliopsis
targioniana 166
Hookeria
flabellata 155
Leptodon 149
Leskea
trichomanoides 154

Neckera 159
bhutanensis 159
crenulata 159, 163
coreana 161
decurrens 160
var. rupicola 160
denigricans 159
enrothiana 159
flexiramea 160
humilis 161
inopinata 161
konoii 161
ligulaefolia 156
montagneana 156
neckeroides 157
subserrata 165
pusilla 159
scalpellifolia 159
setschwania 162
targioniana 166
xizangensis 159
yezoana 153
Neckeropsis 162
calcicola 162
lepineana 167
nitidula 163
Pendulothecium 165
Pinnatella 163
alopecuroides 167
ambigua 164
anacamptolepis 164
homaliadelphoides 163
makinoi 163
mucronata 164
taiwanensis 164
Porotrichum
alopecuroides 167
makinoi 163
perplexans 157
Pseudoleskeella 167
Pterigynandrum
trichomitrium 153
Shevockia 164
Symphyodon 154
pennatulus 154
Taiwanobryum 164
anacamptolepis 164
guangdongense 164

<i>mucronatum</i>	164	<i>Thamnobryum</i>	165
<i>speciosum</i>	165	<i>subserratum</i>	165
		<i>Thamnomalia</i>	154