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A brief overview of and key to species of *Collema* from China

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Abstract — Forty-seven taxa of the lichen genus *Collema* belonging to 33 species are reported in the present paper. Among them, the following nine taxa are new to China: *Collema coccophorum*, *C. furfuraceum* var. *luzonense*, *C. kauaiense*, *C. nepalense*, *C. nipponicum*, *C. poeltii*, *C. polycarpon, C. subnigrescens* f. *caesium,* and *C. tenax* var. *expansum*. A key to the known species from China is given. *Collema pulchellum* var. *leucopeplum* and *C. latzelii* are excluded from the lichen flora of China.

Key words — *Collemataceae*, *Lecanorales*, lichenized *Ascomycetes*

Introduction

Collema is a crustose to foliose lichen genus belonging to *Collemataceae*, *Lecanorales*, *Ascomycota* (Kirk et al. 2001). It comprises about 80 species in the world (Kirk et al. 2001) and has been monographed by Degelius (1954, 1974).

The genus has been reported from China in 29 scattered publications with 59 taxa belonging to 43 species (Wei 1991; Jiang 1992, 1993; Liu & Wei 2003ab). The first species from China, *Collema limosum* was reported by Nylander & Crombie (1883). The second one, *C. coccophylloides* Nyl. (= *C. callibotrys* var. *coccophyllizum*), was recorded by Hue (1898). The two species, *Synechoblastus sublaevis* Jatta (= *C. furfureolum*) and *S. flaccidus* (Ach.) Körb. (≡ *C. flaccidum*) were reported by Jatta (1902). Zahlbruckner (1930, 1933) added six taxa, viz. *C. nigrescens*, *C. substipitatum*, *C. raishanum* Zahlbr. (= *C. leptaleum*), *C. ogatae* Zahlbr. (≡ *C. tenax* var. *ogatae*), *C. complanatum* and *C. japonicum*. Magnusson (1940) described two species from China, *C. kansuense* H. Magn. (= *C. tenax* var. *corallinum*) and *C. substellatum* H. Magn. (≡ *C. tenax* var. *substellatum*). Degelius (1974) added five taxa, viz. *C. glebulentum*, *C. pulchellum* var.

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subnigrescens, *C. subflaccidum*, *C. tenax* var. *vulgare* and *C. texanum*. The following 12 taxa were added to the Chinese *Collema* flora in eight papers (Wei 1991), viz. *C. pustuligerum* Hue (= *C. pulchellum* var. *pulchellum*) (Asahina 1952), *C. crispum* (Wu & Xiang 1981), *C. fasciculare* (Chen et al. 1981a), *C. peregrinum* (Ikoma 1983), *C. furfuraceum*, *C. ryssoleum*, *C. subnigrescens*, *C. tunaeforme* (Ach.) Ach. (= *C. fuscovirens*) [the above mentioned four species were recorded by Wu (1987)], *C. leptaleum* var. *biliosum*, *C. rugosum* [both in Thrower (1988)], *C. cristatum* (Wu & Qian 1989) and *C. subconveniens* (Chen et al. 1989).

Twelve taxa from China were described by Jiang (1992), viz. *C. beijingense*, *C. brevisporum*, *C. clavisporiferum*, *C. corniculatum*, *C. fanjingshanense*, *C. fusiosporum*, *C. lushanense*, *C. multipartitum* var. *granulosum*, *C. pulchellum* var. *multipartitum*, *C. sorediatum*, *C. tetrasporum* and *C. tianmuense*. The same author (Jiang 1993) reported 13 new records: *C. auriforme*, *C. callopismum*, *C. ceraniscum*, *C. cristatum* var. *marginale*, *C. latzelii*, *C. pulchellum* var. *leucopeplum*, *C. shiroumanum*, *C. tenax* var. *ceranoides*, *C. tenax* var. *crustaceum*, *C. tenax* var. *diffracto-areolatum*, *C. tenax* f. *papulosum*, *C. undulatum* var. *undulatum* and *C. undulatum* var. *granulosum*. Abbas & Wu (1998) reported *C. thamnodes* from Xinjiang. The occurrence of *Collema* in China was also reported by Magnusson (1944), Wang & Lai (1973), Chen et al. (1981b), Wu et al. (1984), Wei (1991), Abbas et al. (1996, 2001), Aptroot & Seaward (1999) and Guo (2005).

Although a large number of species were reported, there has not been any revisionary study on *Collema* from China. As part of this research, we synonymized five taxa described by Jiang (1992), recorded *C. multipartitum* as new to China (Liu & Wei 2003a), and described *C. sichuanense* and *C. substipitatum* var. *gonggashanense* (Liu & Wei 2003b). In this paper, we report 47 taxa belonging to 33 species, including nine new records, and we exclude two taxa from the Chinese lichen flora.

Materials and methods

Most of the specimens examined are deposited in the Herbarium Mycologicum Academiae Sinicae-Lichenes (HMAS-L); some are in the Herbarium of Xinjiang University (XJU) and the Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences (KUN).

For the morphological and anatomical studies, a dissecting (Motic) and a compound microscope (Olympus BHA) were routinely used for all materials. Hand sections were routinely made and examined with water as the mounting medium. Terms of morphology and anatomy follow Degelius (1954, 1974). Comments on the distribution of *Collema* taxa are mainly based on Wei (1991).

Results and discussion

Forty-seven taxa belonging to 33 species are accepted in the present paper. Among them, nine taxa are new to China: *C. coccophorum*, *C. furfuraceum* var. *luzonense*, *C. kauaiense*, *C. nepalense*, *C. nipponicum*, *C. poeltii*, *C. polycarpon, C. subnigrescens* f. *caesium* and *C. tenax* var. *expansum*; these are marked with "***" in the taxonomic list. Both *C. pulchellum* var. *leucopeplum* and *C. latzelii* are misapplied names and are therefore excluded from the lichen flora of China.

Collema F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

Thallus crustose to foliose, gelatinized; upper side smooth, rugose to ridged or pustulate. Apothecia superficial, commonly sessile with constricted base. Thallus without cortex, homoeomerous; photobiont *Nostoc*. Apothecia zeorine; thalline exciple with or without a pseudocortex; proper exciple euthyplectenchymatous, subparaplectenchymatous or euparaplectenchymatous; ascospores 8 per ascus, 1- to multi-septate or somewhat muriform, variable in size and shape, colorless.

Corticolous, saxicolous to terricolous.

Key to the taxa of *Collema* from China

1. Thallus crustose to subfoliose, often fenestrate; lobes indistinct or absent 2
1. Thallus foliose to somewhat subfoliose, not fenestrate (but see *C. nepalense*); lobes distinct 9
2. Thallus with isidia, rugose on upper side; apothecia absent ..... *C. leptaleum* var. *biliosum*
2. Thallus without isidia 3
3. Spores submuriform (with longitudinal septa) 4
3. Spores without longitudinal septa 5
4. Spores cubic ..... *C. lushanense*
4. Spores ellipsoid ..... *C. nipponicum*
5. Spores > 10-celled, vermiform and curved in various ways, > 65 µm long ..... *C. fasciculare*
5. Spores < 10-celled, not vermiform, straight or curved 6
6. Spores bacillar and 4-celled, < 50 µm long; proper exciple euparaplectenchymatous ..... *C. leptaleum* var. *leptaleum*
6. Spores not bacillar, > 4-celled 7
7. Spores dumbbell-shaped, < 50 µm long; proper exciple euthyplectenchymatous ..... *C. shiroumanum*
7. Spores fusiform to acicular, > 60 µm long 8

8. Proper exciple euthyplectenchymatous to subparaplectenchymatous ..... *C. substipitatum* var. *substipitatum*
8. Proper exciple euparaplectenchymatous ..... *C. substipitatum* var. *gonggashanense*

9. Thallus rugose on both sides ..... *C. auriforme*
9. Thallus rugose only on upper side or not rugose 10

10. Lobes swollen and sometimes plicate (at least in the tips) 11
10. Lobes not swollen and not plicate 21

11. Lobes convex, repeatedly furcate ..... *C. texanum*
11. Lobes plane to concave 12

12. Thallus commonly < 2 cm diam.; lobes < 2 mm wide 13
12. Thallus > 2 cm diam.; lobes > 2 mm wide 16

13. Lobes erect, often forming erect clusters ..... *C. tenax* var. *corallinum*
13. Lobes adnate to ascending, not forming erect clusters 14

14. Thallus areolate, isidiate ..... *C. tenax* var. *diffracto-areolatum*
14. Thallus not areolate, nonisidiate 15

15. Spores 2-celled ..... *C. coccophorum*
15. Spores 4-celled to submuriform ..... *C. tenax* var. *crustaceum*

16. Thallus > 5 cm diam.; lobes > 5 mm wide; upper side glossy ..... *C. tenax* var. *expansum*
16. Thallus < 5 cm diam.; lobes < 5 mm wide; upper side dull 17

17. Lobes long, up to 15 mm long ..... *C. tenax* var. *substellatum*
17. Lobes short, commonly < 5 mm long 18

18. Upper side with erect accessory lobules ..... *C. tenax* var. *ogatae*
18. Upper side not so 19

19. Thallus isidiate ..... *C. tenax* f. *papulosum*
19. Thallus nonisidiate 20

20. Spores 4-celled to submuriform; proper exciple euthyplectenchymatous ..... *C. tenax* var. *vulgare*
20. Spores 4-celled; proper exciple subparaplectenchymatous to euparaplectenchymatous ..... *C. polycarpon*

21. Lobes > 5 mm wide and plane 22
21. Lobes < 5 mm wide, concave, plane or convex 38

22. Upper side of the thallus with regular ridges or pustules 23
22. Upper side of the thallus without regular ridges or pustule 33

23. Upper side of the thallus with isidia 24
23. Upper side of the thallus without isidia 25

24. Proper exciple euparaplectenchymatous ..... *C. furfuraceum* var. *luzonense*
24. Proper exciple euthyplectenchymatous ..... *C. furfuraceum* var. *furfuraceum*

25. Thalline exciple with pseudocortex; proper exciple euthyplectenchymatous 26
25. Thalline exciple without pseudocortex; proper exciple euparaplectenchymatous 31

26. Spores fusiform to ellipsoid 27
26. Spores broadly acicular to acicular 29
27. Thallus often fenestrate; apothecia pruinose; spores 4–6-celled ..... *C. nepalense*
27. Thallus not fenestrate; apothecia epruinose; spores 6-celled 28
28. Spores > 5 μm wide; saxicolous ..... *C. ryssoleum*
28. Spores < 5 μm wide; corticolous ..... *C. sichuanense*
29. Spores acicular, 6–10-celled, < 5 μm wide ..... *C. nigrescens*
29. Spores broadly acicular, 6-celled, > 6 μm wide 30
30. Apothecia pruinose ..... *C. subnigrescens* f. *caesium*
30. Apothecia epruinose ..... *C. subnigrescens* f. *subnigrescens*
31. Spores > 65 μm long; upper side of the thallus mainly ridged ..... *C. complanatum*
31. Spores < 65 μm long 32
32. Upper side of the thallus mainly ridged ..... *C. pulchellum* var. *subnigrescens*
32. Upper side of the thallus mainly pustulate ..... *C. pulchellum* var. *pulchellum*
33. Spores with longitudinal septa ..... *C. subconveniens*
33. Spores without longitudinal septa 34
34. Thallus rarely isidiate; proper exciple euparaplectenchymatous ..... *C. japonicum*
34. Thallus isidiate; proper exciple euthyplectenchymatous to subparaplectenchymatous 35
35. Thallus with squamiform isidia ..... *C. flaccidum*
35. Thallus with globular to teretiform isidia 36
36. Isidia teretiform, > 1 mm long, repeatedly branched ..... *C. glebulentum*
36. Isidia globular to teretiform, < 1 mm long, not branched or slightly so 37
37. Upper side with irregular ridges or pustules; isidia teretiform ..... *C. rugosum*
37. Upper side without ridges or pustules; isidia often globular ..... *C. subflaccidum*
38. Thallus nonisidiate 39
38. Thallus isidiate 42
39. Lobes convex, < 1 mm wide, not crisped; proper exciple euparaplectenchymatous ..... *C. multipartitum*
39. Lobes concave to plane 40
40. Lobes canaliculate at least in part 41
40. Lobes not so, strongly undulate ..... *C. undulatum* var. *undulatum*
41. Lobes irregularly furcate, incised with lobules in margin ..... *C. cristatum* var. *cristatum*
41. Lobes regularly furcate, often entire in margin ..... *C. cristatum* var. *marginale*
42. Isidia squamiform when old; lobes crisped 43
42. Isidia globular to cylindrical when old; lobes not crisped or slightly so 44
43. Spores < 20 μm long ..... *C. furfureolum*
43. Spores > 20 μm long ..... *C. crispum*

44. Lobes concave, furcate ..... *C. undulatum* var. *granulosum*
44. Lobes plane to somewhat concave, not branched or slightly so 45
45. Upper side of the thallus irregularly pustulate ..... *C. fuscovirens*
45. Upper side of the thallus not pustulate 46
46. Proper exciple euthyplectenchymatous to subparaplectenchymatous. .... *C. poeltii*
46. Proper exciple euparaplectenchymatous ..... *C. kauaiense*

1. *Collema auriforme* (With.) Coppins & J.R. Laundon, in Laundon, Lichenologist 16(3): 228 (1984).

This species is characterized by 1) thallus with distinct wrinkles on both sides; 2) lobes 4–10 mm wide, irregularly branched; 3) proper exciple euparaplectenchymatous; 4) spores submuriform, (17–) 27–40.5 (–51) × 6.5–15.5 (–17) μm. It is muscicolous on soil-covered rocks.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1250 m, Gao XQ, 758. HEBEI, Mt. Xiaowutaishan, 1800 m, Jiang ZG, 3627. QINGHAI, Huangcheng, 3000 m, 11.IX.1958, Ma QM, 9. XINJIANG, Yecheng, 3000 m, 8.VIII.1992, Abbas A, 92-0244.

Literature records for China: JILIN, HEBEI (Jiang 1993, p. 70), SHAANXI (Guo 2005, p. 46), QINGHAI (Jiang 1993, p. 70; Guo 2005, p. 46), XINJIANG (Guo 2005, p. 46).

2. *Collema coccophorum* Tuck., Proc. Am. Acad. Arts & Sci. 5: 385 (1862).***

This species is characterized by 1) thallus foliose, 3 cm diam.; 2) lobes numerous, concave, 1–2 mm wide, with swollen ends; 3) thallus and thalline exciple not pseudocorticate; 4) proper exciple euthyplectenchymatous; 5) spores fusiform to ovate, 2-celled, (17–) 20.5–25 × 6.5–9 μm. It is terricolous.

In gross morphology, *C. coccorphorum* resembles some infraspecific taxa of *C. tenax*, which differs in having 4-celled to submuriform spores.

Selected specimens examined: NEI MONGOL, Xilinhot, Inner Mongolian Grassland Ecosystem Research Station of Academia Sinica, 1150 m, 27.VII.2003, Liu HJ, 740. HUNAN, Mt. Hengshan, 1200 m, 1.IX.1964, Zhao JD & Xu LW, 10351.

3. *Collema complanatum* Hue, J. Bot. (Morot) 20: 85 (1906).

This species differs from other species of *Collema* in having long, 6–10-celled, acicular spores (commonly > 65 μm long). It is corticolous.

Selected specimens examined: NEI MONGOL, Ergun Zuoqi, 1200 m, 16.VIII.1985, Gao XQ, 1620. JILIN, Mt. Changbaishan, 1100 m, 7.VIII.1977, Wei JC, 2776. HEILONGJIANG, Dailing, 450 m, 2.X.1975, Wei JC, 2055. SHAANXI, Mt. Taibaishan, 2300 m, 9.VII.1988, Ma CH, 60 [The above mentioned specimens were cited by Jiang (1993) as *C. pulchellum* var. *leucopeplum*]. ANHUI, Yuexi, 1150 m, 4.IX.2001, Liu HJ, 444. JIANGXI, Mt. Lushan, Zhao JD et al., 579 [Jiang (1993) as *C. shiroumanum*]. YUNNAN, Lijiang, Mt. Yulongshan, 3050 m, 15.XII.1964, Wei JC, 2504-5 [Jiang (1993) as *C. pulchellum* var. *pulchellum*].

Literature records for China: SHAANXI (Guo 2005, p. 46), ZHEJIANG (Wu & Qian 1989, p. 194), FUJIAN (Wu et al. 1984, p. 1), TAIWAN (Zahlbruckner 1933, p. 26; Wang & Lai 1973, p. 90; Degelius 1974, p. 161), HONG KONG (Thrower 1988, p. 83; Jiang 1993, p. 72).

4. *Collema crispum* (Huds.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

This species is characterized by the foliose thallus with crisped, < 5 mm wide lobes. It is terricolous.

Specimen examined: XIZANG, Lhünzê, 3600 m, 5.VII.1975, Zang M, 1117.

Literature records for China: SHAANXI (Wu 1987, p. 53), JIANGSU (Wu & Xiang 1981, p. 2; Wu & Qian 1989, p. 194; Wu 1987, p. 53), ZHEJIANG (Wu & Qian 1989, p. 194).

5. *Collema cristatum* (L.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

5.1. var. ***cristatum***

This variety is characterized by 1) thallus foliose, often > 5 cm diam.; 2) lobes radiating and irregularly furcate, < 2 mm wide, somewhat concave; 3) thalline exciple without pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores ellipsoid, 4-celled to submuriform, 17–28 × 6.5–12 µm. It is saxicolous to terricolous, often growing together with var. *marginale*.

Selected specimens examined: NEI MONGOL, Hexigten Qi, 1500 m, 29.VII.1985, Gao XQ, 1049. HEBEI, Mt. Xiaowutaishan, 2100 m, Jiang ZG, 3692. XINJIANG, Zhaosu, 2.VII.1992, Abbas A, 219, 221. Wensu, Mt. Tomur, 2600 m, 30.VI.1977, Wang XY et al., 341.

Literature records for China: BEIJING, HEBEI (Jiang 1993, p. 70), XINJIANG (Guo 2005, p. 46).

5.2. var. ***marginale*** (Huds.) Degel., Symb. Bot. Upsal. 13(2): 316 (1954).

This variety is similar in anatomy (thalline and proper exciples, spore shape and size) to var. *cristatum*, but differs in having the regularly furcate lobes. It is saxicolous to terricolous.

Selected specimens examined: NEI MONGOL, Hexigten Qi, 1500 m, 29.VII.1985, Gao XQ, 1035. HEBEI, Mt. Baihuashan, 1500 m, 18.VII.1964, Xu LW & Zong YC, 8461. XINJIANG, Zhaosu, 6.VII.1993, Abbas A, 930172 [Abbas & Wu (1998) and Abbas et al. (1996, 2001) as *C. fuscovirens*].

Literature records for China: BEIJING, NEI MONGOL (Jiang 1993, p. 70), XINJIANG [Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 62; Abbas et al. 2001, p. 363 (All cited as *C. fuscovirens* in the abovementioned three literatures); Guo 2005, p. 46].

6. *Collema fasciculare* (L.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

This species differs from all other crustose to subfoliose Chinese taxa of *Collema* in having 10–16-celled, vermiform spores that are > 65 µm long. It is corticolous.

Collema fasciculare can be well distinguished from *C. complanatum* by its crustose to subfoliose thallus without ridges or pustulates on the upper side.

Selected specimens examined: JILIN, Mt. Changbaishan, 1100 m, 8.VIII.1977, Wei JC, 2807-1. SICHUAN, Mt. Emeishan, 2200 m, 14.VIII.1963, Zhao JD & Xu LW, 7322.

Literature records for China: HEILONGJIANG (Chen et al. 1981a, p. 134; Wu 1987, p. 53), SHAANXI (Wu 1987, p. 53).

7. *Collema flaccidum* (Ach.) Ach., Lichenogr. Univ.: 647 (1810).

This species is characterized by its foliose thallus with broad (> 5 mm wide) lobes, irregular pustules or ridges on the upper side, and squamiform isidia. Spores fusiform, 23.8–37.4 × 5–8.5 μm. It is corticolous.

Selected specimens examined: HEILONGJIANG, Mulin, 610 m, 21.VII.1977, Wei JC, 2545-1. ANHUI, Yuexi, 1670 m, 5.IX.2001, Huang MR, 655. SICHUAN, Mt. Emeishan, 2200 m, Zhao JD et al., 7399. XINJIANG, Mt. Altay Shan, 1700 m, Abbas A, 2002948.

Literature records for China: SHAANXI (Jatta 1902, p. 480; Zahlbruckner 1930, p. 76; Wu 1987, p. 53), JIANGSU (Wu 1987, p. 53), ANHUI (Wu & Qian 1989, p. 194), XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 61; Abbas et al. 2001, p. 363; Guo 2005, p. 46).

8. *Collema furfuraceum* (Arnold) Du Rietz, Ark. Bot. 22A(13): 3 (1929).

8.1. var. ***furfuraceum***

This taxon is characterized by 1) thallus foliose, with regular ridges and pustules on upper side; 2) lobes > 5 mm wide; 3) cylindrical isidia on ridges and pustules; 4) thallus and thalline exciple often with typical pseudocortex; 5) proper exciple euthyplectenchymatous to somewhat subparaplectenchymatous; 6) spores fusiform, commonly 6-celled, 36–67 × 3.5–6.5 μm. It is corticolous.

In its isidia and lobe width, this taxon resembles *C. subflaccidum*, from which it can be separated by the regular ridges and pustules on the upper side.

Selected specimens examined: JILIIN, Mt. Changbaishan, 20.VIII.1977, Wei JC, 3118. SHAANXI, Mei Xian, 800 m, 12.IV.1963, Ma QM & Zong YC, 2008. ANHUI, Jinzhai, 680 m, 10.IX.2001, Huang MR, 674. HUNAN, Mt. Hengshan, 600–1000 m, 31.VIII.1964, Zhao JD & Xu LW, 9872, 10011. SICHUAN, Mt. Emeishan, 1400–3160 m, 20.VIII.1963, Zhao JD & Xu LW, 7704, 8220. XINJIANG, Mt. Tianshan, 2500 m, 7.VIII.1978, Wang XY, 1205.

Literature records for China: ZHEJIANG, ANHUI, JIANGXI (Wu 1987, p. 53), SHAANXI (Wu 1987, p. 53; Guo 2005, p. 46), XINJIANG (Guo 2005, p. 46).

8.2. var. ***luzonense*** (Räsänen) Degel., Symb. Bot. Upsal. 20(2): 179 (1974).***

This taxon differs from var. *furfuraceum* in having euparaplectenchymatous proper exciple. It is corticolous.

Specimen examined: HUNAN, Mt. Hengshan, 500 m, 11.II.1965, Wei JC, 3030.

9. *Collema furfureolum* Müll. Arg., Flora 72: 142 (1889).

This species is characterized by 1) thallus foliose, without ridges and pustules; 2) end lobes 2–3 mm wide, slightly crisped; 3) isidia superficial, squamiform; 4) thallus without typical pseudocortex. It is saxicolous.

Specimen examined: SHAANXI, Mt. Taibaishan, 4.VI.1963, Wei JC et al., 2718.

Literature records for China: SHAANXI (Jatta 1902, p. 481; Zahlbruckner 1930, p. 76; Degelius 1974, p. 79; Guo 2005, p. 46), ZHEJIANG (Degelius 1974, p. 79).

10. *Collema fuscovirens* (With.) J.R. Laundon, Lichenologist 16(3): 219 (1984).

This species is characterized by the branched foliose thallus with < 5 mm wide lobes and irregularly pustulate upper side, and obovate to ellipsoid spores (14–26 × 6.5–12 μm). It is saxicolous to terricolous.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1250 m, 3.VII.1985, Gao XQ, 729-1. SHAANXI, Mt. Taibaishan, 1200 m, 7.VII.1988, Gao XQ, 2937 [Jiang (1993) as *C. undulatum* var. *undulatum*]. SICHUAN, Huanglong, 3325 m, 25.IX.2001, Jiang YM & Zhao ZT, S220. XIZANG, Nyalam, 3350 m, 21.V.1966, Wei JC & Chen JB, 1083-1. XINJIANG, Mt. Altay Shan, Abbas A, 98-006-8a.

Literature records for China: SHAANXI (Wu 1987, p. 55), JIANGSU (Wu 1987, p. 55; Wu & Qian 1989, p. 195), XINJIANG (Guo 2005, p. 46).

11. *Collema glebulentum* (Nyl. ex Cromb.) Degel., in Magnusson, Ark. Bot. ser. 2, 2(2): 88 (1952).

The species is distinct from all other species of *Collema* by the repeatedly branched and large isidia (often > 1 mm long). It is corticolous.

Specimen examined: JILIN, Mt. Changbaishan, 16.VIII.1977, Wei JC, 3041.

Literature records for China: SHAANXI (Guo 2005, p. 46). XINJIANG (Degelius 1974, p. 144; Abbas & Wu 1998, p. 63; Guo 2005, p. 46).

12. *Collema japonicum* (Müll. Arg.) Hue, Nouv. Arch. Mus. Hist. Nat. Paris Sér. 3, 10: 220 (1898).

This species is characterized by 1) thallus foliose with > 5 mm wide lobes; 2) upper side smooth or with irregular pustules and ridges; 3) thalline exciple with pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores fusiform, 6-celled, 27–54 (–67) × 5–9 μm. It is corticolous, rarely saxicolous.

Selected specimens examined: SHAANXI, Mt. Taibaishan, 1100 m, 30.VI.1963, Wei JC et al., 2779. ANHUI, Jinzhai, 650 m, 10.IX.2001, Liu HJ, 548. HUNAN, Mt. Hengshan, 960 m, 2.IX.1964, Zhao JD & Xu LW, 10288. SICHUAN, Mt. Gonggashan, 2500 m, 1.VII.1982, Wang XY et al., 8646.

Literature records for China: SHAANXI (Guo 2005, p. 46), ANHUI, ZHEJIANG (Wu & Qian 1989, p. 195), TAIWAN (Zahlbruckner 1933, p. 26; Wang & Lai 1973, p. 90).

13. ***Collema kauaiense*** H. Magn., in Magnusson & Zahlbruckner, Ark. Bot. 31A(1): 63 (1943).***

This species is characterized by 1) thallus foliose, 2 cm diam.; 2) lobes 2–3 mm wide, margin crisped, not swollen; 3) isidia on upper side, laminal, globular to somewhat squamiform; 4) apothecia pruinose; 5) proper exciple euparaplectenchymatous; 6) spores fusiform, 4–6-celled, 23.5–34.5 × 6.5–10 μm. It is corticolous.

In having pruinose apothecia, this species resembles *C. nepalense* and *C. subnigrescens* f. *caesium*, from which it can be separated by the smaller thallus (< 3 cm diam.), narrower lobes (< 5 mm wide) and upper side without ridges and pustules.

Specimen examined: SICHUAN, Mt. Gonggashan, 2500 m, 1.VII.1982, Wang XY et al., 8638.

14. ***Collema leptaleum*** Tuck., Proc. Am. Acad. Arts & Sci. 6: 263 (1866).

14.1. var. ***leptaleum***

= *C. brevisporum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 83 (1992).

This variety is similar in appearance to var. *biliosum*, but differs in lacking isidia and in having numerous apothecia. It is corticolous. See Liu & Wei (2003a) for details.

Literature records for China: JILIN, HEILONGJIANG, ZHEJIANG, YUNNAN (Liu & Wei 2003a, p. 350), TAIWAN (Zahlbruckner 1933, p. 26, 1940, p. 247; Wang & Lai 1973, p. 90; Degelius 1974, pp. 102 & 107), HONG KONG (Thrower 1988, p. 84).

14.2. var. ***biliosum*** (Mont.) Degel., Symb. Bot. Upsal. 20(2): 105 (1974).

This taxon is characterized by 1) thallus crustose to subfoliose, sometimes fenestrate; 2) upper side irregularly rugose, with globular isidia; 3) apothecia absent. It is corticolous.

Selected specimens examined: JILIN, Mt. Changbaishan, Wenquan, 16.VIII.1977, Wei JC, 3048. NEI MONGOL, Horqin Youyi Qianqi, 1200 m, 6.VII.1985, Gao XQ, 892-1. SHAANXI, Mt. Taibaishan, 4.VI.1963, Wei JC et al., 2718-3. JIANGXI, Mt. Lushan, 21.IV.1960, Zhao JD, 519. YUNNAN, Weixi, 2900 m, 18.VII.1981, Wang XY et al., 3848. HONG KONG, 1.I.1973, Thrower SL, 1527.

Literature records for China: SHAANXI (Guo 2005, p. 46), HONG KONG (Thrower 1988, p. 85).

15. ***Collema lushanense*** Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16: 83 (1992).

Type(!): JIANGXI, Mt. Lushan, 3.IV.1960, Zhao JD et al., 577 (HMAS-L). Corticolous.

This species is characterized by 1) thallus subcrustaceous to subfoliose, markedly rugose, fenestrate; 2) isidia and pruina absent; 3) thallus and thalline exciple

without pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores 8 per ascus, cubic, submuriform, 13.5–17 × 8.5–10 μm. It is corticolous.

This species differs from other Chinese *Collema* taxa in having cubic spores. It is endemic to China and known only from the original locality.

Literature records for China: JIANGXI (Jiang 1992, p. 83).

16. *Collema multipartitum* Sm., in Smith & Sowerby, Engl. Botan. vol. 36, tab. 2582 (1814).
= *C. multipartitum* var. *granulosum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 83 (1992).

This species is characterized by the foliose thallus with narrow (< 5 mm wide), repeatedly furcate, convex lobes, euparaplectenchymatous proper exciple, and 4-celled linear-oblong spores (34–37.4 × 5–6.5 μm). It is saxicolous. See Liu & Wei (2003a) for details.

Literature records for China: HEBEI (Liu & Wei, 2003a, p. 352).

17. *Collema nepalense* Degel., Symb. Bot. Upsal. 20(2): 157 (1974).***

This species is characterized by 1) thallus foliose, often fenestrate; 2) upper side regularly pustulate to somewhat ridged; 3) lobes often > 5 mm wide; 4) thalline exciple with distinct pseudocortex; 5) proper exciple euthyplectenchymatous to somewhat subparaplectenchymatous; 6) spores fusiform, 6-celled, (34–) 38–44 (–51) × (3.5–) 5–7 μm. It is corticolous.

Selected specimens examined: YUNNAN, Lijiang, 3050 m, 15.XII.1964, Wei JC, 2493-1. XIZANG, Zogang, Mt. Meilixueshan, 3200 m, 8.X.1982, Su JJ, 5501.

18. *Collema nigrescens* (Huds.) DC., in Lamarck & de Candolle, Fl. Franç., ed. 3, 2: 384 (1805).

This species is mainly characterized by its foliose thallus with regular ridges and pustules, pseudocorticate thalline exciple, euthyplectenchymatous to subparaplectenchymatous proper exciple and 6–10-celled, transversely septate spores. It differs from *C. subnigrescens* by its longer [58–87 (–102) μm vs 54–69 (–85) μm] and narrower [3.5–5 μm vs (3.5–) 5–7 μm] spores with more septa [6–10-celled vs 6-celled]. It is corticolous.

Selected specimens examined: HEILONGJIANG, Dailing, 450 m, 1.VIII.2002, Chen JB & Hu GR, 22030. NEI MONGOL, Hexigten Qi, 1950 m, 30.VII.1985, Gao XQ, 1084.

Literature records for China: SHAANXI, ZHEJIANG, ANHUI, GUANGDONG (Wu 1987, p. 54), SICHUAN (Zahlbruckner 1930, p. 76), HUNAN, YUNNAN, FUJIAN (Wu 1987, p. 54; Zahlbruckner 1930, p. 76).

19. *Collema nipponicum* Degel., Symb. Bot. Upsal. 20(2): 53 (1974).***

This species is characterized by 1) thallus subfoliose, 2–3 cm diam.; 2) lobes swollen towards margin; 3) thallus and thalline exciple without pseudocortex;

4) proper exciple euparaplectenchymatous; 5) spores ellipsoid, submuriform, 27–35 × 9–13.5 μm. It grows on soil-covered rocks.

In gross morphology *C. nipponicum* resembles some infraspecific taxa of *C. tenax*, but differs in the euparaplectenchymatous proper exciple.

Specimens examined: XINJIANG, Tomort, 2800–2900 m, 3–25.III.1977, Wang XY et al., 394, 533-1.

20. *Collema poeltii* Degel., Symb. Bot. Upsal. 20(2): 96 (1974).***

This species is characterized by 1) thallus foliose, often fragmented, 2–4 cm diam.; 2) lobes 1–2 mm wide, slightly crisped; 3) thalline exciple with typical pseudocortex; 4) proper exciple euthyplectenchymatous to subparaplectenchymatous; 5) spores fusiform, (4–)6-celled, 28–45 × 7–10 μm. It is saxicolous or terricolous.

Selected specimens examined: HEBEI, Mt. Donglingshan, 18.VIII.1957, Zhao JD, 008 [Jiang (1993) as *C. latzelii*]. HENAN, Mt. Jigongshan, 20.IX.2001, Liu HJ, 705. ANHUI, Yuexi, 1450 m, 5.IX.2001, Liu HJ, 477. YUNNAN, Xichou, 1580 m, 17.XI.1991, Chen JB, 5173.

21. *Collema polycarpon* Hoffm., Deutschl. Fl. 2: 102 (1796).***

This species is characterized by 1) thallus foliose, 2–3 cm diam.; 2) lobes 1–2 mm wide, margins slightly swollen; 3) thallus and thalline exciple without pseudocortex; 4) proper exciple subparaplectenchymatous; 5) spores fusiform, 4-celled, 17–26 × 6–8.5 μm. It is terricolous.

Specimen examined: YUNNAN, Yingjiang, 1500 m, Wang X. Y. et al., 3277.

22. *Collema pulchellum* Ach., Syn. Meth. Lich.: 321 (1814).

22.1. var. ***pulchellum***

This taxon is characterized by the foliose thallus with regular pustules on the upper side, euparaplectenchymatous proper exciple and acicular spores (commonly < 5 μm wide). It is corticolous. See Liu & Wei (2003a) for details.

Selected specimens examined: HEILONGJIANG, Tahe, 500 m, 3.VIII.1984, Gao XQ, 084. JILIN, Mt. Changbaishan, 1000 m, 25.VII.1983, Wei JC & Chen JB, 6053, 6111, 6150 [The above three specimens were cited by Jiang (1993) as *C. pulchellum* var. *leucopeplum*].

Literature records for China: Northeast China (Asahina 1952, p. 375; Degelius 1974, p. 176), NEI MONGOL, HEILONGJIANG, JILIN, HEBEI, ANHUI, HUNNAN (Liu & Wei 2003a, p. 354), YUNNAN (Degelius 1974, p. 176; Jiang 1993, p. 72; Liu & Wei 2003a, p. 354), FUJIAN (Jiang 1993, p. 72; Liu & Wei 2003a, p. 354), SHAANXI, XINJIANG (Liu & Wei 2003a, p. 354; Guo 2005, p. 46).

22.2. var. ***subnigrescens*** (Müll. Arg.) Degel., Symb. Bot. Upsal. 20(2): 173 (1974).
= *C. corniculatum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 85 (1992).

This taxon differs from var. *pulchellum* in having regular ridges rather than pustules on the upper side and broader spores (commonly > 5 μm wide). It is corticolous.

Specimens examined: see Liu & Wei (2003a) for details.

Literature records for China: HEILONGJIANG (Liu & Wei 2003a, p. 355), SHAANXI, QINGHAI (Liu & Wei 2003a, p. 355; Guo 2005, p. 46), HUBEI (Chen et al. 1989, p. 420; Liu & Wei 2003a, p. 355), SICHUAN, GUIZHOU (Liu & Wei 2003a, p. 355), YUNNAN (Degelius 1974, p. 176; Liu & Wei 2003a, p. 355), XIZANG (Liu & Wei 2003a, p. 355), HONGKONG (Thrower 1988, p. 86; Liu & Wei 2003a, p. 355).

23. *Collema rugosum* Kremp., in Fenzl, Reise Österr. Novara Bot. 1: 128 (1870).

The species is characterized by its foliose thallus with > 5 mm wide lobes, distinct ridges on upper side and rugose to isidiate apothecial margin. It is corticolous.

It is similar to *C. subflaccidum,* but differs in having isidiate apothecial margins and distinct ridges on the upper side of the thallus.

Selected specimens examined: HEILONGJIANG, Jingpohu Lake, 30.VII.1977, Qian ZG, Herbarium no.: 021472 (HMAS-L). ANHUI, Yuexi, 950 m, 4.IX.2001, Liu HJ, 458. JIANGXI, Mt. Lushan, 2.IV.1960, Zhao JD, 519-1; GUIZHOU, Daozhen, 1600 m, 11.VI.1987, Wu, 2929. XINJIANG, Kalas, 2300 m, Abbas A, 980088.

Literature records for China: HONG KONG (Thrower 1988, p. 87; Aptroot & Seaward 1999, p. 83). XINJIANG (Guo 2005, p. 46).

24. *Collema ryssoleum* (Tuck.) A. Schneid., Guide Study Lich.: 181 (1898).

This species resembles *C. nigrescens* and *C. subnigrescens* in general appearance, but differs in having 4–6-celled, fusiform to ellipsoid spores (23.5–40.5 × 4.5–9.5 μm), and in being saxicolous rather than corticolous.

Selected specimens examined: HEBEI, Lingshou, Manshan, 1400 m, 13.VI.1986, Jiang ZG, 2000. SHAANXI, Mt. Taibaishan, 2750 m, 11.VII.1988, Ma CH, 123. SICHUAN, Mt. Emeishan, 2800 m, 18.VIII.1963, Zhao JD & Xu LW, 8140. YUNNAN, Mt. Gongshan, Dulongjiang, 2000 m, 3.IX.1982, Su JJ, 3978.

Literature records for China: SHAANXI (Wu 1987, p. 54; Guo 2005, p. 46).

25. *Collema shiroumanum* Räsänen, Journ. Jap. Bot. 16: 147 (1940).

This species is characterized by its 6–8-celled, (31–) 37.5–47.5 (–54.5) × 3.5–5 μm, dumbbell-shaped spores. It is corticolous.

Selected specimens examined: HUBEI, Shennongjia, 2250 m, 3.VII.1984, Chen JB, 10030. JIANGXI, Mt. Lushan, 3.IV.1960, Zhao JD et al., 573.

Literature records for China: HUBEI, JIANGXI (Jiang 1993, p. 73).

26. *Collema sichuanense* H.J. Liu & J.C. Wei, Mycosystema 22: 531 (2003).

Type(!): SICHUAN, Zoige County, Tiebu, 2800 m, 21.VI.1983, XY Wang & X Xiao, 10093 (HMAS-L). Paratype(!): SICHUAN, Aba, 3100 m, 28.VI.1983, XY Wang, 11343 (HMAS-L).

This species is characterized by 1) thallus foliose, lobes > 5 mm wide; 2) upper side regularly pustulate; 3) thallus and thalline exciple with pseudocortex; 4) proper exciple euthyplectenchymatous; 5) spores 6-celled, linear-fusiform, (27–) 30.5–37.5 (–44) × 3.5–5 μm. See Liu & Wei (2003b) for details.

Literature records for China: SICHUAN (Liu & Wei 2003b, p. 531).

27. *Collema subconveniens* Nyl., Lich. Nov. Zel.: 8 (1888).

= *C. tianmuense* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 84 (1992).

This species is characterized by its foliose thallus with broad lobes (> 5 mm wide) having a distinct pseudocortex on both sides, and its submuriform spores. It is corticolous or terricolous. See Liu & Wei (2003a) for details.

Literature records for China: HUBEI, YUNNAN (Liu & Wei 2003a, p. 357), SHAANXI (Liu & Wei 2003a, p. 357; Guo 2005, p. 47), XINJIANG (Abbas & Wu 1998, p. 62; Liu & Wei 2003a, p. 357; Guo 2005, p. 47).

28. *Collema subflaccidum* Degel., Symb. Bot. Upsal. 20(2): 140 (1974).

This species is characterized by 1) foliose thallus with > 5 mm wide lobes; 2) upper side without regular ridges or pustules; 3) globular to occasionally cylindrical isidia on the upper side; 4) spores 6-celled, fusiform, 34–57.5 × 3.5–8.5 (–13.5) μm. It is corticolous.

Selected specimens examined: BEIJING, Mt. Xishan, 12.X.1961, Zhao JD & Sun ZM, 5069. JILIN, Mt. Changbaishan, 20.VIII.1977, Wei JC, 3118. NEI MONGOL, Horqin Youyi Qianqi, 1200 m, 6.VII.1985, Gao XQ, 930. SHAANXI, Mt. Taibaishan, 2260 m, 10.VI.1963, Wei JC et al., 2589. ANHUI, Jinzhai, 650 m, 10.IX.2001, Liu HJ, 552. GUIZHOU, Mt. Fanjingshan, 1220 m, 19.VIII.1963, Wei JC, 300-1. JIANGXI, Mt. Tianchishan, 800 m, 12.II.1965, Wei JC, 3090. YUNNAN, Zhongdian, 3650 m, 22.VIII.1981, Wang XY et al., 7562. XINJIANG, Mt. Altay Shan, Abbas A, 200732.

Literature records for China: HEILONGJIANG (Chen et al. 1981a, p. 134; Wu 1987, p. 55), JILIN (Wu 1987, p. 55), SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47), XINJIANG (Guo 2005, p. 47), JIANGSU (Wu & Xiang 1981, p. 2; Wu & Qian 1989, p. 195; Wu 1987, p. 55), ANHUI, SHANGHAI, ZHEJIANG (Wu & Qian 1989, p. 195), JIANGXI (Degelius 1974, p. 140), FUJIAN (Wu et al. 1984, p. 1).

29. *Collema subnigrescens* Degel., Symb. Bot. Upsal. 13(2): 413 (1954).

29.1. f. *subnigrescens*

= *C. pulchellum* var. *multipartitum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 86 (1992) (p.p.).

This form differs from f. *caesium* in having apothecia without pruina. It is corticolous. See Liu & Wei (2003a) for details.

Literature records for China: SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47), HUNNAN, SICHUAN, XIZANG (Liu & Wei 2003a, p. 358).

29.2. f. ***caesium*** (Clemente) Degel., Symb. Bot. Upsal. 13(2): 417 (1954).***

This form is characterized by 1) thallus foliose, lobes > 5 mm wide; 2) upper side with regular ridges and pustules; 3) apothecia pruinose; 4) thalline exciple with pseudocortex; 5) proper exciple euthyplectenchymatous; 6) spores broadly acicular, 6-celled, (34–) 45–64 × (3.5–) 5–7 μm. It is corticolous.

Selected specimens examined: SICHUAN, Yanyuan, 3450 m, 26.VIII.1983, Wang LS, 83-1294 (KUN 6911). GUIZHOU, Mt. Fanjingshan, 1220 m, 19.VIII.1963, Wei JC, 300.

30. ***Collema substipitatum*** Zahlbr., in Handel-Mazzetti, Symb. Sin. 3: 76 (1930).

30.1. var. ***substipitatum***

This taxon resembles *C. leptaleum* and *C. shiroumanum* in external appearance (with subfoliose to crustose and fenestrate thallus, rugose upper side and < 5 mm wide lobes), but differs in having 6–10-celled, longer (> 40 μm long), fusiform to acicular spores.

Selected specimens examined: GUIZHOU, Daozhen, 1600 m, 15.VI.1987, Wu, 2933. SICHUAN, Mt. Emeishan, 2800 m, 18.VIII.1963, Zhao JD & Xu LW, 8017.

Literature records for China: YUNNAN (Zahlbruckner 1930, p. 76. Degelius 1974, p. 188); TAIWAN (Degelius 1974, p. 188).

30.2. var. ***gonggashanense*** H.J. Liu & J.C. Wei, Mycosystema 22: 532 (2003).

Type(!): SICHUAN, Mt. Gonggashan, Dongpo, Yanzigou, 2650 m, 2.VII. 1982, XY Wang et al., 8729-1 (HMAS-L).

This taxon differs from var. *substipitatum* in having a well developed euparaplectenchymatous proper exciple. See Liu & Wei (2003b) for details.

Literature records for China: SICHUAN (Liu & Wei 2003b, p. 532).

31. ***Collema tenax*** (Sw.) Ach., Lichenogr. Univ.: 635 (1810).

This species is distinguished by the marginally swollen and plicate lobes, euthyplectenchymatous proper exciple, and fusiform to ellipsoid, 4-celled to submuriform spores (15–28 × 6–10.5 μm). It is terricolous.

Literature records for China: HEILONGJIANG (Chen et al. 1981b, p. 150), SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47).

The articles mentioned above recorded this species without indicating infraspecific taxa. In any case, var. *tenax* is not included here because it has not been found in the materials we have examined from China so far.

31.1. var. ***corallinum*** (A. Massal.) Degel., Symb. Bot. Upsal. 13(2): 165 (1974).

This variety is characterized by 1) thallus subfoliose to foliose, 2–3 cm diam.; 2) lobes < 2 mm wide, erect, often forming erect clusters. It is terricolous.

Selected specimens examined: NEI MONGOL, Xilinhot, Inner Mongolian Grassland Ecosystem Research Station of Academia Sinica, 1150 m, 27.VII.2003, Liu HJ, 751.

XINJIANG, Pishan, 3500 m, 13.VIII.1992, Abbas A, 92-0373-c [Abbas & Wu (1998) as *C. tenax* var. *substellatum*].

Literature records for China: NEI MONGOL (Degelius 1974, p. 49), GANSU (Magnusson 1944, p. 20; Degelius 1954, p. 183, 1974, p. 49), XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 63; Abbas et al. 2001, p. 363; Guo 2005, p. 47).

31.2. var. ***crustaceum*** (Kremp.) Degel., Symb. Bot. Upsal. 13(2): 164 (1954).

In general habit, this variety resembles *C. tenax* var. *vulgare*, but differs in having smaller thallus (< 1 cm diam.), narrower lobes (< 2 mm wide) and smaller apothecia (< 1.5 mm diam.).

Selected specimens examined: HUNAN, Mt. Hengshan, 700 m, 1.IX.1964, Zhao JD & Xu LW, 10047. XINJIANG, Tomort, 2900 m, 25.VII.1977, Wang XY et al., 553.

Literature records for China: HEBEI (Jiang 1993, p. 69), XINJIANG (Guo 2005, p. 47).

31.3. var. ***diffracto-areolatum*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 164 (1954).

This variety differs from other infraspecific taxa of *C. tenax* by the isidiate and areolate thallus.

Selected specimens examined: XINJIANG, Yecheng, 3000 m, 8.VIII.1992, Abbas A, 92-0293.

Literature records for China: HEBEI (Jiang 1993, p. 70), XINJIANG (Guo 2005, p. 47).

31.4. var. ***expansum*** Degel., Symb. Bot. Upsal. 13(2): 162 (1954).***

This variety is characterized by 1) thallus foliose, > 5 cm diam.; 2) lobes glossy, plane, often > 5 mm wide, with somewhat swollen and plicate margins; 3) thallus and thalline exciple without typical pseudocortex; 4) proper exciple euthyplectenchymatous; 5) spores fusiform to ellipsoid, 4-celled to submuriform, (13.5–) 17–24 (–27) × (7–) 9–13.5 μm.

It differs from all the other infraspecific taxa of *C. tenax* in the large thallus and glossy upper side.

Selected specimens examined: NINGXIA, Mt. Helanshan, 30.V.1984, Liu SR, 9.

31.5. var. ***ogatae*** (Zahlbr.) Degel., Symb. Bot. Upsal. 20(2): 47 (1974).

This variety is characterized by its foliose thallus with distinctly branched lobes and accessory lobules on the upper side.

Selected specimens examined: XINJIANG, Kuche, 2600 m, 23.V.1992, Abbas A, 92-0741; Aketao, 3000 m, 30.VII.1992, Abbas A, 92-024 [Abbas & Wu (1998) as *C. fuscovirens*].

Literature records for China: TAIWAN (Zahlbruckner 1933, p. 27; Degelius 1974, p. 47 & 49; Ikoma 1983, p. 59), XINJIANG (Guo 2005, p. 47).

31.6. var. ***substellatum*** (H. Magn.) Degel., Symb. Bot. Upsal. 20(2): 47 (1974).

This taxon differs from all the other infraspecific taxa of *C. tenax* in having long (15 mm long) and narrow (< 1 mm wide) lobes.

Specimen examined: XINJIANG, Baicheng, 2600 m, 21.V.1998, Wang XY, 6678-1.

Literature records for China: XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 63; Abbas et al. 2001, p. 363; Guo 2005, p. 47), GANSU (Magnusson 1940, p. 41; Degelius 1974, p. 49).

31.7. var. ***vulgare*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 163 (1954).

This taxon is characterized by its radiating, narrow (1–4 mm wide), plane lobes.

Selected specimens examined: HEBEI, Mt. Xiaowutaishan, 2100 m, Jiang ZG, 3696-1. NEI MONGOL, Ergun Zuoqi, Awuni, 10.VIII.1985, Gao XQ, 1467. NINGXIA, Mt. Helanshan, 1300 m, 21.V.1961, Han SJ et al., 2013. XINJIANG, Aketao, 3000–3250 m, 30.VII.1992, Abbas A, A-B, 920023, 920025, 920030, 9200109 [the specimens mentioned above from Xinjiang were cited as *C. fuscovirens* by Abbas & Wu (1998) and Abbas et al. (1996)].

Literature records for China: XIZANG (Degelius 1974, p. 49), XINJIANG (Abbas et al. 1996, p. 12, as *C. fuscovirens*; Abbas & Wu 1998, p. 63; Guo 2005, p. 47).

31.7.1. f. ***papulosum*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 163 (1954).

This form often grows together with var. *vulgare,* from which it differs mainly in having the numerous, dense and globular isidia on the upper side.

Selected specimens examined: HEBEI, Mt. Baihuashan, 900 m, 14.IX.1978, Wei JC & Jiang YM, 3501. XINJIANG, Kuche, 3200 m, 23.V.1992, Abbas A, 92-0767 [Abbas & Wu (1998) as *C. tenax* f. *vulgare*].

Literature records for China: HEBEI (Jiang 1993, p. 69), XINJIANG (Guo 2005, p. 47).

32. *Collema texanum* Tuck., Am. Journ. Arts & Sci., ser. 2, 28: 200 (1859).

The species is characterized by the foliose thallus with repeatedly furcate, convex, marginally swollen, narrow (< 2 mm wide) lobes. It grows on soil-covered rocks.

Specimen examined: YUNNAN, Kunming, 1780 m, 16.I.1981, Jiang YM, 1153-1.

Literature records for China: ZHEJIANG (Degelius 1974, p. 57).

33. *Collema undulatum* Laurer ex Flot., Linnaea 23: 161 (1850).

33.1. var. ***undulatum***

The variety is characterized by the foliose thallus with 2–4 mm wide, repeatedly furcate, somewhat concave and undulate lobes. It is terricolous.

Selected specimens examined: XINJIANG, Kuche, 3100–3500 m, 22–30.V.1992, Abbas A, 92-0426, 92-0800.

Literature records for China: SHAANXI, GUANGXI (Jiang 1993, p. 71), XINJIANG (Guo 2005, p. 47).

33.2. var. ***granulosum*** Degel., Symb. Bot. Upsal. 13(2): 369 (1954).

This variety differs from var. *undulatum* in having globular isidia on upper side. It is saxicolous or terricolous.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1500 m, 9.VII.1985, Gao XQ, 937. SHAANXI, Mt. Taibaishan, 1300 m, VII.1992, Chen JB & He Q, 5614. JILIN, Mt. Changbaishan, 1850 m, 28.VIII.1984, Lu XD, 848390-1.

Literature records for China: NEI MONGOL, HEBEI (Jiang 1993, p. 71), SHAANXI (Guo 2005, p. 47).

Taxa excluded from China

1. ***Collema pulchellum*** var. ***leucopeplum*** (Tuck.) Degel.
Symb. Bot. Upsal. 20(2): 172 (1974).

This name has been used for specimens of three taxa, *C. complanatum*, *C. pulchellum* var. *pulchellum* and *C. pulchellum* var. *subnigrescens* (see specimen citation of each taxon for details). It was reported from Nei Mongol, Jilin, Heilongjiang, Shaanxi and Qinghai (Jiang 1993).

2. ***Collema latzelii*** Zahlbr., Österr. Bot. Zeitschr. 59: 493 (1909).

This species was reported from Hebei by Jiang (1993) based on a misidentified specimen of *C. poeltii* (see specimen citation for details).

Taxa not included in this study

The following taxa were previously recorded in China. Among them, three species described by Jiang (1992), *C. fanjingshanense*, *C. fusiosporum* and *C. tetrasporum*, are doubtful because the original descriptions are short, not very informative, and not consistent with the type material. Specimens of the other taxa listed below were not available for study and the reports, therefore, could not be verified.

1. ***Collema beijingense*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 84 (1992).

Literature records for China: BEIJING, HEBEI (Jiang 1992, p. 84).

2. ***Collema callibotrys*** var. ***coccophyllizum*** (Zahlbr.) Degel.,
Symb. Bot. Upsal. 20(2): 68 (1974).

Literature records for China: YUNNAN (Hue 1898, p. 217; Zahlbruckner 1930, p. 76).

3. ***Collema callopismum*** A. Massal., Miscell. Lich.: 23 (1856).

Literature records for China: HEBEI (Jiang 1993, p. 70).

4. ***Collema ceraniscum*** Nyl., Flora 48: 353 (1865).

Literature records for China: BEIJING, HEBEI (Jiang 1993, p. 70).

5. ***Collema clavisporiferum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).
Literature records for China: YUNNAN (Jiang 1992, p. 85).

6. ***Collema fanjingshanense*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 86 (1992).
Literature records for China: GUIZHOU (Jiang 1992, p. 86).

7. ***Collema fusiosporum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).
Literature records for China: YUNNAN (Jiang 1992, p. 85).

8. ***Collema limosum*** (Ach.) Ach., Lichenogr. Univ.: 629 (1810).
Literature records for China: SHANGHAI (Nylander & Crombie 1883, p. 62; Degelius 1974, p. 52).

9. ***Collema peregrinum*** Degel., Symb. Bot. Upsal. 20(2): 109 (1974).
Literature records for China: TAIWAN (Degelius 1974, pp. 109–111; Ikoma 1983, p. 59).

10. ***Collema sorediatum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).
Literature records for China: ANHUI, GUANGXI, SICHUAN (Jiang 1992, p. 85).

11. ***Collema tenax*** var. ***ceranoides*** (Borrer) Degel.,
Symb. Bot. Upsal. 13(2): 162 (1954).
Literature records for China: HEBEI (Jiang 1993, p. 69)

12. ***Collema tetrasporum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 84 (1992).
Literature records for China: BEIJING (Jiang 1992, p. 84).

13. ***Collema thamnodes*** Tuck. ex Riddle, Bull. Torrey Bot. Club 43: 155 (1916).
Literature records for China: XINJIANG (Abbas & Wu 1998, p. 64).

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