

Miscellanea on *Rhodiola* (Crassulaceae)

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Recent collections of *Rhodiola* (Crassulaceae) were examined taxonomically. The collections from Qinghai Province, China are listed according to Ohba's infrageneric system. Notable specimens collected in various other parts of SW China are also reported.

Key words: Crassulaceae, Flora of China, herbarium specimens, *Rhodiola*, taxonomy.

Examination of specimens of *Rhodiola* (Crassulaceae) have continued after the preparation of my revisional works (Ohba 1980–1982, 2003). Among them are collections from Qinghai Province, W China. Qinghai Province, located on the northern part of the Tibetan Plateau, is regarded as a key area for the dispersal of species of *Rhodiola* and the related genus, *Pseudosedum*. Other specimens were collected in various parts of China and the Himalayan region.

I. A list of the specimens of *Rhodiola* collected from Qinghai Province

In Flora Qinghaiica, Pan (1999) recorded 12 species of *Rhodiola* from the province. Knowledge of the *Rhodiola* flora, however, was quite limited and insufficient. Two botanical research teams collected numerous specimens from various localities in Qinghai Province. One of the teams consisted of T. N. Ho, B. Bartholomew, M. Watson and M. Gilbert (E), and the other of D. E. Boufford, M. J. Donoghue, X. F. Lu and T. S. Ying (A). Those specimens are deposited in the Harvard University Herbaria (A), the California Academy of Sciences (CAS),

the Royal Botanic Garden, Edinburgh (E), the Northwest Plateau Institute of Biology (HNWP – most complete set), and also, partly, the Herbarium of the University of Tokyo (TI).

The species collected are listed according to Ohba's infrageneric system and species delimitation (2003).

Subgen. *Primuloides*

1) *Rhodiola humilis* (Hook. f. & Thomson) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 217 (2003).

Nangqên Xian: Bêca Xiang: below Gaersi monastery, SE of Bêcaca, 31°50'N, 76°29'E. Elev. 3900 m. Gentle slopes with degraded alpine meadow; steeper slopes with groves of *Juniperus*. On rocks under *Juniperus*. Mat forming perennial succulent. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2941, 7 Sept. 1996.

Subgen. *Crassipedes*

2) *Rhodiola tsuiana* S. H. Fu in Acta Phytotax. Sin. Addit. 1: 127 (1965); Pan in S.-W. Liu, Fl. Qinghai. 2: 4 (1999).

Nangqên Xian: Just W of Jiangxi Forest Station on W side of the Zi Qu, SE of Mozhong. 32°05' N, 97°01' E. Elev. 3600 m. Valley with *Picea likiangensis* forest, lower slopes with *Juniperus* and *Berberis*. Growing on rock outcrop in fissures. T. N. Ho, B. Bartholomew, M. Watson

& M. G. Gilbert 2438, 27 Aug. 1996.

3) **Rhodiola dumulosa** (Franch.) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 215 (2003): Pan in S.-W. Liu, Fl. Qinghai. 2: 7 (1999).

Huzhu Tu Aut. Co., Upper Zhalongzsaou valley, near Nanzhangzhagon village, 36°46' N, 102°32' E. Elev. 2735 m. Dry limestone rocks by stream. D. G. Long, C. Brickell, R. J. D. Mc Beath, E. J. Strangman, R. Steele, X. F. Lu, D. S. Deng & S. R. Zhang (Sino-British Qinghai Exp. 1997) 1203, 24 July 1997.

Yushu Xian: Xiao Surmang Xiang: between Jêrikug and the Xizang border, 32°06' N, 97°16' E. Elev. 3550–3650 m. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2286, 24 Aug. 1996; loc. sit., 32°07' N, 97°16' E, T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2340, 24 Aug. 1996; Jiangxi Gou, E of Jiangzi Forest Station on E side of Zi Qu, SE of Mozhong, 32°05' N, 97°04' E. Elev. 3640 m. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2691, 29 Aug. 1996.

Nangqên Xian: Larong Gou on E side of the Zi Qu, N of Jiangzi Forest Station and SE of Mozhong, 32°09' N, 97°03' E. Elev. 3450 m. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2599, 29 Aug. 1996.

Rhodiola dumulosa is one of the representative species with a wide range of distribution extending from the E Himalaya (Bhutan) and Burma northeastward to Shanxi, Gansu and Mongolia. In Qinghai it appears to occur from the south part near the Sichuan border to the east-central part near the Gansu border.

Subgen. **Rhodiola** sect. **Rhodiola**

4) **Rhodiola crenulata** (Hook. f. & Thomson) H. Ohba: Ohba in Ill. Handb. Succ. Crassula., 214 (2003).

Rhodiola rotundata (Hemsl.) S. H. Fu: Pan in S.-W. Liu, Fl. Qinghai. 2: 9 (1999).

Dari (Darlag) Xian: Saiergeng, Jimai (Gyūmai) Xiang, along the Dari He (Dar Qu) on S side of the Huang He. 33°21' 23" N, 99°33' 43" E. Elev. 4200–4600 m. Valley sides with dense turfs and areas of large rounded boulders. Among boulders. T. N. Ho, B. Bartholomew & M. G. Gilbert 1215, 14 Aug. 1993 (female).

Rhodiola crenulata is dominant on boulders close to glaciers, and is characterized by the fastigiate, smooth flowering stems ca. 6 mm thick, with numerous blackish dead stems remaining, and reddish petals.

5) **Rhodiola kirilowii** (Regel) Maxim.: H.

Ohba in Ill. Handb. Succ. Crassula., 219 (2003): Pan in S.-W. Liu, Fl. Qinghai. 2: 7 (1999).

Gande (Gadê) Xian: near Shangongma Xiang, Gande (Gadê) Shan, on road from Dari (Darlag) to Gande (Gadê). 33°53' 45" N, 99°40' 50" E. Elev. 4150 m. Flat bottomed valley with moist alpine meadows on bottom, slopes with rocky outcrops and thick turf, quite a lot of disturbance. On slopes, best developed in area of soft soil. T. N. Ho, B. Bartholomew & M. G. Gilbert 946, 9 Aug. 1993 (female & male<died>).

Tongde Xian: Longmuier Xiuma, between Jungong (Gyumgo) and Hebei on N side of the Huang He. 34°43' 31" N, 100°43' 10" E. Elev. 3650 m. Mosaic of Juniper woodland on rockier areas and sloping alpine meadows with many seepage areas. Under juniper on rock cliffs. T. N. Ho, B. Bartholomew & M. G. Gilbert 193, 22 July 1993 (male).

Maqin (Maqên) Xian: Talalong, Heitu Shan, between Jungong (Gyumgo) and Maqin (Maqên) on S side of the Huang He. 34°39' 30" N, 100°37' 37" E. Elev. 3350–3450 m. Open *Picea crassifolia* woodland on steep slope, ground cover close turf, *Polygonum viviparum* common. T. N. Ho, B. Bartholomew & M. G. Gilbert 223, 23 July 1993 (female); Talalong, Heitu Shan, between Jungong (Gyumgo) and Maqin (Maqên) on S side of the Huang He. 34°39' 30" N, 100°37' 37" E. Elev. 3350–3450 m. Open *Picea crassifolia* woodland on steep slope, ground cover close turf, *Polygonum viviparum* common. T. N. Ho, B. Bartholomew & M. G. Gilbert 200, 23 July 1993 (male); Xihalong Guo, between Jungong (Gyumgo) and Maqin (Maqên) on S side of the Huang He. 34°38' 56" N, 100°36' 38" E. Elev. 3500–3600 m. Rocky cliff at edge of alpine meadow. *Picea* forest on N & E slopes, *Juniperus* forest on W facing slopes, alpine meadow along valley between and at top of altitude range covered. T. N. Ho, B. Bartholomew & M. G. Gilbert 272, 23 July 1993 (male); Dawu Xiang, along the Deleni He, S Maqin (Maqên). 34°22' 6" N, 100°13' 18" E. Elev. 3870 m. Under rock outcrop. Succulent perennial herb; leaves flat, barely succulent; inflorescence yellowish. Narrow gorge, bottom and parts of steep sides with alpine meadow/scrub, sides partly rock outcrops. T. N. Ho, B. Bartholomew & M. G. Gilbert 867, 6 August 1993 (male).

Nangqên Xian: Xiaolong Gou, W of Nangqên on road to Domba. 32°17' N, 96°16' E. Elev. 4000–4100m. Narrow limestone gorge with river at bottom. Shrub covered rocky slopes, limestone cliffs, and damp spring- or stream-fed areas. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2815, 3 Sept. 1996 (female); Ca. 15–20 km E of the town of Nangqên along the Zaqu River in Shixia Gou: 32°17' 59" N; 96°32' 29" E. Elev. 3700–3800 m. On cliff in moss. Flowers greenish brown. D. E. Boufford, M. J. Donoghue, X. F. Lu & T. S. Ying 26618, 21 June 1995 (male).

Yushu Xian: Jiangxi Gou, E of Jiangxi Forest Station on E side of the Zi Qu, SE of Mozhong. 32°05' N, 97°04' E. Elev. 3640 m. Succulent perennial herb; annual stems unbranched, to 35 cm; in fruit. Growing under *Picea*. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2690, 29 August 1996. (female); S of the road between Yushu and Gyairong and ca. 1/4 of the way between the two towns. 33°03' N, 96°51' E. Elev. 3850–3950m. Valley: one side with areas of very closely cropped *Kobresia* meadow and mostly low bushland with *Salix*, *Sibiraea*, and some *Rhododendron*, densest along side valley with dry stream bed; the other side with more open bushland and areas of consolidated scree. Growing in consolidated scree. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2107, 19 August 1996 (female); Yushu Xian: South of the city of Yushu on the road to Nangqen at Shang-Baitang: 32°55' 04" N, 97°02' 23" E. Elev. 3690–3750 m. Overgrazed meadow and rocky slope. Exposed rocky slope around shrubs. D. E. Boufford, X. F. Lu & T. S. Ying 26755, 29 June 1995 (male and female).

6) **Rhodiola tangutica** (Maxim.) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 226 (2003).

Rhodiola algida (Ledeb.) Fisch. & C. A. Mey. var. *tangutica* (Maxim.) S. H. Fu: Pan in S.-W. Liu, Fl. Qinghai. 2: 9 (1999).

Maqin (Maqên) Xian: Caigongka, Xueshan Xiang, W of Maqin (Maqên). 34°38' N, 99°44' E. Elev. 4300–4600 m. Alpine meadow through to scree. T. N. Ho, B. Bartholomew & M. G. Gilbert 453, 28 July 1993 (female/fruit).

Dari (Darlag) Xian: Mobadong Shan, Deang (Dêrnang) Xiang between Dari (Darlag) and Banma (Baima). 33°22' 37" N, 100°17' 24" E. Elev. 4400–4700 m. Steep slopes with mostly *Kobresia* meadows, some lower slopes with *Potentilla* scrub on soft black soil, peak with loose open scree slopes of sand and small stones. On steep open slope. T. N. Ho, B. Bartholomew & M. G. Gilbert 1262, 15 August 1993 (male).

Maduo (Madoi) Xian: Huoluogugai, Qingshui Xiang, between Dari (Darlag) and Huashixia. 34° 49' 22" N, 99°2' 34" E. Elev. 4600–4730 m. Base of slope with pool and hummock *Kobresia* bog, upper parts with loose and semiconsolidated scree, rest with areas of frost-heave and level *Kobresia* turf. In soil pockets among rocks. Succulent herb; forming small tufts only. T. N. Ho, B. Bartholomew & M. G. Gilbert 1360, 17 August 1993 (fruit); Xian: Doucuo, Heihai Xiang, between Wenquan and Huashixia. 35°21' 21" N, 99°08' 2" E. Elev. 4190 m. Flat steppe vegetation with scattered tussock grasses, probably slightly saline. In bare place in *Stipa purpurea* steppe. T. N. Ho, B. Bartholomew & M. G. Gilbert 1434, 19 August

1993 (fruit).

Xinghai Xian: Wenquan Xiang, along the Qulong He, just NE of Wenquan on the road to Daheba. 35°25' 15" N, 99°28' 1" E. Elev. 4010 m. River terrace, mostly with almost close turf. Growing along stream. T. N. Ho, B. Bartholomew & M. G. Gilbert 1400, 18 August 1993 (fruit).

Chindu Xian: Qingshuihe Xiang: W of road between Madoi and Yushu on road to Zadoi; just S of Qingshuihe. 33°45' N, 97°07' E. Elev. 4300 m. Rolling hills: slopes with vertical stripes of loose scree, frost-heave areas poor in grasses and sedges but abundant *Delphinium* and *Aconitum*, and dense *Kobresia* turf; lowermost slopes and valley bottoms with turf forming hummocks with *Pedicularis* in wetter areas; stony stream beds with *Rhodiola* prominent. Tussock forming perennial to 30 cm across. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 1595, 11 Aug. 1996 (female); Qingshuihe Xiang: W of road between Madoi and Yushu on road to Zadoi just S of Qingshuihe. 33°45' N, 97°03' E. Elev. 4350 m. South facing rocky slope with *Kobresia* meadow. Tussock forming perennial to 30 cm across. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 1658, 11 Aug. 1996 (female); Xiwu Xiang, road between Xiwu and the Sichuan border ca. 26 km E from Yushu-Xining highway (highway 214). 33°10' 13" N, 97°32' 33" E. Elev. 4470 m. Overgrazed meadow on slope and along stream. Moist, grassy area along stream. D. E. Boufford, Lu & Ying 26923, 2 July 1995 (young female).

Rhodiola tangutica is dioecious. In the female flowers (without the remains of stamens) the ovaries are opposite the petals. The petals are longer than the sepals, erect, oblong-lanceolate with rounded apex, membranaceous, white, often tinged purplish red along the midvein or upper part or margin. When mature the length of the petals decreases, probably because of desiccation. The narrowly triangular or triangular-lanceolate sepals are 2/3 to 1/2 the length of the petals.

The creeping rhizomes have scale-like leaves and numerous branches. The branches, if close enough to each other, resemble a massive rhizome and hold a considerable amount of soil. The rhizomes become thick and cylindrical after three years (1.5 cm thick in Ho & al. 1434). *Rhodiola tangutica* often forms a gregarious community by branching of the rhizomes.

The flowering stems are fastigiate, with the leaves rather dense and sometimes bent. Sterile shoots without inflorescences are a characteristic of *R. tangutica*. The leaves are nearly equal

from base to apex, linear-lanceolate and with a rounded apex. The peduncles are only slightly elongate, and usually with 2 or 3(-5) flowers on pedicels less than 8 mm long, so that the inflorescences are compact.

Ovaries are completely lacking in male flowers. The sepals, petals and stamens are all erect, so that a single flower appears tubular. The stamens are apparently longer than the petals, pale purplish red; the anthers are globose, ca. 0.5 mm long, and reddish purple before dehiscence. The petals are 1/2 to 2/3 the length of the stamens, usually pale reddish purple, the shape and size almost the same as in female flowers. The sepals are basally to form a calyx tube. The border between calyx and pedicels is indistinct, with the calyx tube tapering gradually at the base.

I saw *Rhodiola tangutica* around lakes in the interior regions of Roqiang in the Kunlun Mountains. At that time I saw the plants with flowers (actually ovaries), and leaves of the flowering stems changed to deep purplish (blackish) red, growing gregariously on gentle rocky slopes, especially by streams. The habitat notes on the collection labels of specimens from Qinghai well describe the site and situation.

Subgen. *Rhodiola* sect. *Chamaerhodiola*

7) ***Rhodiola himalensis*** (D. Don) S. H. Fu subsp. ***taohoensis*** (S. H. Fu) H. Ohba in J. Fac. Sci. Univ. Tokyo, sect. III, **13**: 140 (1982); K. T. Fu & H. Ohba in Z. Y. Wu & P. Raven, Fl. Chin. **8**: 260 (2001); H. Ohba in Ill. Handb. Succ. Crassula., 217 (2003).

Rhodiola taohoensis S. H. Fu in Acta Phytotax. Sin. Addit. **1**: 121 (1965); in Fl. Reipubl. Popularis Sin. **34**(1):192 (1984); in Fl. Xizang. **2**: 421 (1985); Pan in S.-W. Liu, Fl. Qinghai. **2**: 9 (1999).

Maqin (Magen) Xian: Xueshan Xiang, along the Dongke He, W of Maqin (Magen). On exposed rocks. Clump of fleshy stems to 15 cm long with persistent remains of old branches; fruit yellow flushed red. Along low basement complex rock outcrop, very sparsely vegetated. Elev. 3725 m, 34°34'34"N, 99°53'42"E. T. N.

Ho, B. Bartholomew & M. G. Gilbert 43828, July 1993; Ehem, Dawu Xiang, along the Gequ He, S of Maqin (Magen) on the road to Gande (Gade). On rocks in flat-bottomed valley; bottom with dwarf bushland/chart turf mosaic, extensively disturbed; slopes with dwarf bushland/alpine meadow. Elev. 3900 m. 34°20'43"N, 100°15'18"E. T. N. Ho, B. Bartholomew and M. G. Gilbert 577, 30 July 1993.

Dari (Darlag) Xian: Huleanma, Jiansha Xiang, S. side of the Huang He and SW of confluence with the Dari He (Dar Qu). In rock crevices. Slopes with Kobresia meadow and rock out crops; some areas with deep sandy soil and more open vegetation. Elev. 4040 m. 33°43'40"N, 99°21'1"E. T. N. Ho, B. Bartholomew & M. G. Gilbert 1112, 11 Aug. 1993 (female).

The type of subsp. *taohoensis* was collected by the Taoho Expedition team along Tao River in Gansu Province (collection number 3340, PE). Subspecies *taohoensis* represents an isolated population in the northeasternmost area of the range of *R. himalensis*. It differs from subsp. *himalensis* in having brownish (not purplish red) flowering stems. The linear lanceolate leaves with nearly entire margins resemble those of subsp. *himalensis*. The range extension of subsp. *taohoensis* to Qinghai Province is phytogeographically remarkable.

8) ***Rhodiola tibetica*** (Hook. f. & Thomson) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 226 (2003).

Chindu Xian: just S of Chumda, along E side of the Tongtian He (upper Chang Jiang). 33°00' N, 97°15' E. Elev. 3440 m. Steep sided valley, bottom filled by alluvial fan, mostly colonized by *Elsholtzia frutescens*, slopes of metamorphic rock with *Caragana*, *Cotoneaster*, *Caryopteris* etc., *Artemisia* species common throughout. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 1814, 15 Aug. 1996 (female).

Maqin (Maqên) Xian: Ehem, Dawu Xiang, along the Gequ He, S of Maqin (Maqên) on the road to Gande (Gadê). 34°20' 43" N, 100°15' 18" E. Elev. 3900 m. Flat-bottomed valley; bottom with dwarf bushland/short turf mosaic, extensively disturbed; slopes with dwarf bushland/alpine meadow. On rocks. T. N. Ho, B. Bartholomew & M. G. Gilbert 577, 30 July 1993; Xueshan Xiang, along the Dongke He, W of Maqin (Maqên). 34°34' 34" N, 99°53' 42" E. Elev. 3725 m. Side of valley with steep slope, mostly dry with large tussock grasses and bare soil, shallower slopes with alpine meadow, areas of deeper soil with shrubs, shallow soils, mainly on slope. T. N. Ho, B.

Bartholomew & M. G. Gilbert 613, 31 July 1993.

Rhodiola tibetica differs from *R. himalensis* in the smooth flowering stems, the smaller fruits, the relatively small female flowers with conspicuous leafy bracts, and the linear leaves. Ho & al. 577 and 613 were identified as *Rhodiola taohoensis* by the collectors, but the plants lack papillae on the flowering stems. Ho & al. 613 approaches *R. himalensis* in having narrowly oblong-lanceolate leaves with a truncate or very slightly amplexical base and obtuse apex, flowering stems shaded purplish red, and compact inflorescences. The flowering stems, however, are smooth and without papillae.

9) ***Rhodiola coccinea*** (Royle) Boriss.: H. Ohba in Ill. Handb. Succ. Crassula., 213 (2003).

Yushu Xian: WNW of Yushu at the pass about half way between Yushu and Gyairong. 33°08' N, 96°43' E. Elev. 4700 m. High pass with scree slopes. T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2054, 19 Aug. 1996 (female).

Nangqen Xian: Zherebuma Pass; 31°55' 38" N, 96°27' 35" E. Elev. 4500 m. Alpine meadow vegetation heavily grazed by yaks, with sparsely distributed shrubs of *Salix*, *Rhododendron* and *Caragana*. Stony slope at 4800 m. D. E. Boufford, M. J. Donoghue, X. F. Lu & T. S. Ying 270980, 24 June 1995 (female).

Maduo (Madoi) Xian: Huoluoguoqai, Qingshui Xiang, between Dari (Darlak) and Huashixia. 34°49' 22" N, 99°02' 34" E. Elev. 4600–4730 m. Base of slope with pool and hummock *Kobresia* bog, upper parts with loose and semiconsolidated scree, rest with areas of frost-heave and level *Kobresia* turf. In rock crevices. T. N. Ho, B. Bartholomew & M. G. Gilbert 1364, 17 August 1993 (female).

Dari (Darlak) Xian: Mobadong Shan, Deang (Dêrnang) Xiang between Dari (Darlak) and Banma (Baima). 33°22' 37" N, 100°17' 24" E. Elev. 4400–4700 m. Steep slopes with mostly *Kobresia* meadows, some lower slopes with *Potentilla* scrub on soft black soil, peak with loose open scree slopes of sand and small stones. On rocks at peak. T. N. Ho, B. Bartholomew & M. G. Gilbert 1276, 15 August 1993 (female).

All above cited collections represent a single form of the *Rhodiola quadrifida* complex, which is characterized by numerous thick softy woody rhizome branches with persistent remains of dead leaves. The leaves are bright green and

subterete, and the young fruits are reddish. The fruits almost always with 5 (not 4) carpels is one of the differences distinguishing it from typical *R. coccinea*.

10) ***Rhodiola quadrifida*** (Pallas) Fisch. & C. A. Mey.: H. Ohba in Ill. Handb. Succ. Crassula., 222 (2003): Pan in S.-W. Liu, Fl. Qinghai. 2: 11 (1999).

Maqin (Maqên) Xian: Nizhuoma Pass, Nizhuoma Xiang, between Maqin (Maqên) and Changmahe (Qamalung). 34°34' 51" N, 99°27' 3" E. Elev. 4780–4900 m. Alpine meadow and rocky slopes in the vicinity of the pass. In rocky stream bed. T. N. Ho, B. Bartholomew & M. G. Gilbert 759, 4 August 1993.

Nangqen Xian: Zherebuma Pass; 31°55' 38" N, 96°27' 35" E. Elev. 4800 m. Alpine meadow vegetation heavily grazed by yaks, with sparsely distributed shrubs of *Salix*, *Rhododendron nivale* and *Caragana*. Cushion plant with deep tap root. D. E. Boufford, M. J. Donoghue, X. F. Lu & T. S. Ying 26708, 24 June 1995 (female).

The collections resemble the holo- and isotypes of *Rhodiola kashgarica* Boriss., and probably *R. kashgarica* represents a form of *R. quadrifida* complex distributed in an area extending from the NE side of the Karakorum Mountains to the NE part of the Tibetan Plateau through the Kunlun and Tanghra Mountains.

II. Additional specimens of *Rhodiola* from China

During my stay the Harvard University Herbaria I examined numerous specimens of *Rhodiola*, including the unidentified ones. The Harvard Herbaria have rich collections from Sichuan and Yunnan, and is a center for research on the species diversity in *Rhodiola* in China. The following list consists mainly of recent collections, mostly from Sichuan and Yunnan, and includes some old collections. Except for *Rhodiola tsuiana*, all specimens are deposited in the Harvard University Herbaria (A/GH).

1) ***Rhodiola chrysanthemifolia*** (H. Lév.) S. H. Fu subsp. **sacra** (Raym.-Ham.) H. Ohba: H. Ohba in Ill. Handb. Succ. Crassula., 213 (2003).

Sichuan: Xiangcheng Xian: Maxiong Gou (29°7' 26''

E, 99°59' 48'' N). Elev. 4000–4300 m. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28462, 9 July, 1998. Xiangcheng Xian: Xiarewu on road between Xiangcheng and Daxue Shan (28°46' 2'' E, 99°52' 12'' N). Elev. 2920 m. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29049, 22 July, 1998; Xiangcheng Xian: Reda: Vicinity of the town of Reda (29°06' 11'' E, 99°37' 55'' N). Elev. 3450–3650 m. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28802, 16 July, 1998.

2) **Rhodiola tsuiana** S. H. Fu in Acta Phytotax. Sin. Addit. 1: 127 (1965).

Xizang (Tibet): Lhazê Xian, Jia Tsuo La (Gyatso La). 29°00' N, 87°29' E. Elev. 4610 m. Rocky slopes by stream. S. Akiyama, H. Ikeda & S. K. Wu 106490, 14 Aug. 2001 (TI); Nagarzê Xian, around Yamzho Yumco (Yamdok Tso). Elev. 4300 m. On rocks. S. Akiyama, H. Ikeda & S. K. Wu 106439, 9 Aug. 2001 (TI).

Rhodiola tsuiana was described from a single specimen collected by Y. W. Tsui at Jo-ya, Changdu in Tibet in 1951. Fu (1965) considered it to have affinities with *R. chrysanthemifolia* subsp. *sacra* and distinguished it by its papillate nature. Later, Fu (1980) treated it as a variety of *R. sacra*. *Rhodiola tsuiana* belongs to the *Rhodiola chrysanthemifolia* complex. The classification is not yet sufficient. The relations and range of variation of the taxa are still not well understood. *Rhodiola tsuiana* resembles *R. alterna* S. H. Fu collected from NE Tibet (Xizang). The type resembles *Rhodiola nepalica* (H. Ohba) H. Ohba from C Nepal and shares the papillate nature of the flowering stems, but differs in the ovate to widely ovate leaves with rather fine serrations.

3) **Rhodiola kirilowii** (Regel) Regel & Maxim.: H. Ohba in Ill. Handb. Succ. Crassula.: 219 (2003).

Sichuan: Xiangcheng Xian: Reda Lincha upstream on Mayi River from the town of Reda. 29°08' 31'' E, 99°38' 59'' N. Elev. 3450–3500 m. Cut over forests, overgrazed meadows and rock ledges with remnant patches of *Quercus*, *Salix* and mixed conifers along Mayi River. On steep rock face. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28820, 17 July, 1998; Daocheng Xian: Between Sandui and Litang, SW of Haizi Shan. 29°16' 16'' E, 100°04' 56'' N. Elev. 3980 m. River terraces and wet meadows with shrubs

of *Salix*, *Ribes*, *Potentilla*, with juvenile *Picea* and *Larix*. Meadow on river terrace; growing among boulders. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28092, 1 July 1998 (male).

Xinjiang Uygur Zizhiqu: Upper northeastern slope of Tian Shan in Urumqi River gorge, approx. 75 km (air) southeast of Urumqi, 8 km southwest of main Glacier Research Station. Small canyon with *Picea schrenkiana*, *Caragana jubata*, *Betula*, *Salix*, *Sorbus*, *Lonicera*, etc. 43°14' N, 87°05' E. Elev. 2400–2600 m. Aaron Liston 8181–53.

4) **Rhodiola himalensis** (D. Don) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 216 (2003).

Sichuan: Daocheng Xian: Between Xiangcheng and Sandui; pass at summit of Wuming Shan. 29°08' 2'' E, 100°2' 33'' N. Elev. 4600–4700 m. Disturbed, shrub-grassland (with *Salix*, *Spiraea*, *Lonicera*) heavily grazed by livestock. In rocks and among shrubs of *Rhododendron*. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28174, 2 July, 1998 (young female).

5) **Rhodiola humilis** (Hook. f. & Thomson) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 217 (2003).

Sichuan: Daocheng Xian: SW side of Haizi Shan between Sandui and Litang. 29°23' 9'' E, 100°08' 58'' N. Elev. 4500–4600 m. Boulder stream previously glaciated area adjacent to remnant glacial lake. Grassy places. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28015, 1 July 1998 (male).

6) **Rhodiola crenulata** (Hook. f. & Thomson) H. Ohba: H. Ohba in Ill. Handb. Succ. Crassula., 214 (2003).

Sichuan: Xiangcheng Xian: Crest of ridge along summit of Wuming Shan (dividing line Daocheng and Xiangcheng Xian). 29°08' 46'' E, 100°02' 18'' N. Elev. 4700 m. Alpine meadows, dwarf *Rhododendron* scrub and rock fields. Rocks field. Shrubs 0.5–1.3 m in diam. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28666, 12 July 1998 (female); Xiangcheng Xian: Crest of ridge along summit of Wuming Shan (dividing line between Daocheng and Xiangcheng Xian). 29°08' 46'' E, 100°02' 18'' N. Elev. 4700 m. Alpine meadows, dwarf *Rhododendron* scrub and rock fields. Rocks field. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28665, 12 July 1998 (female); Xiangcheng Xian: Sichuan-Yunnan border area. North side of Daxue Shan between Zhongdian and Xiangcheng. 28°35' 38'' E, 99°50' 49'' N. Elev. 4100–

4300 m. Mixed *Abies-Larix-Picea-Juniperus* forest with large *Rhododendron* and open talus slopes and meadows. Scree slope. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29238, 26 July 1998 (female).

7) ***Rhodiola macrocarpa*** (Praeger) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 220 (2003).

Yunnan: Zhongdian Xian, Dongwang: Sichuan-Yunnan border area. Village of Dongwang on N side of pass over Daxue Shan. 28°37' 8" E, 99°49' 17" N. Elev. 3700–3800 m. Cut over mixed conifer-*Quercus* forest and adjacent open, grazed meadows along Donwang river. Along stream at waters edge. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29296, 26 July 1998 (female).

8) ***Rhodiola nobilis*** (Franch.) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 221 (2003).

Sichuan: Xiangcheng Xian: Maxiong Gou. 29°07' 26" E, 99°59' 48" N. Elev. 4000–4300 m. *Quercus* forest and mixed conifers along streams on slopes. Rocky landslide area. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28466, 9 July 1998. (female); Daocheng Xian: Bowa pass on road from Daocheng to Gongling. 28°53' 57" E, 100°17' 8" N. Elev. 4460–4650 m. Dwarf *Rhododendron* scrub, alpine meadows and gravelly slide areas. Cliff and in *Rhododendron* scrub and on scree slopes. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28274, 5 July 1998 (young female).

Yunnan: Zhongdian Xian: Sichuan-Yunnan border area. South side of Zhongdian Daxue Shan. 28° 34' 24" E, 99°48' 42" N. Elev. 4280–4600 m. Grazed meadows, *Rhododendron* thickets and limestone scree slopes. Among large boulders in *Rhododendron* shrubs. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29149, 25 July 1998 (female). Fruits red.

9) ***Rhodiola wallichiana*** (Hook.) S. H. Fu: H. Ohba in Ill. Handb. Succ. Crassula., 226 (2003).

Yunnan: Zhongdian Xian: Sichuan-Yunnan border area. South side of Zhongdian Daxue Shan. 28°34' 24" E, 99°48' 42" N. Elev. 4280–4600 m. Grazed meadows, *Rhododendron* thickets and limestone scree slopes. In *Rhododendron* thickets. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29171, 25 July 1998.

10) ***Rhodiola macrocarpa*** (Praeger) S. H.

Fu: H. Ohba in Ill. Handb. Succ. Crassula., 220 (2003).

Sikang (Sichuan): Bao-hsin (Moupin), T'u-pa-kou-Ta-chong-pun. Elev. 8800 ft. Common, succulent herb; stem red. S. Y. Hu 1302, July–Aug. 1939 (female).

Yunnan: Zhongdian Xian: Sichuan-Yunnan border area. South side of Zhongdian Daxue Shan. 28° 34' 24" E, 99°48' 42" N. Elev. 4280–4600 m. Grazed meadows, *Rhododendron* thickets and limestone scree slopes. In open beside *Rhododendron* thicket. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29170, 25 July, 1998 (male). Flowers creamy white. Growing near *Rhodiola* no. 29171.

11a) ***Rhodiola yunnanensis*** (Franch.) S. H. Fu subsp. **yunnanensis**: H. Ohba in Ill. Handb. Succ. Crassula., 227 (2003).

Yunnan: Dali Xian, E side of Diancang Shan mountain range. Vicinity of Yinglofeng, directly W of the city of Dali. Elev. 2550–2700 m. 25°42' N, 100°07' E. 1984 Sino-Amer. Bot. Exped. 991, 11 July 1984. (male and female); Yangbi Xian, W side of Diancang Shan mountain range. En route from Xueshanhe to Dapingzi. Elev. 2600–3000 m. 25°43' N, 100°02' E. 1984 Sino-Amer. Bot. Exped. no. 182, 17 June 1984. (male); Yunnan. Dali Xian, alpine meadow near the summit of Diancang Shan mountain range in the vicinity of Yinglofeng Peak, directly W of Dali city. Elev. ca. 3900 m. 25°42' N, 100°05' E. 1984 Sino-Amer. Bot. Exped. no. 1041, 11–12 July 1984 (male and female); Guizhou. Jiangkou Xian, vicinity of Jinding along the crest of the Fanjing Shan mountain range. Elev. 2000–2300 m. Growing at thicket margin in subalpine meadow. Sino-American Guizhou Botanical Expedition 638, 28–29 Aug. 1986 (female).

Sichuan: Omei-hsien: Mt. Omei. alt. 3000 m. Under forests, bush, 30 cm; occasionally. W. P. Fang 12968, 5 Aug. 1938 (female); Omei-hsien: Mt. Omei. W. P. Fang 8304, 6 Nov. 1946 (female); Win-chuan: Tsaopuh. Elev. 11700 ft. Common succulent with thick rhizome. S. Y. Hu 2686, Aug. 1942 (male); Win-chuan: Tsaopuh, 12000 ft. In tall-grass land; in tufts; common; rather succulent herb. S. Y. Hu 2677, Aug. 1942 (female); Bao-hsin (Moupin), Liang-ho-kow, 11900 ft. Erect succulent herb; on steep slope. S. Y. Hu 1352, Jul.–Aug. 1939 (male); Xiangcheng Xian: Village of Sanggong on E side of Shouqu River between Xiangcheng and Daocheng. 29°6' 29" E, 99°54' 28" N. Elev. 3040–3100 m. Moist, shrub covered stony slope in rich, dark soil. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 28543, 11 July 1998 (male).

11b) ***Rhodiola yunnanensis*** (Franch.) S. H. Fu subsp. **forrestii** (Raym.-Hamet) H. Ohba: H.

Ohba in Ill. Handb. Succ. Crassula., 227 (2003).

Yunnan: Zhongdian Xian, Dongwang: Sichuan-Yunnan border area. Village of Dongwang on N side of pass over Daxue Shan. 28°37' 8" E, 99°49' 17" N. Elev. 3700–3800 m. Cut over mixed conifer–*Quercus* forest and adjacent open, grazed meadows along Donwang river. Steep slope under large trees of *Quercus*. D. E. Boufford, B. Bartholomew, C. Y. Chen, M. J. Donoghue, R. H. Ree, H. Sun & S. K. Wu 29252, 26 July 1998 (female).

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Literature cited (otherwise cited in text)

- Ohba H. 1980–1982. A revision of the Asiatic species of *Sedoideae* (*Crassulaceae*) Part 1. J. Fac. Sci., Univ. Tokyo, Sect. III, **12**: 337–405 (1980); [Part 2] **13**: 65–119 (1981); [Part 3] 121–174 (1982).
- Ohba H. 2003. *Rhodiola*. In: Egli U. (ed.), Illustrated Handbook of Succulent Plants, *Crassulaceae*. pp. 210–227. Springer-Verlag, Berlin.
- Pan Jin-Tang 1999. *Rhodiola*. In: Liu S.-W. (ed.), Flora Qinghaiica **2**: 3–11. Qinghai People's Publishing House, Xining.

大場秀章：イワベンケイ属（ベンケイソウ科）分類雑集

イワベンケイ属（ベンケイソウ科）分類校訂を 1980～1982 年に発表し、2003 年刊の「多肉植物便覧・ベンケイソウ科」（Illustrated Handbook of Succulent Plants, *Crassulaceae*, U. Egli 編集）にその要約を書いた。これでイワベンケイ属の研究を終えるつもりだったが、その後多くの調査チームによって中国西南部の雲南・四川、チベット、青海を中心に同属の多数の標本が採集され、それらを検討する機会を与えられた。その結果、先に発表した校訂論文は、抜本的な改訂は迫られないものの、かなりの追加種や種間関係の見直し、分布範囲の修正等が必要となった。目下、これらの点に対応した新たな分類誌を準備中であるが、ここには 1) 最近青海省で採集されたイワベンケイ属種の一覧と 2) その他地域から採集された興味深い標本を列挙した。とくに青海省はこれまで採集されたイワベンケイ属の標本が少なく、その実体が不完全にしか理解されていなかっ

た地域だった。

1) と 2) で取り上げた *Rhodiola tsuiana* はこれまでタイプ以外の標本がなく、正しい理解がされていなかったが、今回新たに 3 地点で採集され、変異性も明らかになった。ネパールで記載した *Rhodiola nepalica* にも近縁であることが明らかになった。

Rhodiola kirilowii は青海省の複数地点で見出されたが、この種はイワベンケイ属中、イワベンケイ、ムラサキイワベンケイに次いで分布域が広範囲に及ぶことが明らかになった。

両性花をもつ *Crassipedes* 亜属の *Rhodiola algida* の変種として記載された *R. tangutica* は雌雄異株で前者とは異なり、イワベンケイ亜属に属する。青海省では多くの地点で採集されていることから同省内では広い範囲に分布すると考えられる。

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