

A REVISION OF THE EASTERN HIMALAYAN SPECIES
OF THE SUBGENUS RHODIOLA OF THE GENUS
SEDUM (CRASSULACEAE)

by

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The present study aims to provide a revision of the eastern Himalayan species of the subgenus *Rhodiola* of the genus *Sedum* (Crassulaceae). The area designated as eastern Himalaya in this paper extends from Nepal through Sikkim and southernmost Tibet (Chumbi Valley) to Bhutan. The subgenus *Rhodiola* is characterized mainly in having fleshy rhizomes bearing radical or scaly leaves and flowering stems arising from axils of radical or scaly leaves. *Rhodiola* includes about 50 species. Geographically the species of *Rhodiola* are distributed in the temperate and frigid regions of the northern hemisphere, but most of them concentrate in the alpine regions from the Himalayas to N. W. China and in the Central Asia.

Studies of the Himalayan *Rhodiola* were started by J. D. Hooker and Thomson when they published 'Conspectus' in *Praecursores ad Floram Indicam* in 1858, though prior to Hooker and Thomson some species were already described by D. Don, Royle, Edgeworth, etc. Hooker and Thomson treated *Rhodiola* as a section of the genus *Sedum* and recognized 18 species. Hooker and Thomson's treatment of *Rhodiola* was mostly followed by C. B. Clarke (1878) in Hooker's *Flora of British India*, vol. 2. Since then, there was a little attempt to revise the species of *Rhodiola* in the Himalayan region, e.g. R.-Hamet published critical reviews of *S. humile* (1925), the *S. linearifolium* group (1926) and *S. Hobsonii* (1926), and numerous new species were described by R.-Hamet and by Praeger. Praeger (1921) proposed a new concept on the infrageneric treatment of the genus *Sedum* based on its cultivated species. His treatment was mostly followed by Berger (1930) in the second edition of Engler and Prantl's *Die natürlichen Pflanzenfamilien*. Fröderström (1930-35) adopted a relatively broad concept of the genus *Sedum* in his monograph in which *Rhodiola* was recognized as a section and divided into four groups, i.e. *Primuloides*, *Chamae-Rhodiola*, *Eu-Rhodiola*, and *Trifida*, based mainly on the differences in vegetative features. In 1942, Fröderström revised the *Chamae-Rhodiola* group. In the present study, *Rhodiola*, treated as a subgenus, is divided into five sections, i.e. *Hobsonia*, *Primuloida*, *Smithia*, *Prainia* and *Rhodiola*. The section *Rhodiola* is subdivided into two subsections, *Chamae-rhodiola* and *Rhodiola*.

In eastern Himalaya, most of the species of the subgenus *Rhodiola* grow in the alpine zone and some of them ascend to more than 6000 m in altitude. *Rhodiola*

is the most conspicuous element and often dominates in alpine desert and windward grassland developed on windblown slopes, windswept mountain summits and ridges, boulder drifts, scree, etc. Some species such as *S. himalense*, associate with alpine dwarf-shrubs dominated by *Rhododendron Anthopogon*, *R. lepidotum* and *R. setosum*. To such alpine regions, *Rhodiola* is considered to be much favourable by means of its structure and functions as having well-developed rhizomes, succulent stem and leaves, and Crassulaceous acid metabolism.

The species of *Rhodiola* show so considerably wide ranges of variation, especially in vegetative structures, that the delimitation between species often becomes obscure. It appears to me that the strong variability is caused by inconstancy of the growth period in higher altitudes. On the contrary, morphological diversity among the species is inconspicuous, especially in floral organs. These factors suggest that the current differentiation of species in eastern Himalaya is a fairly recent evolutionary development, although isolation and speciation have not always led to morphological differentiation.

Among 21 species of *Rhodiola* known from this region, 12 are dioecious. All the species in the subsection *Chamaerhodiola*, which grow at higher altitudes even ascending to 6000 m, are dioecious, although one might expect that the bisexual species would grow at higher altitudes where insect pollination may be unreliable because of short flowering periods and unfavourable weather conditions. The bisexual species among *Rhodiola*, i.e. *Sedum linearifolium*, *S. ovatisepalum*, *S. nepalicum*, *S. sacrum*, *S. Wallichianum*, *S. Prainii*, *S. Smithii*, *S. humile* and *S. Hobsonii*, occur in rather arid regions or relatively low altitudes.

This revision is based mainly upon my field observations and studies of the specimens of the following herbaria: BM: British Museum (Natural History), London, Great Britain; BO: Herbarium Bogoriense, Lembaga Biologi Nasional, Bogor, Indonesia; CAL: Central National Herbarium, Botanical Survey of India, Calcutta, India; E: Royal Botanic Garden, Edinburgh, Great Britain; GB: Herbarium, Institute of Systematic Botany, University of Göteborg, Göteborg, Sweden; K: The Herbarium and Library, Royal Botanic Gardens, Kew, Great Britain; KATH: Department of Medicinal Plants, Ministry of Forests, Kathmandu, Nepal; KYO: Department of Botany, Faculty of Science, Kyoto University, Kyoto, Japan; LE: Herbarium of the Komarov Botanical Institute of the Academy of Sciences of the U.S.S.R., Leningrad, U.S.S.R.; P: Laboratoire de Phanérogamie, Muséum National d'Histoire Naturelle, Paris, France; TI: Department of Botany, Faculty of Science, University of Tokyo, Tokyo, Japan; TNS: The National Science Museum, Tokyo, Japan.

I am deeply indebted to Dr. Hiroyoshi Ohashi, Department of Botany, Faculty of Science, the University of Tokyo, who continuously gave me valuable advice. My sincere thanks are also due to Prof. Emeritus Hiroshi Hara, the University of Tokyo, for his encouragement throughout the course of my study. The courtesy of the curators of the herbaria mentioned above for allowing me examining specimens is also much appreciated. This study has been supported partly by Grants-in-Aid for Fundamental Scientific Research by the Ministry of Education of Japan in 1973.

Sedum L. subgen. **Rhodiola** (L.) H. Ohba, stat. nov.

Rhodiola L. [Gen. Pl. ed. 1, 318 (1737)], Sp. Pl. ed. 1, 1035 (1753)—Fischer et Meyer in A. Schrenk, Enum. Pl. Nov. **1**: 67 (1841)—A. Boriss. in Komarov, Fl. USSR **9**: 24 (1939)—Webb in Fl. Europ. **1**: 363 (1964), non Loureiro (1790).

Sedum L. sect. *Rhodiola* (L.) Scopoli, Fl. Carn. ed. 2, **1**: 326 (1771)—Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 95 (1858)—Maxim. in Bull. Acad. Sci. St. Pétersb. **29**: 124 (1883)—Praeger in Journ. Roy. Hort. Soc. **46**: 26 (1921)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 439 (1930), pro majore parte, excl. *S. sikokianum*, *S. Durisii*, et *S. tuberosum*—Fröd. in Act. Hort. Gothob. **5**: append. 16 (1930); **15**: 3 (1942).

Clemensia Rose in Bull. New York Bot. Gard. **3**: 3 (1903).

Chamaerhodiola (A. Schrenk) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 27 (1934).

Perennial herb. Rhizomes fleshy, massive or slender, bearing radical or scaly leaves, usually the apical part epigeous. Flowering stems arising from the axils of radical or scaly leaves, annual but in sect. *Rhodiola* the dead flowering stems often remaining, simple, foliiferous. Cauline leaves alternate, crassus, estipulate, simple, usually symmetric in shape. Inflorescences terminal, usually a compound or simple corymb or dichasium but rarely (*S. Hobsonii*) helicoid cyme or rarely reduced a single flower, mostly bracteate, pedunculate and pedicellate. Bracts leafy. Flowers actinomorphic, dioecious or hermaphrodite, when dioecious, in the male flowers the petals and nectar-scales opposite but in the female flowers petals and nectar-scales alternate; when hermaphrodite, petals and nectar-scales opposite. Calyx persistent, not spurred, deeply divided into (3–)4–5(–6)-lobes, green, crassus, usually stomatiferous. Petals mostly distinct, nearly symmetrical, as many as the calyx-lobes, white, reddish, purplish-red or yellow. Androecia 2 whorls, obdiplostemonous, usually twice as many as petals, the oppositipetalous stamens mostly epipetalous, the alternipetalous ones usually distinct, anthers ellipsoidal or ovoidal, 2-celled, dehiscent longitudinally, mostly basifixed but rarely (*S. Hobsonii*) dorsifixed, before dehiscent usually purplish red and after dehiscence becoming yellow. Nectar-scales usually linear to oblong or semicircular. Gynoecia superior, basally connate, usually as many as petals. Ovary uniloculed, unicarpelled, sessile, the style very short and slender, the stigma epapillate or minutely mamillate, the ovules many to a few, usually descending, 0.6–1 mm long, ellipsoidal, anatropous, the placenta nearly marginal. Fruit a follicle. Seed exalbuminous, less than 5 mm long.

Key to the sections and species.

1. Radical leaves developed, forming a lax rosette.
 2. Anthers dorsifixed. Inflorescence forming a helicoid cyme. Radical leaves deciduous. Scaly leaves dimorphic, the larger ones with a linear or oblong apical appendage (1–1.5 mm long 0.4–0.6 mm wide). Cauline leaves 2–4.5 mm wide, usually spatulate or narrowly obovate or trullate. Petals erect at anthesis [Sect. *Hobsonia*] *S. Hobsonii* (p. 289)
 2. Anthers basifixed. Flowers usually solitary or forming a small corymb. Radical leaves deciduous, but the petioles long persistent after death and

- rigescent, densely tufted. Scaly leaves not dimorphic, lacking any apical appendages. Cauline leaves 0.9–2.3 mm wide, linear-ovate or -elliptic. Petals ascending at anthesis [Sect. Primuloida] *S. humile* (p. 292)
1. Radical leaves not developed 3
 3. Scaly leaves distinctly heteromorphic, the larger ones with a linear or oblong apical appendage (the appendage 1.5–3 mm long 0.3–0.8 mm wide) [Sect. Smithia] *S. Smithii* (p. 296)
 3. Scaly leaves not dimorphic, lacking apical appendages 4
 4. Cauline leaves 4 to 6, nearly verticillate [Sect. Prainia] 5
 5. Flowers hermaphrodite. Inflorescence bracteate, forming a corymb or a corymbosely compound-dichasium, 13–18-flowered, peduncles and pedicels 1.3–2.5 mm long. Cauline leaves usually 4, the petiole 1–3 cm long, the lamina 2–6 cm long 2.5–4 cm wide *S. Prainii* (p. 299)
 5. Flowers dioecious. Inflorescence ebracteate, forming a small but long pedicellate, simple or monochasial corymb, (1–)3–6-flowered, peduncles about 5 mm long, pedicels 10–13 mm long. Cauline leaves 5 or 6, the petiole 0.2–0.35 cm long, the lamina 0.8–1.5 cm long 0.4–0.7 cm wide *S. Stapfii* (p. 301)
 4. Cauline leaves many, alternately arranged throughout or rarely aggregate [Sect. Rhodiola] 6
 6. Rhizome densely surrounded by tufts of the former years' old flowering stems. Annotious flowering stems 2–25 [Subsect. Chamaerhodiola] 7
 7. Cauline leaves linear to linear-elliptic or linear-ovate to linear-obovate or very narrowly ovate (SADT n. 36)¹⁾, 3–12 mm long 0.6–1.5 mm wide 8
 8. Plant usually less than 5 cm high. Annotious flowering stems 2–10 in number. Leaves 3–7 mm long 0.6–0.8 mm wide, linear to linear-elliptic. Flowers usually solitary but rarely forming a dichasium, mostly 4-merous but rarely 3- or 5-merous. Petals 2.5–3.5 mm long, 0.8–1.7 mm wide. Gynoecia of female plants 4–6 mm long, connate in the lower 1/4–2/5 part ventrally *S. quadrifidum* (p. 345)
 8. Plant usually 6–13 cm high. Annotious flowering stems (6–)8–15(–20) in number. Leaves 8–12 mm long 1.2–1.5 mm wide, linear-ovate or -obovate or very narrowly ovate. Flowers (4–)6–14(–17), forming a monochasium-fascicles, mostly 5-merous but occasionally 4-merous. Petals 3.5–6 mm long (1–)1.3–1.7 mm wide. Gynoecia 6–8 mm long, connected the lower 1/15–1/20 part ventrally *S. fastigiatum* (p. 350)
 7. Cauline leaves narrowly obovate (SADT n. 45–46) to narrowly

1) The SADT numbers correspond to the numbers of definitions and figures by Systematic Association Committee for Descriptive Biological Terminology in Taxon 11: 145–156, 245–247 (1962).

- elliptic or ovate, 5–20 mm long 2.2–7 mm wide 9
9. Cauline leaves narrowly obovate or narrowly elliptic, remotely crenulate-denticulate to nearly entire along the margin, sparsely to moderately papillate above, epapillate beneath (the papilla 0.05–0.15 mm long). Inflorescence 10–50-flowered. Calyx epapillate, (3–)4–5(–5.5) mm long *S. himalense* (p. 355)
9. Cauline leaves usually ovate, entire or very shallowly repandous along the margin, very densely papillate (the papilla 0.2–0.3(–0.4) mm long). Inflorescence (3–)5–6(–7)-flowered. Calyx moderately papillate outside (the papilla 0.2–0.3 mm long), 2.5–3.8 mm long *S. Bouvieri* (p. 360)
6. Rhizome usually lacking the remains of the former years' old flowering stem or if some former year's stems present, then not tufted. Annotinous flowering stems 1–15 [Subsect. *Rhodiola*] 10
10. Flowers hermaphrodite, the pistil opposite to the petal..... 11
11. Calyx-lobes 1.5–3.5 mm long. Gynoecia 5–10 mm long. Hypogaeous part of rhizome creeping and 2–10 mm across 12
12. Leaves aggregated on the upper 1/4–1/3 parts of the stem, ovate to oblong-obovate, more or less deeply imparilobulate or sinuate. Calyx-lobes 1.5–2.5 mm long. Petals very narrowly oblong-ovate *S. ovatisepalum* (p. 339)
12. Leaves alternately arranged throughout the stem. Calyx-lobes 2–3.3 or 3.5–5 mm long. Petals narrowly ovate to ovate or elliptic (in *S. linearifolium*) or narrowly obovate (in *S. sacrum*) 13
13. Leaves very narrowly obovate to linear-obovate, more or less deeply lobulate at the upper a third to nearly entire along the margin. Calyx-lobes 2–3.3 mm long. Petals narrowly ovate to ovate or elliptic, (6–)7–11(–12) mm long, 2–4 mm wide *S. linearifolium* (p. 333)
13. Leaves ovate to oblong-ovate or elliptic, crenulate-serrate or minutely lobulate along the margin. Calyx-lobes 3.5–5 mm long. Petals narrowly obovate, 5–7 mm long 1.2–2 mm wide *S. sacrum* (p. 342)
11. Calyx-lobes 4–8 mm long. Gynoecia 9–18 mm long. Hypogaeous part of rhizome erect to ascending and 6–10 mm across (in *S. nepalicum*) or 20–30 mm across, and the hypogaeous part creeping (in *S. Wallichianum*) 14
14. Leaves linear to very narrowly ovate (SADT n. 36) or very narrowly elliptic (SADT n. 1), remotely and irregularly crenulate, 1.2–3 cm long 0.12–0.6 cm wide. Rhizomes usually 2–3 cm across, the hypogaeous part creeping. Flowering stem usually epapillate but rarely papillate on the upper part. The papilla about 0.1 mm long *S. Wallichianum* (p. 313)

14. Leaves narrowly elliptic (SADT n. 2) or narrowly ovate (SADT n. 37), 5- or 7-lobulate or remotely crenulate-serrate, 1-4 cm long 0.6-1.5 cm wide. Rhizome 0.6-1 cm across, the hypogaeous part ascending or erect. Flowering stem always densely to moderately papillate. The papilla 0.2-0.3 mm long *S. nepalicum* (p. 318)
10. Flowers dioecious, in the female the pistils opposite to the calyx-lobes 15
15. Rhizome slender, usually 0.2-0.4 cm across, surculose. Flowering stem 0.7-1.1 mm thick. Leaves usually linear or very narrowly elliptic (SADT n. 1) or linear-obovate, (0.6-)0.7-1(-1.4) cm long 0.15-0.25(-0.28) cm wide ..
..... *S. Cretini* (p. 316)
15. Rhizome subcylindrical to long ovoidal, (excepting *S. discolor*) 1-3 cm across, not producing suckers. Flowering stem 1-9 mm thick. Leaves variable in shape, 0.3-0.9-9.5 cm long (0.2-)0.4-4.5 cm wide 16
16. Inflorescence mostly ebractate, exposed in the flowering time, the primary inflorescence-axis consisting of the connection of 2-7 pedicels and often a part of peduncles. Flowers sessile, usually coherent or often connate *S. heterodontum* (p. 304)
16. Inflorescence more or less to densely bracteate, involucrate or rarely exposed, the inflorescence-axis not connate. Flowers more or less sessile to long pedicellate 17
17. Leaves nearly opposite, (narrowly to normally) rhombic-ovate or narrowly elliptic. Inflorescence forming a lax compound-dichasium
..... *S. callianthum* (p. 331)
17. Leaves alternate, variable in shape excepting rhombic-ovate shape. Inflorescence forming a compound-corymb or simple corymb-fascicles 18
18. The ovaries straight and not conspicuously out-curved in the upper part. The former year's dead stems remaining in male as well as in female
..... 19
19. Leaves typically to broadly elliptic (SADT n. 4 or 5), 1-3.3 cm long 0.55-1.7 cm wide, usually minutely crenulate to erose but rarely nearly entire along the margin, round at the apex, indistinctly petiolate, the petioles 0.8-2 mm long. The remains of the dead flowering stems dark purplish-brown, often shining
..... *S. crenulatum* (p. 308)

19. Leaves very narrowly obovate (SADT n. 45) to narrowly elliptic (SADT n. 1—2) or ovate (SADT n. 38), 2–3 cm long 0.3–0.7 cm wide, nearly entire to remotely denticulate along the margin of the upper half, acute at the apex, sessile. The remains of the dead flowering stems stramineous *S. imbricatum* (p. 306)
18. The ovaries straight but abruptly and conspicuously outcurved in the upper part. The former year's dead flowering stems not persistent in male but rarely persistent in female 20
20. Rhizome slender, well branched, 0.7–1.4 cm across, ascending or creeping. Petals 5–6 (♂) or 3–4 (♀) mm long, 1.7–2 (♂) or 0.9–1.2 (♂) mm wide. Leaves more or less to conspicuously glaucous beneath
. *S. discolor* (p. 327)
20. Rhizome usually obconical or massive, sparsely branched in well developed state, 1–3 cm across, ascending or erect. Petals 2.8–4 (♂) or 1.5–3 (♀) mm long, 1.2–1.6 (♂) or 0.5–0.7 (♀) mm wide. Leaves hardly glaucous *S. bupleuroides* (p. 320)

Sect. **Hobsonia** H. Ohba, sect. nov.

Sect. *Rhodiola* ser. *Primuloides* Praeger group 2. *Brevicaules* Praeger in Journ. Roy. Hort. Soc. **46**: 27 (1921).

Sect. *Rhodiola* subsect. *Primuloidea* (Praeg.) Berger § 5. *Brevicaulia* (Praeg.) Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 443 (1930), nonnisi *S. Hobsonii*, excl. cet. sp. cit.

Sect. *Rhodiola* group 1. *Primuloides* Fröd. in Act. Hort. Gothob. **5**: append. 21 (1930), nonnisi *S. Hobsonii*, excl. cet. sp. cit.

Anthera dorsifixa, loculis duobus ad filamentum parallelis, per anthesin loculorum scissuris ventralibus per totam longitudinem loculi dehiscentibus. Flores in drepanio terminali dispositi. Squamae dimorphae, eae majores apice accessione lineari vel oblonga.

Type species: *Sedum Hobsonii* Prain ex R.-Hamet.

This section is represented by the single species and is markedly characterized by the dorsifixed anther, helicoid cyme and dimorphic scaly leaves. In general appearance, the section is similar to sect. *Primuloides*, but is very unique in the anther and inflorescence. The dorsifixed anther is an intermediate form between versatile and basifixed.

Sedum Hobsonii Prain ex R.-Hamet in Kew Bull. **1913**: 154 (1913) et in Act. Hort. Gothob. **2**: 330 (1926)—Fröd. in Act. Hort. Gothob. **5**: append. 23 (1930)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 443 (1930). [Fig. 35]

Sedum Praegerianum W. W. Smith in Not. Bot. Gard. Edinb. **8**: 348 (1915)—Praeger in Trans. Bot. Soc. Edinb. **27**: 107 (1917); in Journ. Roy. Hort. Soc. **46**: 69 (1921); in Not. Bot. Gard. Edinb. **13**: 91 (1921).

Rhodiola Hobsonii (Prain ex R.-Hamet) Fu in Act. Phytotax. Sin. Addit. **1**: 118 (1965).

Sedum mirabile H. Ohba in Journ. Jap. Bot. **49**: 257, fig. 1 (1974).

A perennial herb, usually 7–12 cm high. Roots dauciformed or tuber, usually 6–8 mm across, fleshy, usually 10–20 cm long. Rhizomes thick, usually 10–15 mm across, 1–5 cm long, erect, more or less epigaeous, fleshy, usually simple but when well developed branched, glabrous, the base tapering to the root, the apical part armed by dense scaly and radical leaves. Scaly leaves very densely arranged, chartaceous, more or less persistent; the outer ones rigidulous, usually broadly triangular-ovate or triangular-semicircular, attenuate at the apex, entire along the margin, usually 3–6 mm long 4–5 mm wide, round outside, usually chestnut- or lightbrown; the inner ones usually triangular-ovate or triangular-oblong with linear or oblong appendage at the apex, usually 2.5–5 mm long (excluding the apical appendage), 2–4 mm wide, entire along the margin, chestnut or bright-brown, round outside, the apical appendage 1–1.5 mm long 0.4–0.6 mm wide, round at the apex, more or less fleshy. Radical leaves green, fleshy, flattish, more or less long to shortly petiolate, deciduous, the petiole 7–10 mm long, flat, gradually broadening from the lower $1/3$ – $1/2$ toward the base, the broadening part 2.5–3.5 mm long 2–4 mm wide at the base, the other part about 1.5 mm wide, the lamina narrowly ovate (SADT n. 37) or linear-ovate, 7.5–10 mm long 3.2–4 mm wide, usually obtuse at the apex, entire along the margin. Flowering stem 2–18 in number, annual, ascending, glabrous, nearly epapillate, (5–)7–12(–15) cm long, about 1–1.8 mm across, nearly terete, simple, more or less fleshy, the former year's flowering stems hardly persistent. Leaves alternate, slightly remotely arranged throughout the stem, spreading widely, sessile, nearly spurless, flattish, spatulate, narrowly obovate (SADT n. 45), trullate (SADT n. 56) or narrowly oblong-ovate except ones at the lower 2–4 nodes, usually 6–15 mm long 2–4.5 mm wide, usually shortly attenuate at the base, acutely obtuse to round at the apex, entire and often mamillate along the margin (the mamilla less than 0.05 mm long), the both surfaces glabrous and hardly mamillate, the costa not prominent, the lateral veins 3–5 on each side of the costa, diverging; the leaves near the base similar to the scaly leaves, narrowly triangular or triangular-ovate, 2–2.5 mm long 0.6–1 mm wide, usually brownish. Inflorescences terminal, forming a helicoid cyme, usually 5–10-flowered, 0.7–3.5 cm long 1.2–4.5 cm wide, bracteate; bracts leafy, similar to the upper cauline leaves, 3–11 mm long 1.5–5 mm wide; peduncles 1.2–5 mm long, terete, glabrous, hardly papillate; pedicels very short, usually 0.5–1.5 mm long at anthesis, after anthesis elongate, up to 1.5–4 mm long. Flowers in late August to September, hermaphrodite, mostly 5-merous, usually 7–9 mm across at anthesis. Calyx 4.4–7 mm long, more or less fleshy, glabrous, epapillate, the tube nearly funnel-shaped, 0.8–3 mm long; the lobes 3.5–5.2 mm long 1.5–2.2 mm wide, nearly $1/2$ – $3/5$ as long as the petal, narrowly triangular-ovate or long ovate, long acuminate to acuminate or acute

at the apex (with very minutely mucronulate appendage outside), nearly entire but in the upper half very minutely erose along the margin, very slightly imbricate, nearly flat inside, hardly round outside, green but at least in anthesis pink, the sinus between the lobes round. Petals distinct, 5.5–7.6 mm long 2–3 mm wide, mostly pink, more or less fleshy, usually narrowly ovate or oblong-elliptic, round but often with a very minute mucronulate appendage at the apex, nearly entire along the margin, but under binocular (\times ca. 30 in magnification) often minutely erose in the upper 1/3 of the margin, obtusely keeled outside, wholly flat inside, erect or nearly erect at anthesis. Stamens usually shorter than the petal, erect at anthesis; filaments fleshy, obcompressed, nearly linear, about 0.5 mm wide at the base, glabrous, pinkish, the epipetalous ones inserted 2.5–3.5 mm from the base, 2.6–4 mm long, the alternipetalous ones 5.2–6.3 mm long; anthers dorsifixed, dehiscing longitudinally by two slits on ventral side, with two anther cells, slightly obcompressed, ovoidal or ellipsoidal, round with a minute projection (about 0.2 mm long) at the apex, 0.7–1.2 mm long, before anthesis deep purplish red, after dehiscence yellow. Nectar-scales usually oblong in dorsal view, very narrowly obovate or clavate in lateral view, (0.5–)0.8–1 mm long 0.4–0.6 mm wide, about 0.3 mm thick, round to erose at the apex, reddish. Gynoecium 5.5–7.5 mm long, erect, nearly equalling the petal in length, connected ventrally 1.3–1.9 mm from the base, the ovary slightly bent toward the base ventrally, dorsally somewhat keeled and more or less humped, about 1.5 mm wide, tapering to styles; the style mostly 1.2–2 mm long, usually straight, tapering; the stigma incon-

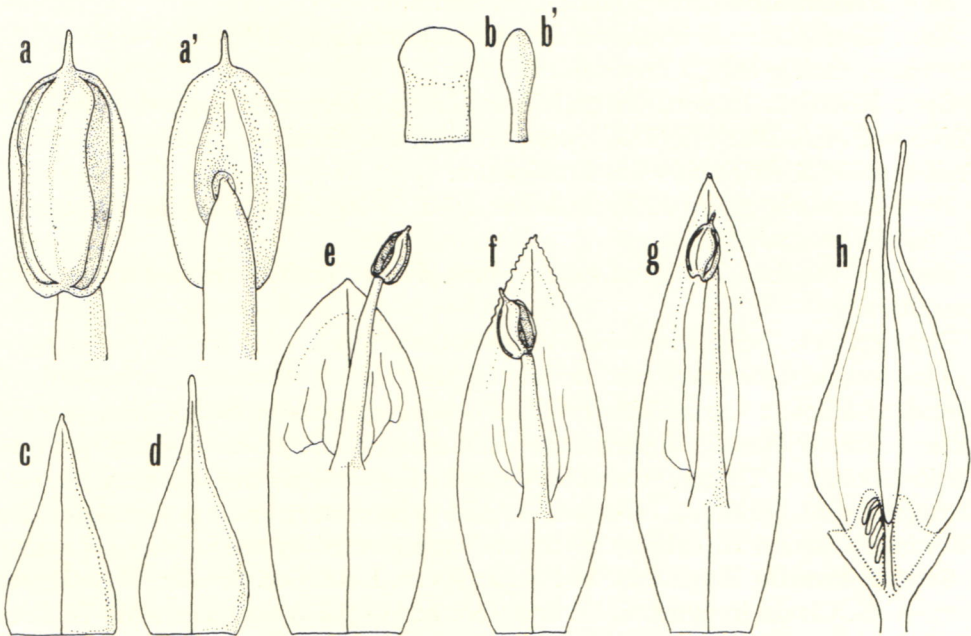


Fig. 35. *Sedum Hobsonii* R.-Hamet. a. Anther in ventral and dorsal (a') view, $\times 30$. b. Nectar-scale in dorsal and lateral (b') views, $\times 15$. c, d. Calyx-lobes, $\times 7.5$. e-g. Petals with stamen, $\times 7.5$. h. Pistils in lateral view, $\times 7.5$. (a, d & f-h. Rohmoo Lepcha 137, b-c & e. Bowes-Lyon 5071).

spicuous, epapillate; the placenta nearly marginal, 2–3 mm long, situated 1.3 mm above the ovary-base. Ovules 10–24 in each locule, ascending to declined, usually 0.6–0.8 mm long, oblong, round at the apex, the funicles usually 0.3–0.4 mm long. Follicles 6–8 mm long, brownish, erect. Seeds oblong, usually 1–1.3 mm long 0.2–0.3 mm wide, light brown.

Distr. Bhutan and Tibet.

Specimens examined. Tibet. Yatung (H. E. Hobson s.n. κ-Holotype of *Sedum Hobsonii* Prain ex R.-Hamet); Chumbi, Gum-bo-teen, 2000 ft. above Chumbi. Flowers red (Dungboo s.n. in July 1878, CAL); Chumbi. Flowers red (Cooper 711, E); Tarkapo, Chumbi Valley, alt. 12000 ft. (Rohmoo Lepcha 137, E-Holotype of *S. Praegerianum* W. W. Smith, CAL-Isotype); Galing at the Mochu river, above Chumbi (Dungboo 4638, CAL); loc. cit. (King 4638, CAL). Bhutan. Kopul Puwthang, alt. 10500 ft. On mossy rocks. Red. fls. (Cooper 2131, E); Sinchu La, alt. 10500 ft. Cliff face. Pink flower (S. Bowes-Lyon 5071, BM-Holotype of *S. mirabile* H. Ohba); Tzatogang-Dotanang, alt. 2800 m. On rock (Kanai, Murata, Ohashi, Tanaka & Yamazaki 1776, TI).

This species is very remarkable in having the dorsifixed anthers and helicoid cyme. The identity of *S. Praegerianum* with *S. Hobsonii* was already discussed in detail by R.-Hamet (1926). *S. mirabile* was proposed as a new species mainly upon its dorsifixed anthers, but there are no differences between *S. mirabile* and *S. Hobsonii* including *S. Praegerianum*.

Sect. **Primuloida** (Praeg.) H. Ohba, stat. nov.

Sect. Rhodiola ser. Primuloides Praeger in Journ. Roy. Hort. Soc. **46**: 27 (1921), pro parte, excl. group 2. Brevicaules Praeg.

Sect. Rhodiola subsect. Primuloidea (Praeg.) Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 443 (1930), pro parte, excl. *S. sikokianum*, *S. Durisii*, *S. Prainii*, *S. Hobsonii* et *S. Balfouri* in § 5. Brevicaulia.

Sect. Rhodiola group 1. Primuloides Fröd. in Act. Hort. Gothob. **5**: append. 21 (1930), pro parte.

Anthera basifixia. Folia radicalia adsunt. Planta pumila vel saepe pulvinae caespitosa.

Type species: *Sedum primuloides* Franchet (lectotype).

This section is characterized mainly by the radical leaves, and includes the six species as follows: *S. primuloides* Franch., *S. pleurogyanthum* Hand.-Mzt., *S. pachyclados* Aitch. et Hemsl., *S. nuristanense* Kitamura, *S. Karpelesae* R.-Hamet, and *S. humile* Hook. f. et Thoms. emend. R.-Hamet. The section ranges from Afghanistan through Nepal, Sikkim, Tibet, and Yunnan to Szechuan, but is not recorded from Bhutan. In eastern Himalaya the section is represented by the following species.

Sedum humile Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 99 (1858), pro parte—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 419 (1878), pro parte—W. W. Smith & Cave in Rec. Bot. Sur. Ind. **4**: 197 (1911)—Praeger in Not. Bot. Gard. Edinb. **13**: 84 (1921)—R.-Hamet in Bull. Soc. Bot. France **72**: 63 (1925), emend.—Fröd. in Act. Hort. Gothob. **5**: append. 21 (1930); in Ark. Bot. **30A**(9): 1 (1943).

[Fig. 36]

Sedum Levii R.-Hamet in Bull. Soc. Bot. France **56**: 568 (1909)—Berger in Engl. & Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 443 (1930).

Sedum Barnesianum Praeger in Not. Bot. Gard. Edinb. **13**: 72 (1921)—Berger, l.c. 443 (1930).

Chamaerhodiola humilis (Hook. f. et Thoms.) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 30 (1934).

Rhodiola humilis (Hook. f. et Thoms.) Fu in Act. Phytotax. Sin. Addit. **1**: 119 (1965).

A perennial herb, usually 2–3 cm high. Rhizomes thick, fleshy, cylindrical or rarely dauciformed, 1.5–2 cm long, usually 0.5–1.5 cm across, erect, more or less epigeaeous, usually simple but branched when well developed, glabrous, having a rather slender root at the base, the apical part densely clothed with scaly leaves and the remains of the petiolar part of the former years' radical leaves. Scaly leaves erect, chartaceous, rigidulous, more or less persistent, subulate, usually 2–5 mm long 0.7–0.9 mm wide, rusty or chestnut-brown, entire along the margin, round and shortly apiculate at the apex. Radical leaves usually 10–20 in number, erect, annual, long-petiolate; the petiole (5–)8–18 mm long 0.4–1 mm wide, linear but very slightly broadening toward the base, flat, slightly brownish green; the lamina 3–8 mm long 1.2–2.3 mm wide, flat, linear-elliptic, very narrowly rhombic-ovate or very narrowly obovate (SADT n. 45), entire along the margin, round or obtuse at the apex, long-attenuate at the base, green, glabrous, epapillate; the former years' dead petioles degenerated into scaly appendages, long persistent, densely tufted, rigescent, blackish or chestnut-brown, somewhat lustrous. Flowering stems (2–)3–5(–6) in number, annual, erect but in the upper half abruptly bent outward, greenish(?), glabrous, nearly epapillate, 1.5–4 cm long, about 0.9 mm across, nearly terete, simple, not fleshy, the dead flowering stem not remaining. Leaves alternate, more or less remotely arranged throughout the stem, spreading widely, nearly spurless, sessile, flattish, linear-ovate or linear-elliptic, 4.5–9.5 mm long 0.9–2.3 mm wide, usually round but rarely acutely obtuse at the apex, attenuate at the base, entire along the margin, glabrous, epapillate, somewhat yellowish green, the costa not prominent, the lateral veins nearly parallel, 3–4 on each side of the costa. Flowers in August and September, hermaphrodite, mostly 5-merous, usually 8–11 mm across at anthesis, usually solitary but rarely forming a small corymb, the inflorescence 2–4-flowered, bracteate; the bract leafy, linear-elliptic, 3–6 mm long 0.6–1.5 mm wide; peduncles and pedicels 1.2–2 mm long. Calyx 3.2–5 mm long, more or less fleshy, green, glabrous, epapillate; the tube nearly funnel-shaped, 0.6–1.5 mm long; the lobes ovate, 2.6–3.5 mm long 1.7–2.5 mm wide, obtuse or acuminate in the apical part, obtuse or round at the apex, nearly entire along the margin, very slightly imbricate, rather flattish, ascending at anthesis; the sinus between the lobes round. Petals distinct, 5–6.5 mm long 1.7–2.7 mm wide, mostly white, more or less fleshy, oblong-ovate or ovate with a round apex, entire along the margin, in the lower 1/4–1/3 flattish, in the upper 2/3–3/4 boat-shaped, ascending at anthesis. Stamens always shorter than the petal, nearly erect at anthesis; filaments linear-subulate, somewhat fleshy, obcompressed, 0.3–0.5 mm wide at the base, glabrous, whitish, the epipetalous ones inserted

1–1.7 mm from the base, 1.7–3.3 mm long, the alternipetalous ones 3–5 mm long; anthers basifixed, ovoidal or globosal, round at the apex, 0.6–0.8 mm long, before anthesis reddish, after dehiscence turning yellow. Nectar-scales transversely oblong (SADT n. 21) or depressed ovate (SADT n. 44) or rarely square, usually 0.5–0.9 mm long 0.8–1.5 mm wide, about 0.15 mm thick, often slightly retuse at the apex, probably reddish, more or less adnate to the ovary. Gynoecium 4–7.5 mm long, erect, usually slightly longer than the petal, connected ventrally 1–1.5 mm from the base, whitish, the ovary 1.2–1.7 mm wide, ventrally straight but in the upper part rather abruptly outcurved, dorsally more or less humped in the lower half and outcurved in the upper half, tapering to styles; the style 0.5–1.7 mm long, usually horizontal, tapering upwards; the stigma inconspicuous and epapillate; the placenta nearly marginal. Ovules usually 8–10 in each locule, mostly declined, usually 0.6–0.7 mm long, oblong, round at the apex, the funicles about 0.2 mm long.

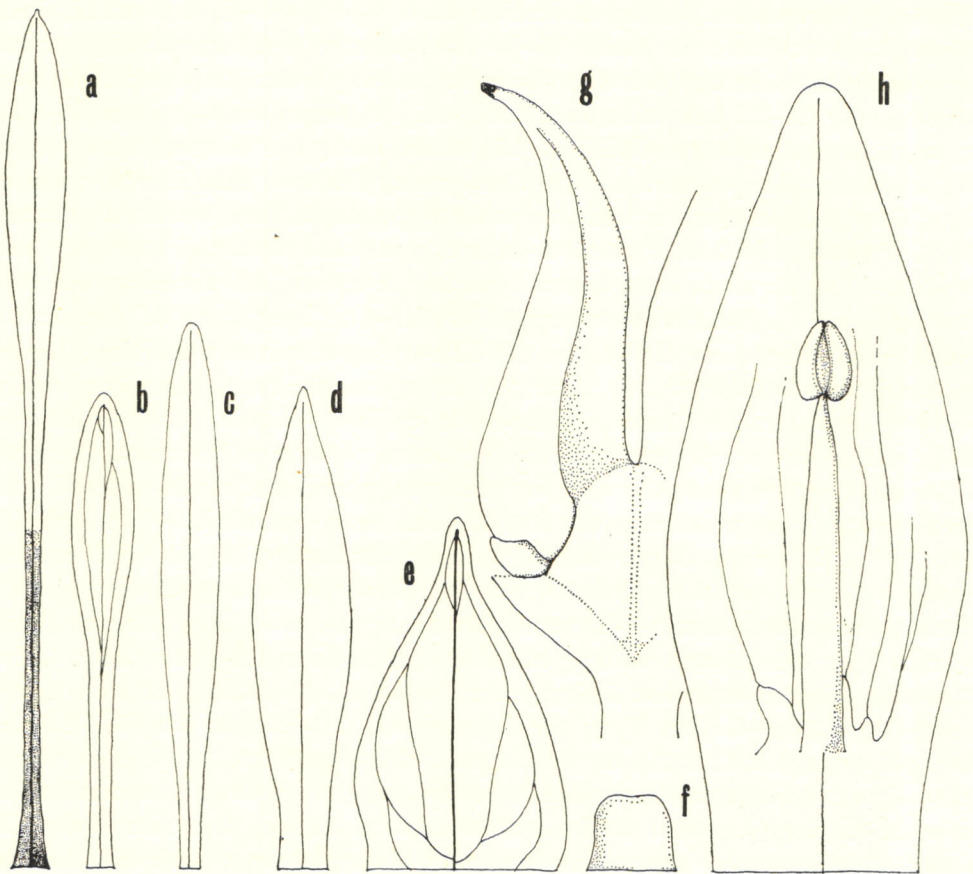


Fig. 36. *Sedum humile* Hook. f. et Thoms. emend. R.-Hamet. a & b. Radical leaves, $\times 3.75$, c & d. Cauline leaves, $\times 7.5$, e. Calyx-lobe, $\times 15$, f. Nectar-scale in dorsal view, $\times 15$, g. Pistil in lateral view, $\times 15$, h. Petal with stamen, $\times 15$. (a, c & g. Hooker s. n., b, d-f & h. Sharma E. 120).

Distr. Nepal, Sikkim, and Tibet.

Specimens examined. Nepal. Langdeng, alt. 7000 ft. Flowers white (Sharma E. 120, BM); Ya-La, Lantang Valley, alt. 3600 m (A. Maire s.n. on July 29, 1972, BM); Dagpache, alt. 16000 ft. Short turf. Perianth white, going pink, leaves fleshy (Polunin 1741, BM). Sikkim. Yeumtong, alt. 15000 ped (J. D. Hooker s.n. on Sept. 6, 1849, K (pro parte)—Lectotype of *Sedum humile* Hook. f. et Thoms. emend. R.-Hamet; CAL); Tunkra Pass (J. D. Hooker s.n., K—Syntype of *Sedum humile* Hook. f. et Thoms.). Tibet. Kalaeree, alt. 16000 ft. (Rohmoo Lepcha 434, E—Lectotype of *Sedum Barnesianum* Praeger); Phari, Chumbi Valley, alt. 14000 ft. (a native collector s.n. on Sept. 20, 1916, E—Syntype of *Sedum Barnesianum* Praeger); Numa, Dry ground (Stewart s.n., CAL); Phembula, 10–15 miles north of Lhasa (Walton s.n., CAL); above Singma Rhangcheng, alt. 11500 ft. (Chapman 618, K); Valley above Pongkar near Druk La Gompa, alt. 12–13000 ft. Abundant on cliff. Prostrate plant forming close mats on open turf banks. Flowers cream, turning reddish later (Kingdon-Ward 6122, K).

The circumscription of this species remained to be obscure until 1925, when R.-Hamet emended Hook. f. and Thomson's sense of *Sedum humile* based on the re-examination of the original material. *S. humile* emended R.-Hamet differs greatly from *S. quadrifidum* Pallas in having radical leaves, numerous remains of petiole of the old year's radical leaves, hermaphrodite flowers and larger petals, i.e. 5–6.5 mm long and 1.7–2.7 mm wide against 2.5–3.5 mm long and 0.8–1.7 mm wide in *S. quadrifidum*. In general appearance, *S. humile* also resembles *S. Smithii*, but differs from the latter mainly in having radical leaves and in lacking heteromorphic scaly leaves, of which the inner ones have linear or oblong appendages at the apex (1.5–3 mm long and 0.3–0.8 mm wide in their size). The identity of *S. Levii* R.-Hamet and *S. Barnesianum* Praeger with *S. humile* was already discussed fully by Hamet (1925).

The typification of *S. humile* is somewhat problematic. In the original description of the species (1858), no specimen was cited. However, Clarke (1878) cited two Hooker's collections from Sikkim, i.e., Yeumtong and Tunkra Pass. It is certain that *S. humile* was described based especially on the specimen from Yeumtong. As already pointed out by Hamet (1925), all the rejectable part in the original description for the delimitation of *S. humile* is coincident with *S. quadrifidum*, and the collection from Yeumtong is a mixture of plants consisted of both *S. humile* emend. R.-Hamet and *S. quadrifidum* Pallas. It is preserved in Herbarium Hookerianum (K) and on this sheet there are 19 plants of which the 6 are *S. humile* and the other 13 are identical with *S. quadrifidum* Pallas. The specimen from Tunkra Pass was collected at relatively late flowering, but all the plants on the specimen are definitely *S. humile*. However, the specimen is very poor and lacks several important characters of the species. Therefore, it seems to be better to select the plant of *S. humile* collected from Yeumtong which I designated by an asterisk on the sheet as lectotype of *S. humile*.

Sect. **Smithia** H. Ohba, sect. nov.

Sect. *Rhodiola* subsect. *Eurhodiola* § 2. *Himalensia* Berger in Engl. et Prantl,

Nat. Pfl.-fam 2 Aufl. **18a**: 442 (1930), nonnisi *S. Smithii*, excl. cet. sp. cit.

Sect. *Rhodiola* group 1. *Primuloides* Fröd. in Act. Hort. Gothob. **5**: append. 21 (1930), nonnisi *S. Smithii*, excl. cet. sp. cit.

Folia radicalia deficientia. Squamae dimorphae, eae majores apice appendiculatae; appendice lineari vel oblonga, 1.5–3 mm longa 0.3–0.8 mm lata. Flores hermaphroditi. Anthera basifixa.

Type species: *Sedum Smithii* R.-Hamet.

This section is represented by the single species. In general appearance it is very similar to sect. *Primuloides*, but distinctly differs from the latter in lacking foliaceous radical leaves.

Sedum Smithii R.-Hamet [in W. W. Smith in Rec. Bot. Surv. Ind. **4**: 259 (1911), nom. nud.] in Engl., Bot. Jahrb. **50**: Beibl. 112, 8 (1913); in Candollea **4**: 48 (1929), ut '*Smithii*'—Fröd. in Act. Hort. Gothob. **5**: append. 25 (1930), ut '*Smithii*'—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930). [Fig. 37]

Sedum chumbicum Prain ex R.-Hamet in Candollea **4**: 48 (1929), pro syn.

Rhodiola Smithii (R.-Hamet) Fu in Act. Phytotax. Sin. Addit. **1**: 122 (1965).

A perennial small herb, usually 2–5 cm high. Roots dauciformed, fleshy, usually 5–8 mm across, 3–5 cm long. Rhizomes thick, usually 5–8 mm across, 5–8 mm long, erect, more or less epigaeous, fleshy, simple, glabrous, the base tapering to the root, the apical part densely covered with scaly leaves. Scaly leaves very densely arranged, chartaceous, rigidulous, more or less persistent; the outer ones usually triangular-ovate or triangular-semicircular but rarely triangular, usually long-acuminate but rarely deltoid at the apical part, mostly obtuse at the apex, entire along the margin, usually 5–8.5 mm long 3–5 mm wide, round outside, usually bright brown; the inner ones usually triangular-semicircular or triangular-ovate with linear or oblong appendage at the apex, usually 3.5–6 mm long (excluding the apical appendage), 2–3.5 mm wide, entire along the margin, chestnut or bright-brown except the apical part, round outside, the apical appendage usually 1.5–3 mm long 0.3–0.8 mm wide, usually pale brown or ivory white, obtuse or round at the apex, fleshy. Flowering stems (1–)2–3 in number, annual, ascending or suberect, arising from the axils of the innermost scaly leaf, glabrous, mostly epapillate, usually 1.7–7 cm long, about 1.7 mm across, nearly terete, simple, more or less fleshy, the former year's flowering stems not remaining. Leaves alternate, slightly remotely arranged throughout, spreading widely, spurless, sessile, flattish, linear-elliptic or linear-ovate, 4.5–14 mm long 1.1–2.2 mm wide, mostly round but rarely obtuse at the apex, nearly truncate or very shortly attenuate at the base, nearly entire along the margin, glabrous, hardly papillate or mamillate, yellowish (?) green, the costa not prominent, the lateral veins nearly parallel, 3–4 on each side of the costa. Inflorescences terminal, forming a small corymb, usually with 5–10 flowers, 5–20 mm long 10–35 mm wide, bracteate; bracts leafy, very similar to the cauline leaves but smaller, usually 3–8 mm long 0.8–1.7 mm wide; peduncles usually 2–3.8 mm long, terete, glabrous, epapillate; pedicels usually 0.3–1.5 mm long. Flowers in late July to early September(?), hermaphrodite, mostly 5-merous, usually 4–5 mm across at anthesis. Calyx 3.1–5.3 mm long, thick, glabrous, epapillate; the tube saucer- or funnel-shaped, 0.7–

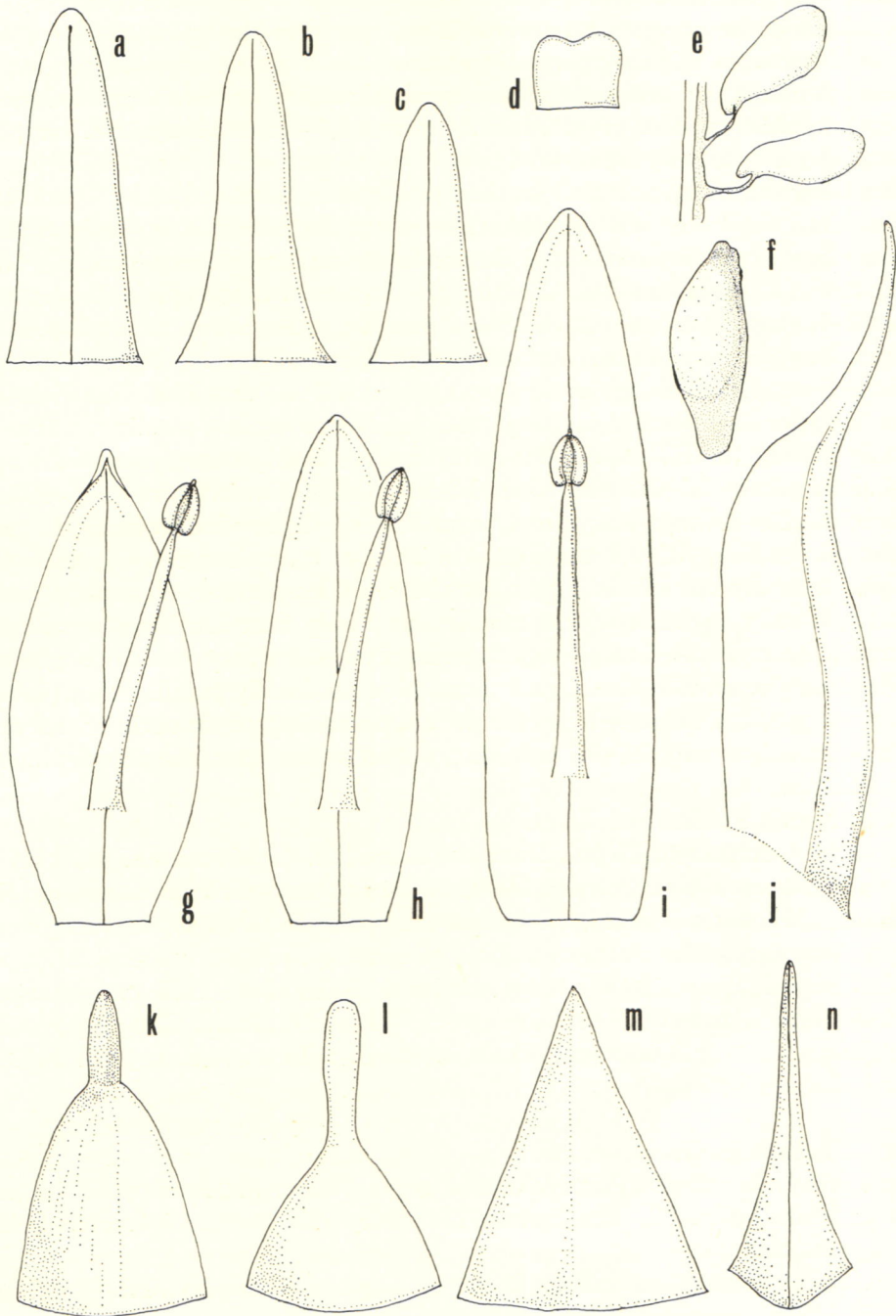


Fig. 37. *Sedum Smithii* R.-Hamet. a-c. Calyx-lobes, $\times 15$, d. Nectar-scale, $\times 15$, e. Ovules, $\times 40$, f. Seed, $\times 30$, g-i. Petals with stamen, $\times 15$, j. Pistil in lateral view, $\times 15$, k-n. Scaly leaves, $\times 7.5$. (a, b, d-f, i-k & m. Smith & Cave 2126, c, g-h, l & n. Stainton, Sykes & Williams 2270).

1.2 mm long; the lobes nearly $\frac{1}{3}$ as long as petal, 2.4–4 mm long 0.7–1.5 mm wide, linear-ovate or very narrowly oblong, round in the apical part, round or obtuse at the apex, slightly round outside, flattish inside, entire along the margin, usually ascending at anthesis, green but often pinkish or reddish; the sinus between the lobes round or obtuse. Petals distinct, 3.7–6.5 mm long 1.4–2 mm wide, mostly(?) pink, usually linear-ovate but rarely narrowly ovate (SADT n. 37), entire along the margin, round in the apical part, round or obtuse at the apex, rather thin, shallowly boat-shaped, suberect or ascending at anthesis. Stamens shorter than the petal, erect at anthesis; filaments long subulate, slightly thick, flat, usually(?) pinkish, about 0.4 mm wide at the base, the epipetalous ones inserted 1–1.5 mm from the base, 1.6–3.2 mm long, the alternipetalous ones 2.7–5.2 mm long; anthers basifixed, oblong-ovoidal, round and having a minute projection (about 0.1 mm long) at the apex, usually 0.5–0.7 mm long, before anthesis reddish, after dehiscence turning yellow. Nectar-scales usually transversely broadly oblong (SADT n. 19) but rarely square, mostly emarginate at the apex, 0.4–0.6 mm long 0.5–0.9 mm wide 0.2 mm thick, flattish, probably reddish. Gynoecium 3.6–7.4 mm long, nearly equalling or slightly longer than the petal, connected ventrally 0.5–0.9 mm from the base, erect, pale green (?), the ovary straight ventrally but in the upper part more or less outcurved, usually convex dorsally, usually broadest at the middle but rarely near the base (usually 0.7–1.5 mm), the style 1.4–2 mm long, tapering from the ovary, usually slightly incurved near the middle, the stigma inconspicuous, hardly papillate; the placenta nearly marginal. Ovules 4–8 in each locule, ascending to descending, narrowly oblong-ovoidal, usually 0.6–0.7 mm long, round at the apex, the funicles 0.6 mm long, filiform.

Distr. Nepal, Sikkim, and Tibet.

Specimens examined. Nepal. Damodar Kund, N. of Muktinath, alt. 14000 ft. Dry stony slopes. Calyx, corolla, filaments and anthers pink (Stainton, Sykes & Williams 2112, BM); Namdo, N. of Mustang, alt. 15500 ft. Open stony slopes. Petals, filaments, anthers and stem pink (Stainton, Sykes & Williams 2270, BM). Sikkim. Llonok, alt. 15000 ft. (W. W. Smith & G. H. Cave 2126, CAL—Isotype of *Sedum Smithii* R.-Hamet). Tibet. Cyangtse (Walton s.n., CAL); Chumbi, Wo Tho (Dungboo s.n., CAL, *S. chumbicum* Prain in sched.); Ten. . . . Zong, alt. 14500 ft. (Lloyd 102, K).

Sect. **Prainia** H. Ohba, sect. nov.

Sect. *Rhodiola* subsect. *Primuloidea* (Praeger) Berger § 5. *Brevicaulia* Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. 18a: 443 (1930), nonnisi *S. Prainii*, excl. ceteris spec. cit.

Sect. *Seda genuia* § 4. *Stapfiana* Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. 18a: 450 (1930), nonnisi *S. Stapfi*, excl. ceteris spec. cit.

Sect. *Rhodiola* group 1. *Primuloides* Fröd. in Act. Hort. Gothob. 5: append. 21 (1930), pro minute parte.

Folia numero 4 to 6, verticillata; ea radicalia deficientia. Squamae unimorphae, sine appendice. Flores hermaphroditi aut dioecii. Anthera basifixia.

Type species: *Sedum Prainii* R.-Hamet.

This section includes two species, i.e. *S. Prainii* R.-Hamet and *S. Staffii* R.-Hamet, and is characterized by the nearly verticillate 4–6 leaves. By lacking both radical leaves and dimorphic scaly leaves, the section is easily distinguished from the sect. *Primuloida* and the sect. *Smithia*.

Sedum Prainii R.-Hamet in Bull. Soc. Bot. France **56**: 566 (1909); in Candollea **4**: 44 (1929), ut '*Prainii*'-Fröd. in Act. Hort. Gothob. **5**: append. 26 (1930)-Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 443 (1930). [Plate 10d; Fig. 38]

Sedum Stewartii Craib ex R.-Hamet in Candollea **4**: 44 (1929), pro syn.

Sedum apiculatum Craib ex R.-Hamet in Candollea **4**: 44 (1929), pro syn.

A small perennial herb, up to 3 cm high. Rhizomes thick, usually 1.5–2 cm across, 2–3 cm long, erect, more or less epigeaeous, the apical part densely covered with scaly leaves. Scaly leaves subulate to very narrowly triangular, chartaceous, rigidulous, persistent, usually 6–8 mm long 1–3.2 mm wide, entire along the margin, mostly very acute at the apex, erect or ascending, blackish or chestnut-brown. Flowering stems solitary, annual, erect, simple, fleshy, terete, glabrous but densely or sparsely papillate or mamillate (the projection less than 0.1 mm long, pellucid), usually 1.5–3 cm long, mostly 2 mm across, the old flowering stems not remaining. Leaves usually 4, nearly verticillate in the lower half of the stem, spreading, spurless, petiolate; the petiole usually 1–3 cm long, 1.3–1.6 mm wide near the base, flattish, glabrous; the lamina oblong-elliptic, elliptic to transversely broadly elliptic (SADT n. 4–7) or ovate to broadly ovate (SADT n. 39–40), usually 2–6 cm long 2.5–4 cm wide, usually round or rarely retuse at the apex, usually very long to rather shortly attenuate or rarely shallowly cordate at the base, nearly entire along the margin, fleshy, flattish, glabrous but moderately or sparsely papillate on both surfaces (including the petiole), densely or moderately papillate along the margin (the papilla capitate, pellucid, about 0.1 mm long), green but often reddish beneath and along the veins above, the costa not prominent, the lateral veins usually 3–4 on each side of the costa, nearly parallel to diverging. Inflorescences terminal, usually hemispherical, 1–2.5 cm across, conspicuously bracteate, forming a corymb or a corymbosely compound-dichasium, usually 13–18-flowered; bracts leafy, flattish, broadly elliptic to circular or ovate, entire along the margin, mostly round but rarely obtuse at the apex, attenuate at the base, often petiolate but usually sessile, the petiole 1.2–3 mm long, the lamina 5–17 mm long 3–8 mm wide in petiolate bracts, 2.4–5 mm long 0.8–3 mm wide in sessile ones, peduncles and pedicels mostly glabrous, nearly terete, usually 1.3–2.5 mm long. Flowers in August to September, hermaphrodite, usually 5- but rarely 6-merous, 4–5 mm across at anthesis. Calyx usually 4–6 mm long, more or less fleshy, generally reddish-green, glabrous, the tube saucer-shaped, 1.3–2.2 mm long, the lobes 1/2–2/3 as long as the petal, usually 2.5–3.7 mm long 1.5–2 mm wide, narrowly triangular-ovate or triangular-ovate, nearly entire along the margin, acute in the apical part, round at the apex, abruptly erect very near the base, round outside, in the lower 1/3 part slightly concaved but gradually flattish towards the apex inside, the sinus obtuse or acute. Petals distinct, 4–6.25 mm long 1.8–3 mm wide, minutely and irregularly crose along the margin, clearly im-

bricated, usually ovate, mostly acuminate or acute at the apex, more or less fleshy, shallowly boat-shaped, usually pale pink or greenish white, glabrous, erect at anthesis. Stamens shorter than the petal (nearly $3/4$), erect at anthesis, usually pale pink; filaments fleshy, obcompressed, about 0.4 mm wide at the base, the epipetalous ones inserted about 0.8 mm from the base, 1.5–2.5 mm long, the alternipetalous ones usually 2–3.5 mm long; anthers basifixed, usually narrowly ovoidal, (0.6–)0.8–1.6 mm long, 0.4–0.7 mm across at the middle, usually obtuse at the apex, but often having a minute projection at the apex (as like as apiculate), before anthesis purplish red, after dehiscence turning yellow. Nectar-scales usually square, slightly round at the apex, often slightly recurved, probably

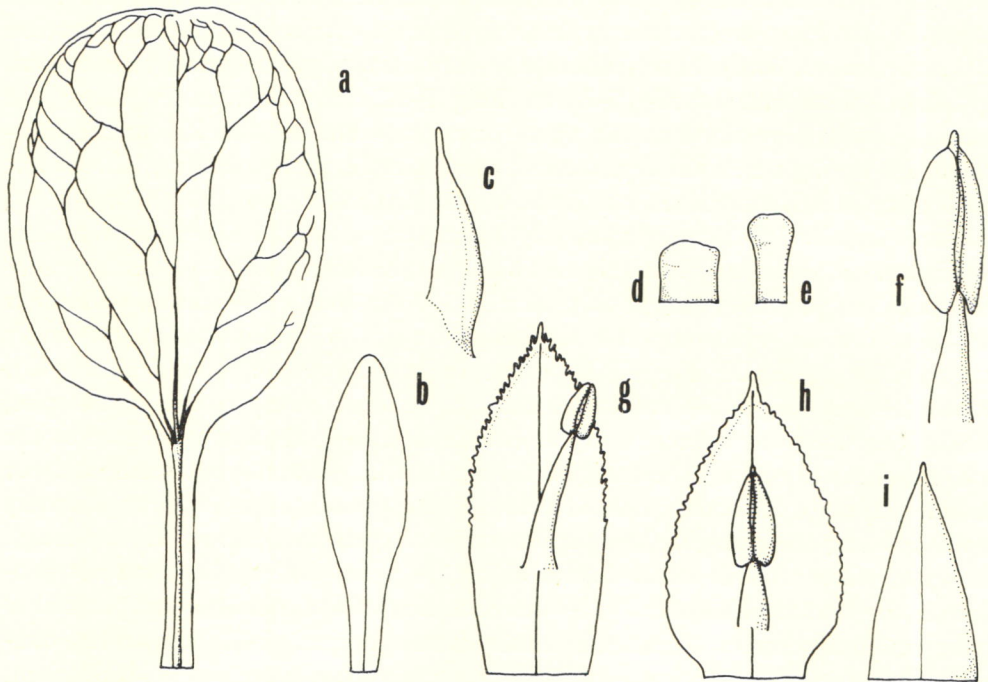


Fig. 38. *Sedum Prainii* R.-Hamet. a. Leaf, $\times 1$, b. Bract, $\times 7.5$, c. Pistil in lateral view, $\times 7.5$, d & e. Nectar-scales in dorsal view, $\times 15$, f. Anther, $\times 15$, g & h. Petals with stamen, $\times 7.5$, i. Calyx-lobe, $\times 7.5$. (a, c, d, f, h & i. Polunin, Sykes & Williams 3800, b, e & g. Dhwoj 134).

reddish, 0.5–0.7 mm long 0.4–0.6 mm wide 0.3 mm thick. Gynoecium usually 3.5–5.2 mm long, distinctly shorter than the petal, connected ventrally 0.5–0.7 mm from the base, erect, usually slightly reddish, the ovary straight ventrally, round towards the apex from the middle dorsally, usually 1–1.5 mm wide at the middle, the styles rather slender, usually 0.6 mm long, nearly straight, the stigma epapillate, inconspicuous; the placenta nearly marginal. Ovules 14–18 or 34–40 in each locule, horizontal to descending, narrowly oblong-elliptic, round at the apex, usually 0.4 mm, the funicles about 0.1 mm long.

Distr. Nepal, Sikkim, and Tibet.

Specimens examined. Nepal. Near Tarakot, Bheri River, alt. ca. 11000 ft. Among

rocks, on ledges, etc. Leaves fleshy, veins red, undersides especially reddish. Buds reddish. Flowers greenish white (Polunin, Sykes & Williams 2447, BM, TNS); near Dogadi Khola, alt. 12000 ft. On boulders near river bed. Leaves reddish-green. Corolla very pale pink; anthers and calyx red (Polunin, Sykes & Williams 3800, BM, TI, KATH); Gokyo, 27°59'N, 86°41'E, alt. 4600 m (Dobremez 396, BM); Pharsey, alt. 14000–16000 ft. (Dhwoj 194, BM, E). Sikkim. Kambajong (Dr. Prain s.n. in Sept. 1903, CAL—Holotype of *S. Prainii* R.-Hamet).

The circumscription of this species described above somewhat differs from the original description by R.-Hamet (1909). The leaves described by R.-Hamet seem to correspond with a part of bracts in my description. After examining the holotype, I note here that his description of floral characters was based on an immature plant.

Sedum Prainii is clearly characterized by the relatively large and petiolate leaves, conspicuously bracteate inflorescences and hermaphrodite flowers. Superficially, this species resembles *S. filipes* Hemsley var. *major* Hemsley in having the large and fewer verticillate leaves. However, the latter belongs to the subgenus *Sedum* in lacking of rhizomes bearing scaly leaves, and there are no close relationships between the two.

Differences between *S. Prainii* and *S. Stapfii* will be mentioned in the latter's note.

Sedum Stapfii R.-Hamet in Kew Bull. **1913**: 156 (1913)—Praeger in Not. Bot. Gard. Edinb. **13**: 91, pl. 174, 3 (1921) in descript. *Sedi pseudo-Stapfii* Praeg.—Fröd. in Act. Hort. Gothob. **5**: append. 26 (1930); in Ark. Bot. **30A**(9): 2 (1943)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 450 (1930). [Fig. 39]

Rhodiola Stapfii (R.-Hamet) Fu in Act. Phytotax. Sin. Append. **1**: 122 (1965).

A perennial herb, up to 3 cm high. Rhizomes thick, about 8 mm across, erect, almost epigeaeous, more or less densely scaly at the apical part. Scaly leaves chartaceous but more or less rigid, deciduous, long-triangular or narrowly triangular, often more or less concave and nearly entire along the margin, long-attenuate or acute at the apex, 0.7–1.2 mm long 1.8–4 mm wide, erect or ascending, mostly chestnut-brown. Flowering stem solitary, annual, erect, 1.4–2.5 cm long, simple, somewhat fleshy, terete, glabrous, sparsely to moderately mamillate (the mamilla about 0.1 mm long), about 1 mm across, the former years' flowering stems not remaining. Leaves usually 5 or 6, nearly verticillate at or near the top of the stem, ascending to spreading widely, spurless, glabrous, petiolate; the petiole usually 2–3.5 mm long 1.3–1.9 mm wide, broadly linear, more or less broadening towards the base; the lamina ovate (SADT n. 39) or oblong-ovate, usually 8–15 mm long 4–7 mm wide, usually obtuse at the apex, round at the base, entire along the margin, epapillate, more or less fleshy, usually somewhat glaucous beneath, the costa not prominent, the lateral veins 4–7 on each side of the costa, diverging. Inflorescences terminal, forming a small but long pedicellate, simple or monochasial corymb, (1–)3–6-flowered, ebracteate; peduncles of the monochasium about 5 mm long, glabrous, sparsely mamillate (the mamilla about 0.1 mm long), nearly terete; pedicels usually 10–13 mm long, glabrous, sparsely mamillate. Flowers in August, dioecious, 5-merous, 4–5 mm across at anthesis. Calyx 3.4–5 mm long, more or less fleshy, glabrous, the tube usually 0.9–1.5 mm

long, the base tapering to the pedicel; the lobes slightly longer or shorter than the petal, usually 2.5–3.5 mm long 1.1–1.9 mm wide, linear to linear-triangular or narrowly triangular, nearly entire but usually moderately or densely mamillate (the mamilla about 0.1 mm long) along the margin, round or obtuse at the apex, often sparsely mamillate outside, slightly convex outside, flattish inside, ascending (δ) or erect and appressed to the ovary (♀) at anthesis. Petals 2.2–3.1 mm long 1–1.8 mm wide, distinct, usually narrowly oblong (SADT n. 14) or narrowly oblong-ovate or obovate, irregularly crenulate to erose (δ) or nearly entire (♀) along the margin, round at the apex, membranaceous, glabrous, ascending (δ) or suberect (♀) at anthesis, shallowly boat-shaped (δ) or flattish (♀). Stamens more or less shorter than the petal, nearly erect at anthesis; filaments subulate, nearly terete, fleshy, glabrous, about 0.3 mm wide at the base, the epipetalous ones inserted about 0.5 mm from the base, 1.3–2 mm long, the alternipetalous ones 1.8–2.3 mm long; anthers basifixed, nearly ovoidal, usually 0.6–0.8 mm long, obtuse and having a very minute projection (about 0.1 mm long) at the apex, before anthesis reddish (?), after dehiscence (?) yellow. Nectar-scales usually square to narrowly oblong, more or less round at the apex, reddish (?), 0.6–0.8 mm long 0.4–0.6 mm wide 0.15 mm thick. Gynoecium of female plants usually 4.5–5.2 mm long, distinctly longer than the petal, connected usually 0.9–1.2 mm ventrally from the base, erect, the ovary straight ventrally, slightly gibbose dorsally, usually 1.2–1.6 mm wide at the middle, narrowed and outcurved in the upper part, the style tapering toward the apex, conspicuously outcurved, usually 0.8–1 mm long, the stigma epapillate, inconspicuous; the placenta nearly marginal. Gynoecium of male plants about 1.5 mm long, distinctly shorter than

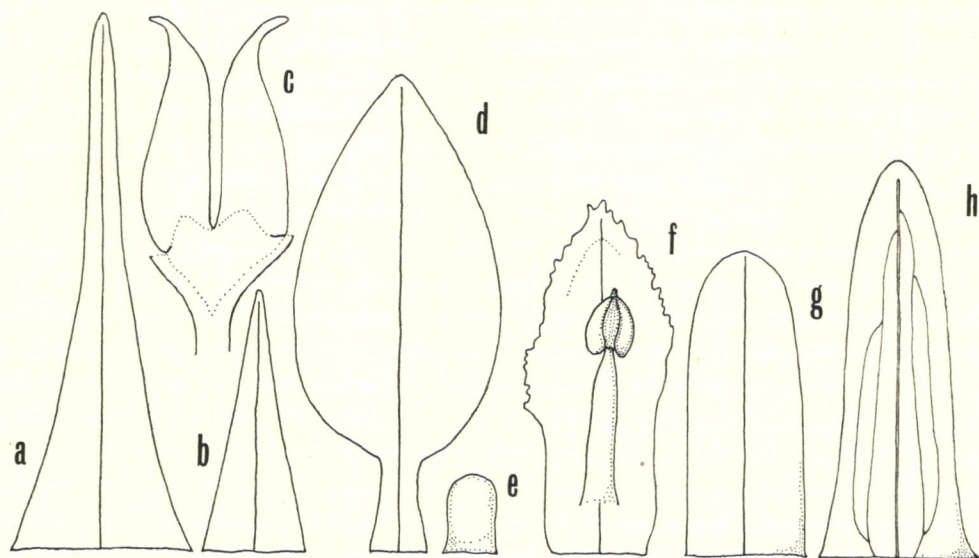


Fig. 39. *Sedum Stapfii* R.-Hamet. a & b. Scaly leaves, $\times 3.75$, c. Pistils in lateral view, $\times 7.5$, d. Leaf, $\times 3.75$, e. Nectar-scale in dorsal view, $\times 15$, f. Petal of male flower, $\times 15$, g. Calyx-lobe, $\times 15$, h. Petal of female flower, $\times 15$. (a–d, g & h. Chapman 611, e & f. Gould 1012).

the stamens, sterile. Ovules mostly 8 in each locule, descending, oblong, about 0.5 mm long, round at the apex, the funicles about 0.1 mm long. Follicles nearly erect. Seeds ovoidal, slightly elongate in the apical part, round at the apex, 0.85–1 mm long, about 0.5 mm wide, the testa nearly smooth.

Distr. Tibet and Bhutan.

Specimen examined. Tibet. (King 318 ♀, κ-Holotype of *Sedum Stapfi* R.-Hamet, CAL-Isotype); above Singma Khangcheng, alt. 11500 ft. (Chapman 611 ♀, κ). Bhutan. Tremo La to Sharna, alt. 15000–9300 ft. (Gould 1012 ♂, κ).

This is a rare but easily recognizable species by the relatively large and nearly verticillate leaves and long pedicellate flowers. This species has strong affinity to *Sedum Prainii*, but is different from the latter by the ebracteate inflorescence, longer pedicels, dioecious flowers and smaller leaves.

This species was compared with *S. pseudo-Stapfi* by Praeger in the latter's original description, but greatly differs from the latter in having rhizomes with scaly leaves.

Sect. **Rhodiola**: Scopoli in Fl. Carn. ed. 2, **1**: 326 (1771)–Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 95 (1858), pro parte–Maxim. in Bull. Acad. Sci. St. Pétersb. **29**: 124 (1883)–Praeger in Journ. Roy. Hort. Soc. **46**: 26 (1921), pro parte, excl. ser. Primuloides Praeger–Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 430 (1930), pro parte, excl. subsect. Primuloidea (Praeg.) Berger–Fröd. in Act. Hort. Gothob. **5**: append. 16 (1930); **15**: 3 (1942), pro parte, excl. group 1. Primuloides.

Rhodiola sect. Eurhodiola A. Schrenk, Enum. Pl. Nov. **1**: 67 (1841).

Rhodiola sect. Chamaerhodiola A. Schrenk, loc. cit. 69 (1841).

Clemensia Rose in Bull. New York Bot. Gard. **3**: 3 (1903).

Chamaerhodiola (A. Schrenk) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 27 (1934).

Rhodiola sect. Clemensia (Rose) A. Boriss. in Komarov, Fl. USSR **9**: 28 (1939).

Scaly leaves relatively uniform, persistent or rather caducous. Radical leaves undeveloped. Cauline leaves more than 10, alternately arranged throughout the stem or aggregate. Flowers hermaphrodite or dioecious, anthers basifixed.

Type species: *Sedum roseum* (L.) Scopoli.

Subsect. **Rhodiola**

Subsect. Eurhodiola (A. Schrenk) Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 430 (1930), excl. pro maj. parte in §2. Himalensia.

Sect. *Rhodiola* group 2. Chamae-*Rhodiola*, pro maj. parte, gr. 3. Eu-*Rhodiola* et gr. 4. Trifida Fröd. in Act. Hort. Gothob. **5**: append. 26 (1930).

Sect. *Rhodiola* group 3. Eu-*Rhodiola* Fröd. in loc. cit. **15**: 3 (1942).

The former years' dead flowering stems not remaining, or if some former years' stems persistent, then not tufted. Annotinous flowering stems usually 1–6 or rarely more but less than 15 in number. Flowers hermaphrodite or dioecious.

This subsection ranges from N. Europe to N. America through Himalaya, N. W. China and N. E. Asia. In eastern Himalaya, I have recognized 12 species in this subsection.

Sedum heterodontum Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 95 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 417 (1878)—Maxim. in Bull. Acad. Sci. St.-Petersb. **29**: 129 (1883), in adnota—Praeger in Journ. Roy. Hort. Soc. **46**: 34 (1921)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 440 (1930). [Fig. 40e-j]

Sedum Rhodiola DC. sensu Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 95 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 417 (1878), pro majore parte, excl. *Sedum imbricatum* Hook. f. et Thoms. et *Rhodiola imbricata* Edgew.

Sedum roseum (L.) Scop. var. *heterodontum* (Hook. f. et Thoms.) Fröd. in Act. Hort. Gothob. **5**: append. 40, Pl. 13, 2 (1930), ut '*heterodontum*', Fedtsch. pro parte; in Ark. Bot. **30A**(9): 4 (1943).

Rhodiola heterodonta (Hook. f. et Thoms.) A. Boriss. in Komarov, Fl. USSR **9**: 32 (1939), pro parte.

A perennial herb, up to 40 cm high. Rhizomes very thick, subcylindrical to narrowly ovoidal, solid, usually 2–3 cm across, accrescent, sparsely branched in well developed state, erect to suberect, the base tapering to the carrot-shaped root, the upper parts greyish brown, more or less epigaeous, marked by elliptic scars of flowering stems, and rather sparsely covered with scaly leaves. Scaly leaves brown, chartaceous, glabrous, more or less persistent, appressed to each axillary flowering stem, triangular-ovate to very broadly ovate with entire margin, obtuse or round at the apex, usually 3–6 mm long and wide. Flowering stems annual, 3–5 in number, erect, simple, robust, pale green and somewhat glaucous, glabrous, mostly epapillate, nearly terete, 10–25 cm long and 4–7 mm thick during the flowering time but after accrescent to 25–40 cm long and 6–10 mm thick, the old flowering stems not remaining. Leaves alternate, more or less remotely arranged throughout the flowering stem (but the internodes usually shorter than the leaf-length), sessile, nearly spurless, fleshy or thick herbaceous, flattish, glabrous, green above, pale green and somewhat glaucous beneath, usually 12–25 mm long 10–15 mm wide, 1–2.2 times longer than broad, triangular or triangular-, pentagonal- or broadly pentagonal-ovate, above deltoid-acuminate to round with an acute or obtuse apex, mostly shallowly cordate to more or less auriculate or rarely truncate at the base, coarsely 2–6(–7)-toothed or repandous to nearly entire along the margin (the teeth with obtuse or round apex, the sinus between teeth round), in dried specimens prominently white- or pellucid-margined, the costa not prominent, the lateral veins diverging and densely anastomosing towards the margin. Inflorescences terminal, a very dense and compact, capitellate, compound-corymbose, usually 80–120-flowered, mostly ebracteate, exposed in the flowering time, 1–2 cm high 2.5–3 cm wide in size; the primary axis of each corymb (consisting of the connection of 2–7 pedicels and often of a part of peduncles) 2–5 mm long, variable in thickness, glabrous, epapillate; bracts when present very similar to the upper cauline leaves in shape and size. Flowers in June and July, usually 4- or 5-merous, almost sessile, usually coherent or rarely connate, dioecious. Calyx 3–4.5 mm long, glabrous, more or less fleshy, greenish, the tube about 0.5 mm long, tapering towards the base, the lobes 2.5–4 mm long, usually 0.6 mm wide, suberect at anthesis, valvate in bud, both surfaces flattish, usually linear with entire and

slightly concaved margin, round at the apex, the sinus between lobes acute (σ) or truncate (φ), the veins not prominent. Petals distinct, valvate in bud, nearly erect (σ) or ascending (φ) at anthesis, very narrowly rhombic-elliptic to oblong or rarely linear in male, mostly linear in female, round or deltoid in the apical part, acute or obtuse (σ) or round (φ) at the apex, entire along the margin, 3.5–4.5 mm long 0.9–1.1 mm wide in male, 1.8–2.3 mm long 0.45–0.6 mm wide in female, glabrous, slightly round outside, concave (σ) or flattish (φ) inside, slightly yellowish or rarely greenish white but in dried specimens usually dull yellow. Stamens distinctly (more or less 2 times) longer than the petals, erect to suberect at anthesis; filaments filiform but scarcely tapering from the base, flattish, about 0.2 mm wide at the base, glabrous, usually pale green, 5.5–9 mm long, the oppositipetalous ones not inserted on the petal; anthers basifixed, ellipsoidal or nearly globosal, usually retuse at the apex, usually 0.7 mm long, before anthesis dull purplish red (?) and after dehiscence turning yellowish. Nectar-scales usually oblong, round or retuse at the apex, slightly concave ventrally and more or less convex

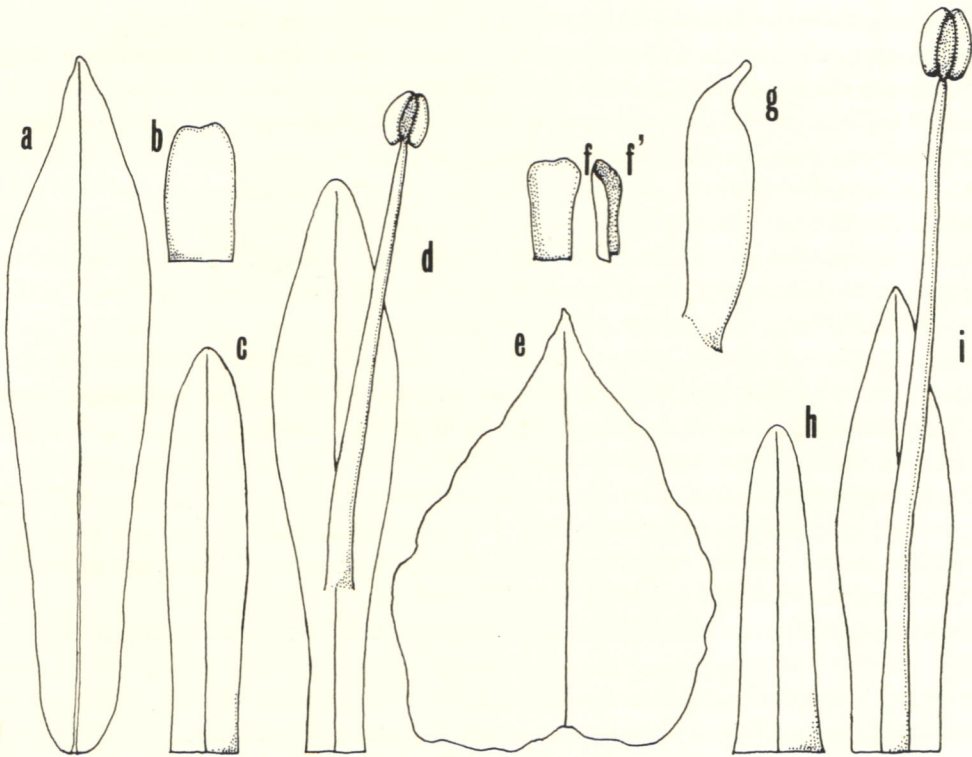


Fig. 40. *Sedum imbricatum* (Edgew.) Walpers (a–d). a. Leaf, $\times 3.75$, b. Nectar-scale in dorsal view, $\times 15$, c. Calyx-lobe, $\times 15$, d. Petal with stamen, $\times 15$. *Sedum heterodontum* Hook. f. et Thoms. (e–i). e. Leaf, $\times 3.75$, f. Nectar-scale in dorsal and lateral (f') views, $\times 15$, g. Pistil in lateral view, $\times 7.5$, h. Calyx-lobe, $\times 15$, i. Petal with stamen, $\times 15$. (a. Polunin, Sykes & Williams 2355, b. Polunin, Sykes & Williams 57, c & d. Edgeworth s.n., e, f, h & i. Stainton 4312, g. Thomson on 16 Jun., 1848).

dorsally, usually 0.8–1.1 mm long 0.4–0.6 mm wide 0.15 mm thick, probably reddish. Gynoecium of female plants usually 5–6 mm long (usually 2.5–3 times longer than the petal), connected 1–1.5 mm ventrally from the base, sessile, nearly erect, the ovary usually isomerous (4 or 5) but rarely anisomerous (3 or 6), ventrally straight but in the uppermost part more or less abruptly outcurved, convex dorsally, broadest above the middle, usually 1.2–1.4 mm wide, the style short, less than 0.6 mm long, oblique, the stigma rather distinct, minutely mamillate (the mamilla less than 0.05 mm long); the placenta nearly marginal. Gynoecium of male plants much smaller, usually 1.2–1.7 mm long, ovules mostly absent. Ovules of female plants 20–30 in each locule, descending, nearly narrowly oblong-elliptic, round at the apex, usually 0.6–0.7 mm long, the funicles about 0.2 mm long. Follicles 6–8 mm long, more or less conspicuously outcurved in the upper ventral side, brown. Seeds brown, nearly ellipsoidal, round at the apex, usually 1.2–1.5 mm long.

Distr. Kashmir, Kumaon, Nepal, and Tibet.

Specimens examined. Kashmir. alt. 6000–7000 ft. (Thomson s.n. ♂ on May 4, 1848, κ (in Herb. Hook.)—Syntype of *Sedum heterodontum* Hook. f. et Thoms.); Kunawar, alt. 9000 ped. (Thomson s.n. ♀ on Aug. 16, 1847, κ (in Herb. Hook.)—Syntype of *S. heterodontum* Hook. f. et Thoms.); Kishtwar, alt. 7000–8000 ped. (Thomson s.n. ♀ on Jun. 16, 1848, κ (in Herb. Hook.)—Syntype of *S. heterodontum* Hook. f. et Thoms.); Chamba State, near Donai, alt. 10000 ft. (Lace 1626, CAL). Kumaon. Pindare, alt. 12700 ft. (Strachey & Winterbottom 11 ♂, κ). Nepal. Phoksomdo Tal, 29°50' N, 82°57' E, alt. 13000 ft. On rocky slopes. Flowers yellow (Stainton 4312 ♂, BM, TI); Tingjegaon, alt. 16600 ft. Among boulders on river terrace. Stamens yellow; perianth green (Polunin, Sykes & Williams 1161, BM). Tibet. Gyantse (Walton s.n. ♂, κ, CAL).

This species is closely related to *Sedum roseum* (L.) Scopoli from Europe but slightly differs from the latter in having triangular or triangular-, pentagonal- or broadly pentagonal-ovate leaves scattered along tall stems.

Hooker f. and Thomson recorded '*S. Rhodiola* DC.' in the Himalayan region. The plant identified as *S. Rhodiola* seems to be different from *S. heterodontum* s. str. in having leaves with entire or nearly entire margin, but is not distinguishable from the latter because the margin of *S. heterodontum* seems to vary continuously from entire through repandous to coarsely toothed.

Sedum imbricatum (Edgeworth) Walpers, Ann. Bot. Syst. **1**: 325 (1848).

[Fig. 40 a–d]

Rhodiola imbricata Edgeworth in Trans. Linn. Soc. London **20**: 47 (1846).

Sedum imbricatum Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 101 (1858).

Sedum Rhodiola DC. sensu C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 417 (1878), pro minore parte.

Sedum roseum (L.) Scop. sensu Fröd. in Act. Hort. Gothob. **5**: append. 37 (1930), pro minima parte.

Sedum crassipes Hook. f. et Thoms. sensu Kitamura in Kihara, Fauna Fl. Nepal Himal. 140 (1955).

A perennial herb, up to 30 cm high. Rhizomes very thick, subcylindrical to

long-ovoidal, usually 2–2.5 cm across, accrescent, sparsely branched in well developed state, erect to ascending, the base tapering to the dauciformed root, the upper parts epigaeous, covered with scaly leaves and also often the remains of former year's dead stem. Scaly leaves blackish brown to chestnut-brown, chartaceous, glabrous, more or less persistent, appressed to each axillary flowering stem, triangular-ovate to very broadly ovate with entire margin, obtuse or round at the apex, 6–9 mm long 5–8 mm wide. Flowering stems annual, 3–5(–6) in number, erect, simple, robust, often somewhat reddish, glabrous, epapillate, nearly terete, 10–20 cm long and (3–)4–6 mm thick during the flowering time but after accrescent to 20–30 cm long (5–)6–9(–10) mm thick; the remains of former year's flowering stem mostly crumbled and stramineous. Leaves alternate, densely arranged throughout, imbricate in bud, sessile, shortly spurred (the spur usually 0.5–1 mm long), thick herbaceous or somewhat fleshy, flattish, glabrous, epapillate, usually 20–30 mm long 3–6(–7) mm wide, 4–6.5 times longer than broad, mostly very narrowly obovate (SADT n. 45) to narrowly elliptic (SADT n. 1–2) or rarely ovate (SADT n. 38), acute or deltoid in the apical part, acute at the apex, round or cuneate at the base, nearly entire to remotely denticulate along the margin of the upper half (the teeth 6–12 in number, oblique upwards, acute, with obtuse sinus), nearly entire in the lower half, the costa not prominent, the lateral veins 5–8 on each side of costa, spreading to arched. Inflorescences terminal, 1–1.5 cm long 2.5–3 cm wide, involucrate (i.e. surrounded by the upper cauline leaves and bracts), forming very dense and compact corymb-fascicles (usually 20–40-flowered, the cluster 6–14 in number) or a simple-corymb (usually consisting of 1–3-flowers), erect throughout the anthesis; peduncles very short or lacking, ca. 0–4 mm long, glabrous, nearly terete; bracts fewer in number, mostly narrowly elliptic but rarely very narrowly obovate, entire along the margin, usually deltoid-acute at the apex, round at the base, sessile, not or very slightly spurred, flattish, glabrous, 7–10 mm long 2–3 mm wide; pedicels glabrous, 3–5 mm long, hardly elongate after flowering. Flowers in June to August, 4- or 5-merous, opening upwards, usually dioecious but rarely andro-dioecious, the alabastrum deep red. Calyx¹⁾ 4.5–6.5 mm long, thick herbaceous, green and very often reddish, the tube 1.2–2 mm long (in length equalling the 1/3–1/4 of the lobes), tapering below, the lobes (2.9–)3–4(–4.3) mm long 0.8–1 mm wide, linear to subulate or linear-ovate, entire along the margin, round at the apex, suberect, flattish, valvate in bud, the sinus between lobes obtusely round. Petals distinct, valvate in bud, ascending or nearly erect in anthesis, very narrowly angular-obovate (SADT n. 63) or oblong-obovate, round at the apex, entire along the margin, 5–6.5 mm long 1.2–1.5 mm wide, glabrous, slightly round outside and concave inside, pale yellow but in dried materials usually dull yellow. Stamens distinctly longer than the petals, nearly erect to ascending at anthesis; filaments filiform but slightly tapering from the base, about 0.25 mm wide at the base, glabrous, reddish or rose pink, flattish, the epipetalous ones inserted 1.5–3 mm from the

1) In the present study the female plant in flowering could not examine. Therefore, the description in the floral parts is based on the male and hermaphrodite plant only.

base, mostly 3.5–4.5 mm long, the alternipetalous ones 5.5–8 mm long; anthers basifixed, nearly ellipsoidal, usually round but rarely retuse at the apex, 0.5–0.7 mm long, before anthesis dark purplish red but after dehiscence turning deep yellow. Nectar-scales usually broadly oblong (SADT n. 17) or rarely oblong with round and often emarginate apex, nearly erect, concave ventrally and convex dorsally, strongly appressed to the ovary, usually 0.7–1.2 mm high 0.5–0.9 mm wide, about 0.15 mm thick, probably dark red. Gynoecium usually 3–5 mm long, erect to suberect, connected 0.5–1.2 mm ventrally from the base, the ovary straight ventrally, slightly convex dorsally, broadest near the middle, about 0.7 mm wide, not conspicuously outcurved in the uppermost part, the style indistinct, gradually tapering from the ovary-apex, less than 0.8 mm long, ending into an epapillate stigma, the placenta nearly marginal. Ovules 8–10 in each locule, ellipsoidal with round apex, about 0.6 mm long, often(?) abortive. Follicles brown, erect, not conspicuously outcurved in the apical part, 8–12 mm long. Seeds reddish brown, about 1.5 mm long, ellipsoidal with elongate apex.

Distr. Kumaon and Nepal.

Specimens examined. Kumaon. Liti, alt. 11000–12000 ped. (Edgeworth s.n. in 1844, κ (in Herb. Bentham.))—Holotype of *Rhodiola imbricata* Edgew. and syntype of *Sedum imbricatum* Hook. f. et Thoms.). Nepal. Sringi Himal, Shiar Khola, alt. 17000 ft. Unconsolidated scree & boulder slopes (Gardner 651 & 652, BM); Kongyur La, alt. 18000 ft. Screes. Flowers yellow (Lowndes 1314, BM); Saldangaon, ca. 4 miles S. W., alt. ca. 18500 ft. On shady scree. Flowers pale yellow (Polunin, Sykes & Williams 5, BM); near Gangla Bhanjyang, alt. 15500 ft. On large broken rock masses. Flowers yellow, but calyx mainly reddish; growing a red appearance especially when in bud (Polunin, Sykes & Williams 2355, BM, TI); Dojan Khola, alt. ca. 18500 ft. Growing on scree slopes. Flowers yellow; anthers brownish purple (Polunin, Sykes & Williams 57, BM); Namdo, N. of Mustang, alt. 17000 ft. Amongst stones on open slope. Inflorescence dark red (Stainton, Sykes & Williams 2339, BM); near Dogadi Khola, alt. 15000 ft. Among boulders & screes. Flowers pale yellow (Stainton, Sykes & Williams 3193, BM, TI); Thinigaon, Muktinath Himal, alt. 15000 ft. On scree slopes. Flowers pale yellow (Stainton, Sykes & Williams 1288, BM); Thaple Himal, alt. 4800 m (Nakao s.n., KYO, TI, TNS).

Rhodiola (= *Sedum*) *imbricata* Edgew. was reduced to a synonym of *S. Rhodiola* DC. (= *S. roseum*) by Clarke (1878). However, the former species seems to be specifically distinguishable from the latter by leaves which are very narrowly obovate or narrowly elliptic with nearly entire margins, usually $20\text{--}30 \times 3\text{--}7$ mm in size and not glaucous against the latter's circular-ovate to narrowly oblong and glaucous leaves with usually dentate margins (usually $12\text{--}26 \times 7\text{--}15$ mm in size). *S. crenulatum* Hook. f. et Thoms. resembles *S. imbricatum* but differs from the latter in having typically or broadly elliptic petiolate leaves and purplish flowers. *S. heterodontum* differs from *S. imbricatum* in having triangular to triangular-, pentagonal-, or broadly pentagonal-ovate leaves, nearly ebracteate inflorescences and relatively narrow petals. *S. imbricatum* Hook. f. et Thoms. is a later homonym of *S. imbricatum* (Edgew.) Walpers and quite identical with the latter.

Sedum crenulatum Hook. f. et Thoms. in Journ. Linn. Soc. Bot. 2: 96 (1858)–

C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 417 (1878)—Hemsley in Journ. Linn. Soc. Bot. **35**: 177 (1902). [Plate 11; Fig. 41]

Sedum rotundatum Hemsley in Hooker's Icon. Pl. **25**: pl. 2469 (May, 1896); in Kew Bull. **1896**: 210 (Nov., 1896); in Journ. Linn. Soc. Bot. **35**: 178 (1902)—R.-Hamet in Not. Bot. Gard. Edinb. **8**: 141 (1913)—Praeger in Journ. Roy. Hort. Soc. **46**: 39, t. 11 (1921); in Not. Bot. Gard. Edinb. **13**: 94 (1921)—Limpricht in Fedde, Repert. Beih. **12**: 392 (1922)—Fröd. in Act. Hort. Gothob. **1**: 28 (1924), descript. pl. femin.; in Hand.-Mzt., Symb. Sin. **7**: 407 (1931)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930).

Sedum roseum (L.) Scop. sensu Fröd. in Act. Hort. Gothob. **5**: append. 37 (1930), pro min. parte.

Sedum bupleuroides Wall. ex Hook. f. et Thoms. var. *rotundatum* (Hemsl.) Fröd. in Act. Hort. Gothob. **5**: append. 44 (1930).

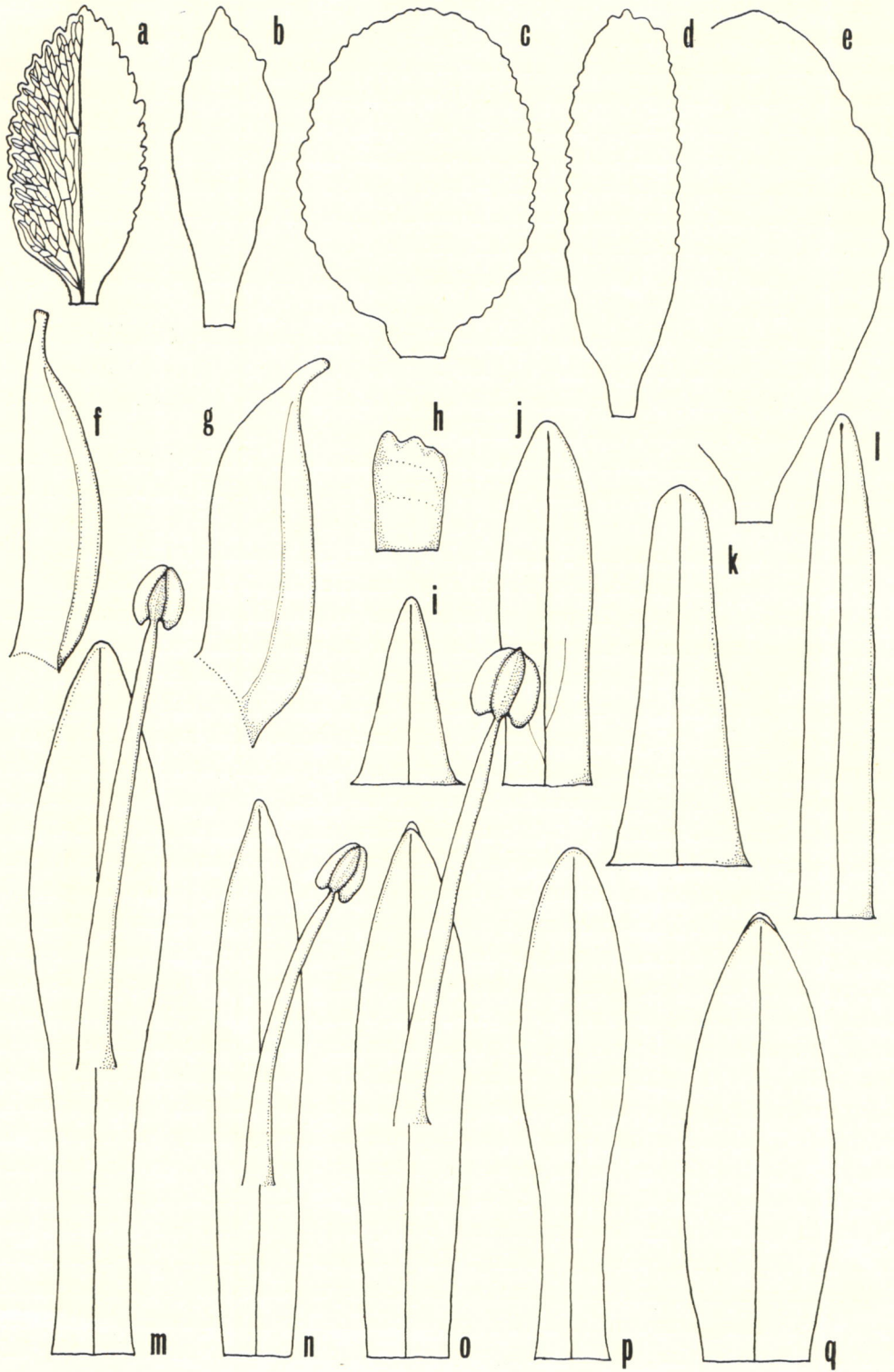
Sedum euryphyllum Fröd. in Hand.-Mzt., Symb. Sin. **7**: 406 (1931); in Act. Hort. Gothob. **10**: append. 157, t. 1262–1270 (1935).

Sedum megalanthum Fröd. in Journ. Wash. Acad. Sci. **25**: 124 (1935); in Act. Hort. Gothob. **10**: append. 158, t. 1271–1277 et pl. 109 (1935); in Ark. Bot. **30A** (9): 4 (1943).

Rhodiola rotundata (Hemsl.) Fu in Act. Phytotax. Sin. Addit. **1**: 122 (1965).

Rhodiola euryphylla (Fröd.) Fu in Act. Phytoax. Sin. Addit. **1**: 122 (1965).

A perennial herb up to 21 cm high. Rhizomes very thick, subcylindrical, usually 2–2.5 cm across, accrescent, sparsely branched in well developed state, more or less epigaeous, suberect to ascending, the base tapering to the dauciformed root, the upper parts clothed with the remains of the former year's old flowering stem and covered with scaly leaves. Scaly leaves ferruginous, thick membranaceous or chartaceous, glabrous, persistent, rigidulous later, very widely to widely triangular-ovate with entire margins, round to obtuse at the apex, appressed to each axillary flowering stem, 7–10 mm long 6–10 mm wide. Flowering stems annual, (3–)5–7(–10) in number, simple, usually fastigate, 15–21 cm long 7–9 mm thick during the flowering time, robust, glabrous, nearly epapillate, terete, waxy yellowish green in the flowering but after turned ruddy brown, the lower parts remaining one year after death; the remains dark purplish brown, often shining. Leaves alternate, rather densely arranged, imbricate, more or less indistinctly petiolate; petioles very short usually 0.8–2 mm long and 1.7–2 mm wide, very strongly obcompressed, concave above, slightly spurred (about 0.5 mm long), glabrous; laminae more or less fleshy, flattish, glabrous, epapillate, typically to broadly elliptic (SADT n. 4–5), round at the apex, round or obtuse at the base, more or less abruptly narrowing into petiole, usually minutely crenulate to erose but rarely nearly entire along the margin (the teeth-apex round to nearly truncate, the sinus between the teeth round to obtuse), 10–33 mm long 5.5–17 mm wide, 1.3–2.2 times longer than broad, yellowish green but in dried specimens mostly ruddy brown, the costa not prominent, the lateral veins spreading. Inflorescences terminal, 20–40-flowered, dense and compact, bracteate, forming simple corymb-fascicles (the cluster mostly 2- or 3-flowered), surrounded by the upper cauline leaves and bracts, usually 1.5–2 × 1.5–2.5 cm in size; peduncles very short, glabrous, nearly terete, usually 0.5–



3 mm long; bracts 4–7 in number, typically or broadly elliptic to oblong or oblong-elliptic, sessile, entire to erose or minutely crenulate along the margin, attenuate to shortly attenuate at the base, 10–30 mm long 4.5–10 mm wide, flattish, glabrous, not or very slightly spurred; pedicels glabrous, usually 3–5 mm long in the flowering time but after elongate, 8–10 mm long. Flowers in June and July, dioecious, almost 5-merous, opening upward. Calyx 4–6(–9) mm long, thick herbaceous, green or (often?) dull red, the tube 1.4–2.4(–3) mm long (equalling about 1/2 of the lobes), tapering below, the lobes 2.6–4(–6) mm long 0.7–1.2 mm wide, nearly erect, valvate, flattish, linear to linear-elliptic or very narrowly ovate (SADT n. 36), entire along the margin, obtuse at the apex, the sinus between lobes obtuse to round, the veins not prominent. Petals distinct, valvate in bud, spreading to diffuse (♂) or nearly erect (♀) at anthesis, oblong-ovate or obovate to angularly obovate, round to obtuse at the apex, entire along the margin, 4.5–7 mm long 1.3–1.5 mm wide, glabrous, convex outside and concave inside, bright crimson or reddish purple or violet-blue when living but in dried material usually dull yellow. Stamens slightly longer than the petals, ascending or erect at anthesis; filaments nearly filiform but slightly tapering from the base, about 0.3 mm wide at the base, glabrous, pale reddish, somewhat fleshy, obcompressed, the oppositipetalous ones inserted 1.5–2 mm from the base and mostly 4–6.5 mm long, the alternipetalous ones distinctly shorter than another, usually 4–6 mm long; anthers basifixed, nearly ellipsoidal with round apex, 0.7–1 mm long, probably before anthesis purplish red and after dehiscence deep yellow. Nectar-scales oblong (SADT n. 16) to broadly oblong (SADT n. 17), ascending and very slightly outcurved, concave ventrally and convex dorsally, usually 0.8–1.2 mm high 0.8–0.9 mm wide about 0.15 mm thick, nearly truncate to rather emarginate at the apex, probably reddish. Gynoecium of female plants usually 7–10 mm long, erect to suberect, connected 1.5–2 mm ventrally from the base, dorsally adnate to the calyx-tube, the ovary nearly straight ventrally, somewhat obtusely keeled dorsally, opposite to the calyx-lobe and nectar-scale, 1.5–2 mm wide, widest between the middle and the base, the uppermost dorsal side more or less abruptly narrowing but hardly outcurved, the style indistinct, gradually tapering from the ovary, straight, about 2–3 mm long, ending into an epapillate stigma; the placenta nearly marginal. Gynoecium of male plants 4–6 mm long, usually shorter than the stamen. Ovules (6–)8–12 in each locule, ellipsoidal with elongate apex, about 0.8 mm (♀) or 0.4–0.6 mm (♂) long; those of male plants usually abortive (?). Follicles dirty red or brown, erect, 12–13 mm long. Seeds reddish brown, 2.0–2.3 mm long 0.8 mm thick, ellipsoidal with elongate apex, obtuse at the apex, the testa longitudinally minutely striate.

← Fig. 41. *Sedum crenulatum* Hook. f. et Thoms. a–e. Leaves, $\times 3.75$, f & g. Pistils in lateral view, $\times 7.5$, h. Nectar-scale in dorsal view, $\times 15$, i–l. Calyx-lobes, $\times 15$, m–o. Petals of male flowers with stamen, $\times 15$, p & q. Petals of female flowers, $\times 15$. (a. Mc Cosh 376, b, g–h, j & q. Hooker s.n., c. Kanai et al. 3238, d. Bowes-Lyon 3411, e, k & m. Forrest 12833, f & p. Forrest 6622, i & n. Littledale s.n., l & o. Hooker s.n.).

Distr. Nepal, Sikkim, Tibet, Bhutan, and Yunnan.

Specimens examined. Nepal. Rolwaling Khola, alt. 17800 ft. Scree (Bowes-Lyon 2196 ♂, BM; TI); Inukhu Khola, Naulekh Mathi, 27°30' N, 86°45' E, alt. 16000 ft. On moraine. Flowers violet blue; stamens reddish (Mc Cosh 376, BM; TI). Sikkim. Yeumtong, alt. 14000 ft. (Hooker s.n. on Sept. 6, 1849 ♂, κ (in Herb. Hooker)—Lectotype of *Sedum crenulatum* Hook. f. et Thoms.); Donkiah, alt. 10000 ft. (Hooker s.n. on Sept. 9, 1849 ♀, κ—Syntype of *Sedum crenulatum* Hook. f. et Thoms.). Tibet. Meenk La (King's collector s.n. ♀, CAL); Gooring Valley, 30°12' N, 90°25' E, alt. ca. 16500 ft. (Littledale s.n. in July–Aug. 1895 ♂, κ—Holotype of *Sedum rotundatum* Hemsley); Niti Pass, alt. 16800 ft. (Strachey & Winterbottom 15, κ—Syntype of *Sedum crenulatum* Hook. f. et Thoms.); Sarong, On Doker-la, Mekong-Salwin divide, 28° 20' N, alt. 12000 ft. Open ledges of cliffs and humus covered boulders. Flowers bright red-crimson (Forrest 14707 ♂, E). Bhutan. Bomtang, Shur Chu, alt. 15400 ft. Among boulders facing south. Flowers red & showy (Bowes-Lyon 3411 ♂, BM); Lingshi–Yale la–Shodu, alt. 4500 m. (Kanai, Murata, Ohashi, Tanaka & Yamazaki 3238 ♂, TI); near Yale la, alt. 4650 m (Nishioka s.n. ♀, TI). Yunnan. Prope Likiang, monte Yülingshan (Handel-Mazzetti 3822 ♂, GB—Isotype of *Sedum euryphyllum* Fröd.); eastern flank of the Lickiang Range, 27°30' N, alt. 13–14000 ft. Stony alpine pasture. Flowers deep rose (Forrest 6622 ♀, E); mountains of the Chungtien Plateau, 27°30' N, alt. 13000 ft. Open ledges of cliffs and on stony pasture. Flowers crimson (Forrest 12833 ♂, E); Yung Ning; the summit, in grass flower bed (Mc Laren's collector 85 ♂, E).

This species closely related with *Sedum imbricatum* and also *S. heterodontum* but is distinguished from the latter two mainly in having shortly petiolate and typically or broadly elliptic leaves and crimson or purple or violet-blue flowers.

Fröderström (1930) considered that *Sedum rotundatum* Hemsley was conspecific with *S. bupleuroides*, and he treated the former as a variety of the latter. However the holotype specimen of *S. rotundatum* (Littledale s.n. ♂, κ) seems to exceed the variation range of *S. bupleuroides* especially in petals, styles and inflorescences; i.e., the shape of male petals linear or linear-obovate against narrowly obovate or oblong-obovate or elliptic in *S. bupleuroides*; the size of the petal 5.5–7 × 0.8–1.5 mm against 2.8–4 × 1.2–1.6 mm; styles 0.3–0.8 mm long against less than 0.3 mm long; inflorescences a simple corymb-fascicles against a compound-corymb. As compared with the authentic specimens of *S. crenulatum*, the type specimen of *S. rotundatum* has extremely large leaves with nearly entire margin, but the size and serration of leaf of *S. crenulatum* as defined above show a considerable variation among the specimens examined. Therefore *S. rotundatum* may not be distinguishable specifically from *S. crenulatum*.

S. euryphyllum is quite similar to *S. crenulatum* as pointed out by Fröderström (1931) in the original description as “modo crescendi et inflorescentia congesta involucreta affine videtur *S. crenulato* . . .”. The isotype specimen of *S. euryphyllum* (Handel-Mazzetti 3822 ♂, GB) has broadly or typically elliptic leaves with nearly entire margin. The leaves is 18–24 × 14–15 mm in size. As regard the size of leaf, *S. euryphyllum* represents an intermediate state between *S. crenulatum* s. str. and

S. rotundatum. Judging from the photograph of the type, *S. megalanthum* seems to represent an intermediate state between *S. rotundatum* and *S. euryphyllum*. Therefore, the variation of its size is considered to be continuous. Then I consider these four species to be conspecific, as I could not find any reliable differences between them.

Sedum Wallichianum Hooker, Icon. Pl. 7: t. 604 (1844)—Hook. f. et Thoms. in Journ. Linn. Soc. Bot. 2: 100 (1858)—Weibel in Candollea 16: 145 (1958)—Hara, Fl. E. Himal. 107 (1966), pro parte. [Fig. 42 1–o]

Sedum crassipes Wall. [Cat. no. 7234 (1832), nom. nud.] ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. 2: 99 (1858)—Maxim. in Bull. Acad. Sci. St.-Petersb. 29: 127 (1883), in adnota—Diels in Engl., Bot. Jahrb. 29: 360 (1901), versim.—Praeger in Journ. Roy. Hort. Soc. 46: 55, fig. 20 (1921); in Not. Bot. Gard. Edinb. 13: 77 (1921)—Fröd. in Act. Hort. Gothob. 5: append. 35 (1930), excl. var. *Cretini* (R.-Hamet) Fröd. et *S. Stephani*; loc. cit. 15: 11 (1942); in Hand.-Mzt., Symb. Sin. 7: 407 (1931); in Bull. Fan Mem. Inst. Biol. Bot. 7: 12 (1936)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. 18a: 442 (1930)—Kitamura in Kihara, Fauna Fl. Nepal Himal. 140 (1955), excl. specim. cit.

Sedum asiaticum (D. Don) DC. sensu C. B. Clarke in Hook. f., Fl. Brit. Ind. 2: 419 (1878), cum var. *Wallichianum*—W. W. Smith in Rec. Bot. Surv. Ind. 4: 259 (1911)—Limpricht in Fedde, Repert. Beih. 12: 391 (1922), versim.—Rao in Rec. Bot. Surv. Ind. 18: 29 (1961), versim.

Chamaerhodiola crassipes (Wall. ex Hook. f. et Thoms.) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, 1: 30 (1934).

Rhodiola crassipes (Wall. ex Hook. f. et Thoms.) A. Boriss. in Komarov, Fl. USSR 9: 476 (1939), in obs.

Rhodiola Wallichiana (Hook.) Fu in Act. Phytotax. Sin. Addit. 1: 125 (1965).

A perennial herb, up to 30 cm high. Rhizomes long elongate, nearly cylindrical, solid, usually 2–3 cm thick, up to 20 cm long, usually not or very scarcely branched except the basal part, eburneous, marked by elliptic scars of flowering stems, creeping except the ascending or suberect apical part, the apical part always epigaeous and crowned by scaly leaves, the base continuously tapering to the dauciformed root. Scaly leaves chartaceous, more or less persistent, rigidulous later, triangular to triangular-ovate or concaved-triangular, acute at the apex, nearly entire along the margin, ferruginous in the beginning, chestnut- or blackish brown later, 3–8 mm long 2–6 mm wide. Flowering stems 5–12 in number, annual, simple, nearly terete, glabrous, usually nearly smooth but often papillate in the upper parts (the papilla about 0.1 mm long), usually fastigiate, 15–30 cm long 3–6 mm thick at anthesis, somewhat accrescent later, slightly yellowish green, the old flowering stem occasionally remaining. Leaves alternate, rather densely arranged throughout, spreading widely, sessile, nearly spurless, thick herbaceous, usually linear to very narrowly ovate (SADT n. 36) or rarely very narrowly elliptic (SADT n. 1), usually 1.2–3 cm long 1.2–6 mm wide, nearly flattish above, somewhat round beneath, obtuse at the apex, long attenuate at the base, remotely and irregularly crenulate in the upper half but nearly entire in the lower half along the margin (the teeth 1–6 in number, convex in the basal side, straight in the apical side, round at the apex), bright or yellowish green above, slightly pale

green beneath, glabrous, mostly epapillate, the costa shallowly depressed, the lateral veins usually 4-7 on each side of the costa, nearly parallel to diverging, scatteringly anastomosing. Inflorescences terminal, dense, nearly globosal to hemispherical, 2-3.5 cm across, bracteate, forming simple corymb-fascicles; the cluster usually 3-4 in number, (1-)2-3-flowered; peduncles and pedicels 1-4 mm

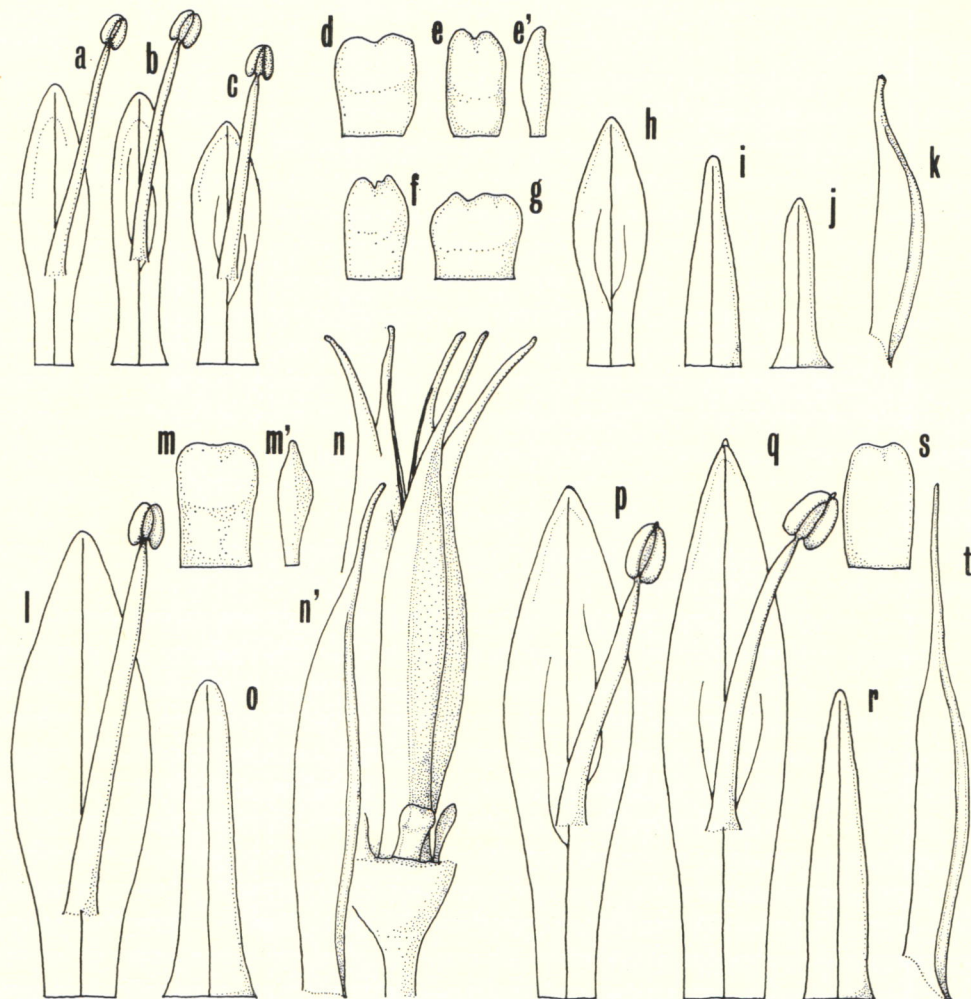


Fig. 42. *Sedum Cretinii* R.-Hamet (a-k). a-c. Petals with stamen, $\times 7.5$, d-g. Nectar-scales in dorsal and lateral (e') views, $\times 15$. h. Petal of female flower, $\times 7.5$, i & j. Calyx-lobes, $\times 7.5$, k. Pistil in lateral view, $\times 7.5$. *Sedum Wallichianum* Hook. (l-o). l. Petal with stamen, $\times 7.5$. m. Nectar-scale in dorsal and lateral (m') view, $\times 15$, n. Pistils, $\times 7.5$. o. Calyx-lobe, $\times 7.5$. *Sedum nepalicum* H. Ohba (p-t). p & q. Petals with stamen, $\times 7.5$. r. Calyx-lobe, $\times 7.5$, s. Nectar-scale in dorsal view, $\times 15$, t. Pistil in lateral view, $\times 7.5$. (a-c Kanai et al. 726352, d-k. Kanai et al. 726348, l-o. Kanai, Hara & Ohba 726012, p, s & t. Stainton, Sykes & Williams 2222, q. Stainton, Sykes & Williams 2045).

long, nearly terete, usually densely or rarely moderately papillate (the papilla pellucid, mostly capitellate, about 0.1 mm across); bracts leafy, very similar to the upper cauline leaves in shape, usually 5–7 mm long 1–1.5 mm wide. Flowers in middle July to early September, hermaphrodite, mostly 5-merous but sometimes 4- or 6-merous, 1–1.2 cm across at anthesis, the alabastrum oblong, obtusely pointed, pale greenish white or pinkish. Calyx 6–8.5 mm long, green, glabrous, the tube usually less than 1 mm long, the base rather continuously tapering to the pedicel, the lobes 5.6–8 mm long 1.3–1.7 mm wide (equalling about the $\frac{3}{4}$ of the petal in length), narrowly triangular (SADT n. 73) or subulate, nearly entire along the margin, round and often reddish at the apex, somewhat round outside, flattish inside, not spreading and rather appressed to the petals alternately. Petals distinct, distinctly imbricated or quincunx in bud, usually pale greenish or yellowish white or often pinkish, somewhat fleshy, glabrous, ascending or slightly spreading at anthesis, usually narrowly elliptic or often linear, round at the apex, shallowly boat-shaped, entire along the margin, 7–11 mm long 1.8–2.5 mm wide. Stamens slightly shorter or longer than the petal, ascending at anthesis; filaments linear-filiform, obcompressed, somewhat fleshy, glabrous, white or pinkish, about 0.4 mm wide at the base, the epipetalous ones inserted about 1.5 mm from the base, and 7–8 mm long, the alternipetalous ones 7.5–12 mm long; anthers basifixed, ellipsoidal or ovoidal, usually 0.4–0.6 mm long, round or slightly retuse at the apex, before anthesis dark purplish red, after dehiscence turning yellow. Nectar-scales oblong, very shallowly retuse at the apex, slightly concaved inside, flattish outside, 1–1.2 mm long 0.6–0.7 mm wide about 0.3 mm thick, pale yellow to orange yellow. Gynoecium 9–14 mm long, usually slightly longer than the petal, very shortly connate (ca. 0.5 mm) ventrally at the base, erect, pale greenish white, the ovary 6.5–10 mm long 1.2–2 mm wide, nearly straight ventrally, gradually tapering to both ends from the middle in dorsal side, the style often outcurved slightly, mostly 2.5–4 mm long, the stigma very slightly swelling, epapillate; the placenta nearly marginal. Ovules 28–36 in each locule, mostly descending, ellipsoidal, somewhat elongate and round at the apex, 0.4–0.6 mm long, the funicles 0.2 mm long.

Distr. Kashmir, Nepal, Sikkim, and Tibet.

Specimens examined. Kashmir. Lowari Pass, alt. 11000 ft. (Harriss 16155, CAL). Nepal. (Scully 231, CAL); Thakurji Lekh, near Jumla, alt. 12000 ft. Growing between boulders by stream. Sepals & petals pale yellow; filaments pale yellow; anthers dark green; ovaries pale yellow with orange glands (Polunin, Sykes & Williams 4718, BM); Annapurna Himal, Seti Khola, alt. 12000 ft. Among boulders. Petals pale green. Anthers orange (Stainton, Sykes & Williams 6673, BM; TI); Lete, S. of Tukucha, Kali Gandaki, alt. 11000 ft. On rocky slopes amongst shrubs (Stainton, Sykes & Williams 7911, BM); Khola Kharka, alt. ca. 13500 ft. Banks. Flowers yellow (Polunin 1074, BM); Bimtakothi, alt. 12500 ft. Moss-covered rocks on old moraine. Flowers greenish white tinged pink; stamens brown pink. Leaves yellow green (Lowndes 1440, BM); Singum Gompa–Gosainkund, alt. 3300 m. On mossy rocks (Kanai, Hara & Ohba 726012, TI); Gosainthan (Wallich 7234, BM, CAL–Type collection of *Sedum crassipes* Hook. f. et Thoms.); Brangechen

Kharka, alt. 13500 ft. Rocky ground. Petals pale green; ovaries red when ripe (Polunin 1711, BM); East of Chalike Pakar, alt. 13000 ft. Among boulders on river bed. Flowers greenish; anthers fawn (Stainton, Sykes & Williams 3740, BM); Maharigam, alt. 14000 ft. Among boulders and on grassy slopes. Flowers pale yellow; anthers yellowish-brown (Polunin, Sykes & Williams 209, BM); above Tankia, alt. 14000 ft. Between boulders beside river. Petals, filaments & ovaries pale yellow; anthers brown (Polunin, Sykes & Williams 3012, BM); Topke Gola, alt. 3600 m. On rocks by stream (Kanai, Ohashi, Iwatsuki, Ohba & Shakya 726010, TI); Beding, sables de Rohraling Khola, alt. 3600 m. Fleurs jaunes (Zimmermann 1423, BM); loc. cit. alt. 12–13000 ft. Flowers greenish yellow (Dhwoj 277, BM); Sangmo, alt. 12–18000 ft. (Dhwoj 293, BM); Lamrak, alt. 10–14000 ft. (Dhwoj 176, BM); Tang Boche, Khumbu, alt. 13000 ft. On wet rocks (Horsfall 23, BM); Thamu–Thami valley, Khumbu, alt. ca. 12500 ft. In moss on wet rocks near river (Horsfall 58, BM); Bagmati zone, Rasuwa District, Changbu, above Khangyin, alt. 3750 m. On rocks. Inflorescence reddish (Nicolson 2582, BM). Sikkim. (King's collector s.n., CAL); regio. alp. alt. 12–16000 ped. (Hooker s.n., CAL—Type collection of *S. crassipes* Hook. f. et Thoms.); Rishenang, alt. 13000 ft. (Ribu & Rhomoo 4506, CAL); Zemu (Smith & Cave 1621, CAL); Llonakh (Smith & Cave 2726, CAL). Tibet. Toong Lung (King's collector 4651, CAL).

Sedum Wallichianum is easily distinguishable from its allies in having relatively large (12–30 × 1.2–6 mm in size) linear or very narrowly ovate or very narrowly elliptic leaves and large white hermaphrodite flowers.

Sedum Cretinii R.-Hamet in Journ. Bot. **54**: suppl. 1, 16 (1916), ut '*Cretini*'—Praeger in Not. Bot. Gard. Edinb. **13**: 77, t. 171, 2 (1921) —Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930). [Fig. 42 a–k]

Sedum crassipes Wall. ex Hook. f. et Thoms. var. *Cretinii* (R.-Hamet) Fröd. in Act. Hort. Gothob. **5**: append. 36 (1930).

Chamaerhodiola Cretinii (R.-Hamet) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 30 (1934).

Sedum Wallichianum var. *Cretinii* (R.-Hamet) Hara, Fl. E. Himal. 108 (1966).

A perennial herb, up to 12 cm high. Roots fibrous, scattering. Rhizomes slender, surculose, always creeping except the apical parts, usually 2–4 mm thick, slightly pale yellowish brown, the apical part epigeaeous nearly erect, crowned by scaly leaves. Scaly leaves membranaceous, caducous, triangular-ovate or semiorbicular, obtuse or round at the apex, entire along the margin, usually chestnut-brown, 2–3 mm long 1.5–2 mm wide. Flowering stems (1–)2–3(–5) in number, annual, more or less ascending or nearly erect, usually 6–12 cm long, 0.7–1.1 mm thick, simple, terete, glabrous but under a lens (× ca. 40) densely or moderately mamillate (the mamilla pellucid, usually less than 0.2 mm long), green, the dead flowering stem not persistent. Leaves alternate, rather densely arranged, spreading widely, sessile, mostly shortly spurred (the spur about 0.5 mm long, with obtuse apex) or rarely nearly spurless, flattish, usually linear or very narrowly elliptic (SADT n. 1) or linear-obovate, entire or very minutely crenulate along the margin (the teeth 3–5 in number), acute or obtuse at the apex, long attenuate at the base, (6–)7–10 (–14) mm long 1.5–2.5(–2.8) mm wide, bright or yellowish green,

glabrous, epappillate, sometimes reddish in the apical part, the costa very shallowly depressed, the lateral-veins not prominent, usually 3–5 on each side of the costa, nearly parallel to diverging. Inflorescences terminal, usually 3–20-flowered, bracteate, forming simple corymb-fascicles, up to 2 cm long and 3 cm wide; the cluster usually 3–7 in number, with 3 or 2 flowers; peduncles and pedicels mostly 1–5 mm long at anthesis, elongate afterwards, 5–10 mm long at fruiting, glabrous, nearly smooth or very sparsely mamillate (the mamilla about 0.1 mm long), terete; bracts leafy, very similar to the upper cauline leaves. Flowers in middle June to August, dioecious, usually 5-, often 4-, rarely 6-merous, usually 6–9 mm wide at anthesis, the alabastrum usually slightly greenish white or rarely reddish. Calyx 3.5–5.5 mm long, green, glabrous, the tube usually 0.6–1.2 mm long, the lobes 2.8–4.5 mm long (equalling $3/5$ – $4/5$ of the petal), 0.4–1.1 mm wide, usually slightly larger in the female, subulate or linear, entire along the margin, round or obtuse at the apex, shallowly boat-shaped or flattish. Petals distinct, slightly greenish or yellowish white, but often reddish near the apex, sessile, somewhat fleshy, glabrous, ascending at anthesis, usually very narrowly elliptic (SADT n. 1) or linear-obovate or very narrowly angular-elliptic, obtuse at the apex, widest at the middle, flattish in the lower part, shallowly boat-shaped in the upper part, entire along the margin, 3.5–6 mm long 0.9–1.5 mm wide. Stamens slightly (about 1.1 times) longer than the petal, ascending or nearly erect at anthesis; filaments linear-filiform, flattish, somewhat fleshy, glabrous, white or often reddish, about 0.4 mm wide at the base, the epipetalous ones inserted about 1.5 mm from the base, usually 4–6 mm long, the alternipetalous ones 5–7 mm long; anthers basifixed, ellipsoidal or globose, 0.5–0.6 mm long, usually slightly retuse at the apex, before anthesis dark purplish red, after dehiscence turning dull yellow. Nectar-scales broadly oblong (SADT n. 17), shallowly retuse at the apex, concave inside, convex outside, 0.6–0.9 mm long 0.5–0.8 mm wide about 0.2 mm thick, pale yellow to yellowish orange. Gynoecium 5–7 mm long, slightly longer in female plants, usually abortive in male plants, usually shortly connate (0.5–1 mm) ventrally at the base, sessile, erect, usually greenish white or often slightly reddish, the ovary 4–5.5 mm long 0.7–1.2 mm wide, nearly straight ventrally, gradually tapering upwards from the middle in dorsal side, the style often slightly incurved, mostly 1.3–1.5 mm long, the stigma slightly swelling, minutely mamillate; the placenta nearly marginal. Ovules 14–24 in each locule, descending, ellipsoidal, round at the apex, about 0.6 mm long, the funicles about 0.2 mm long. Follicles usually 7–10 mm long, nearly erect, rosy- or pale chestnut-brown. Seeds usually 1.6–1.9 mm \times 0.5–0.7 mm in size, the testa more or less thick, glabrous, chestnut-brown.

Distr. Nepal, Sikkim, Tibet, and Bhutan.

Specimens examined. Nepal. Irukhu Khola, Dadh Kosi, alt. 14000 ft. Flowers greenish red (Bowes-Lyon 2077, BM); Arun Valley, Barun Khola, N. of Num, alt. 12500 ft. On rock-ledges. Flowers yellow (Stainton 674, BM, TI); Banduke Pokhari-Saju Pokhari, alt. 4000–4200 m. Among rock crevices by stream. Flowers cream (Kanai, Ohashi, Iwatsuki, Ohba & Shakya 720521, TI); Topke Gola-Jalang Chhyongo, alt. 4300 m. By streams. Petals milky white, often with reddish apex,

anthers before anthesis purplish-red (K.O.I.O. & S. 726353, τ_1); Lama Chungbu-Samdan, alt. 4300 m. By streams. Flowers creamy white (K.O.I.O. & S. 726348, τ_1); Kipudonsu, alt. 3850 m. By streams. Flowers creamy white or pale reddish white (K.O.I.O. & S. 726352, τ_1). Sikkim. Jongri-Olohang, alt. 4000–4200 m. On mossy tree trunk by stream (Hara, Kanai, Murata, Togashi & Tuyama 6676 & 6675, τ_1). Bhutan. Laya, upper Wo chu, alt. 14000 ft. In dry gravelly ravines (Ludlow, Sherriff & Hicks 16466, BM); Guicha La, alt. 15000 ft. (Ribu & Rhomoo 6633, E); Gucha La, alt. 16000 ft. (Rohmoo Lepcha 1007, E).

Having surculose rhizomes, *Sedum Cretinii* is very characteristic among the Himalayan Rhodiola. By the character this species is easily recognizable among other species. *S. Cretinii* is considerably related with *S. Wallichianum* Hook., but apparently differs from the latter in this character and also in having dioecious flowers, deciduous scaly leaves, shorter and narrower leaves, small calyx, small petals, etc. *S. linearifolium* is also similar to *S. Cretinii*, but is distinguished from the latter in having hermaphrodite flowers, pauciflorous inflorescences, and broader petals. *S. fastigiatum* is somewhat similar to *S. Cretinii*, but is clearly distinguishable from the latter in having densely tufted remains of the old flowering stems, more or less massive rhizomes and relatively broad leaves.

In E. Nepal, *S. Cretinii* occurs in altitudes from 3850 m to 4300 m and grows in such habitats as scree, windswept, ridges, gravelly ravines, etc. The male and female plants are usually found together in each isolated colony.

Sedum nepalicum H. Ohba in Journ. Jap. Bot. **49**: 322, fig. 1, a–f (1974).
[Plate 10b; Fig. 42p–t]

A perennial herb, usually 10–30 cm high. Rhizomes very thick, subcylindrical, 6–10 mm in diameter, more or less epigeous, erect to ascending, the base tapering to the long creeping dauciformed root (up to 20 cm long), the upper part accrescent and well branched. Rhizomatoclasts 1–7 in number, usually epigeous, fleshy, subcylindrical, solid, erect to ascending, 10–25 mm long, 3–8 mm thick, rather densely covered with scaly leaves. Scaly leaves chartaceous, more or less persistent, triangular to broadly triangular or broadly trullate (SADT n. 59), 5–10 mm long 3–8 mm wide, acuminate or acute to obtuse at the apex, entire along the margin, deep brown to chestnut-brown. Flowering stems 3–5 from each rhizomatoclast, annual, not persistent when dead, usually 10–30 cm long, erect, simple, nearly terete, glabrous, under a lens (\times ca. 10) always densely or moderately papillate (the papillae pellucid, 0.2–0.3 mm long), greenish, the scars of fallen leaves slightly arisen in dried materials. Leaves alternate, spreading, somewhat remotely arranged (the internodes distinctly shorter than the leaf-length), nearly sessile, almost spurless, thick herbaceous, flattish, glabrous but under a lens (\times ca. 10) sparsely papillate on both surfaces (the papillae pellucid, less than 0.3 mm long), narrowly elliptic or narrowly ovate, 10–45 mm long 6–15 mm wide, 1.5–3.5 times longer than broad, usually round or rarely acute obtusely at the apex, long cuneate to cuneate-attenuate to attenuate at the base, 5- or 7-lobulate or remotely crenate-serrate, under a lens (\times ca. 40) sparsely papillate along the margin, the teeth triangular to broadly triangular with acute or obtuse apex, the sinus between teeth angulate (the angle 60° – 100°), the costa not pro-

minent, the lateral veins 5–7 on each side of the costa, diverging. Inflorescences terminal, 6–12(–15)-flowered, bracteate, forming a simple corymb or a loosely compound corymb, the cluster 3–4 with mostly 3 but occasionally 2 or very rarely single flower; peduncles 5–10(–25) mm long, nearly terete, usually very densely or rarely moderately papillate (the papillae 0.2–0.3 mm long); bracts sessile, the larger ones similar to the upper cauline leaves in shape and size, but smaller ones very narrowly ovate or very narrowly obovate with obtuse apex, nearly entire along the margin, 3–8 mm long 0.7–2 mm wide; pedicels 1–4(–6.5) mm long, nearly terete, mostly very densely or rarely moderately papillate. Flowers in August and September, hermaphrodite, mostly 5-merous, 7–10 mm wide at anthesis. Calyx 5–7 mm long, thick herbaceous, green, glabrous, the tube $1/5$ – $1/7$ as long as the lobes, tapering below, hardly papillate; the lobes linear to linear- or very narrowly ovate-triangular with entire margin, round or obtuse at the apex, 4–5.5 mm long 1–1.5 mm wide, nearly flattish, under a lens (\times ca. 40) sparsely papillate or epapillate, the papilla less than 0.1 mm long. Petals white, distinct, rather thin, glabrous, nearly erect or ascending at anthesis, narrowly elliptic or very narrowly obovate (SADT n. 45) with very shortly mucronulate-obtuse apex, entire but under a lens (\times ca. 40) very minutely undulate along the margin, round outside and concave inside, 8.5–10(–15) mm long 2–2.3(–3) mm wide, 4(–5) times longer than breadth. Stamens usually as long as the petals or rarely slightly shorter than those, ascending at anthesis; filaments subulate, fleshy, flattish, glabrous, white, about 0.5 mm wide at the base, the epipetalous ones inserted mostly about 3 mm from the base, 4.5–5.5(–10) mm long, the alternipetalous ones 7.5–9(–13) mm long; anthers basifixed, narrowly ellipsoidal with very minute projection at the apex, 0.8–1.2 mm long, before anthesis probably dark purplish red, after dehiscence turning yellowish. Nectar-scales oblong with entire margin, slightly to moderately emarginate or truncate at the apex, flattish, probably yellow when living but pale yellowish in dried materials, 0.9–1.2 mm long 0.6–0.7 mm wide about 0.2 mm thick. Gynoecium 12–16(–18) mm long, connected about 1 mm ventrally from the base, sessile, erect, white; the ovary 8.5–10(–13) mm long, straight or very slightly incurved ventrally, dorsally more or less round and tapering upwards from the middle, broadest near the middle. 1.2–1.5 mm wide; the style usually 3.5(–5) mm long, more or less oblique, ending into an epapillate stigma; placenta nearly marginal. Ovules 14–24 in each locule, descending, ellipsoidal with round apex, usually 0.5 mm long.

Distr. W. and C. Nepal.

Specimens examined. Nepal. Dolpo, Lcharka, 29°00' N, 83°26' E, alt. 14500 ft. On riverside gravel. Flowers white (Stainton 5566, BM); Samargaon, N. of Tukucha, Kali Gandaki, alt. 13000 ft. Dry open hillside. Petals & filaments white, anthers red (Stainton, Sykes & Williams 7243, BM, TI); loc. cit. On rocks. Leaves pinkish yellow (Stainton, Sykes & Williams 8095, BM); Tegar, N. of Mustang, alt. 15000 ft. On rock ledges. Petals and filaments white, anthers brown (Stainton, Sykes & Williams 2222, BM—Holotype of *Sedum nepalicum* H. Ohba, TI—Isotype); Muktinath, alt. 12500 ft. On rock beneath, shade of trees. Petals and filaments white; anthers red; calyx green (Stainton, Sykes & Williams 2045, BM, TI).

This species is closely related with *Sedum Stephanii* Chamisso from the Transbaicalian region, but differs from the latter in having papillate stems, larger and papillate leaves, and white flowers. From *S. ovatisepalum* and *S. sacrum*, *S. nepalicum* is clearly distinguishable in having narrowly elliptic or narrowly ovate leaves, elliptic or very narrowly obovate petals and relatively large gynoecia.

Sedum bupleuroides Wall. [Cat. no. 7229 (1832), nom. nud.] ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 98 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 418 (1878)—W. W. Smith et Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911)—W. W. Smith in Rec. Bot. Surv. Ind. **4**: 259 (1911) et 371 (1913)—R.-Hamet in Not. Bot. Gard. Edinb. **5**: 120 (1912); **7**: 131 (1912); **8**: 140 (1913)—Praeger in Journ. Roy. Hort. Soc. **46**: 46, fig. 16 (1921)—Limpricht in Fedde, Repert. Beih. **12**: 391 (1922)—Fröd. in Act. Hort. Gothob. **1**: 29 (1924); **5**: append. 43 (1930), cum var., sed excl. var. *discolor* (Franch.) Fröd. et var. *rotundatum* (Hemsl.) Fröd.; **15**: 11 (1942); in Hand.-Mzt., Symb. Sin. **7**: 407 (1931); in Bull. Fan Mem. Inst. Biol. Bot. **7**: 12 (1936); in Ark. Bot. **30** A (9): 5 (1943), cum var. *parvum* Fröd.—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930)—Kitamura in Kihara, Fauna Fl. Nepal Himal. 140 (1955)—Weibel in Candollea **16**: 143 (1958)—Hara, Fl. E. Himal. **2**: 41 (1971). [Plate 3c; Figs. 43, 44]

Sedum elongatum Wall. [Cat. no. 7233 (1832), nom. nud.] ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 98 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 419 (1878)—W. W. Smith et Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911)—W. W. Smith in Rec. Bot. Surv. Ind. **4**: 259 (1911) et 371 (1913)—Praeger in Journ. Roy. Hort. Soc. **46**: 41, fig. 12 (1921)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 440 (1930)—Hara, Fl. E. Himal. **2**: 41 (1971); non Ledeb. (1843).

Sedum Cooperi Praeger in Journ. Bot. **57**: 49 (1919), non Clemenc. (1868).

Sedum discolor Franch. sensu Praeger in Not. Bot. Gard. Edinb. **13**: 78 (1921), pro parte, incl. specim. 'Forrest 2441 et 5690' cit., sed excl. specim. 'Cooper 26 et 128' cit. quae vere *S. discolor* Franch.—Fröd. in Act. Hort. Gothob. **1**: 29 (1924), versim.

Sedum bhutanense Praeger in Journ. Roy. Hort. Soc. **46**: 43, fig. 13, 14 (June 6, 1921)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 440 (1930).

Sedum bhutanicum Praeger in Not. Bot. Gard. Edinb. **13**: 73 (Aug. 1921).

Rhodiola bupleuroides (Wall. ex Hook. f. et Thoms.) Fu in Act. Phytotax. Sin. Addit. **1**: 124 (1965).

Rhodiola Hookeri Fu in Act. Phytotax. Sin. Addit. **1**: 124 (1965).

Rhodiola bhutanica (Praeger) Fu in Act. Phytotax. Sin. Addit. **1**: 125 (1965).

Sedum Thomsonianum H. Ohba in Journ. Jap. Bot. **48**: 331 (1973).

A perennial herb, very variable in size, usually 5 to 100 cm high. Rhizome thick, elongate or stout, usually massive or nearly obconical, solid, sparsely branched in well developed state, usually 1–3 cm across, up to 10 cm long, usually chestnut- or dark brown, the apical part more or less epigaeous, densely scaly. Scaly leaves chartaceous, ascending or erect, persistent, usually triangular or often oblong-ovate, acuminate to obtuse at the apex, entire along the margin, 1.5–8 mm long 0.5–6 mm wide, ferruginous in the beginning, chestnut- or blackish-brown later. Flowering stems usually 1–2, but rarely (in a dwarf form) 5–10 in number,

annual, usually erect or rarely ascending, nearly terete, glabrous, usually epapillate but often papillate throughout or in the upper part (the papilla usually 0.1–0.2 mm long), usually 5–100 cm long 1–5 mm thick, caducous. Leaves alternate, spreading widely, sessile to shortly petiolate (the petiole less than 10 mm long), spurless, thick herbaceous, flat, very variable in shape and size, usually narrowly, normally or broadly elliptic (SADT n. 2–5), nearly circular or narrowly, normally or broadly ovate (SADT n. 37–40) or obovate (SADT n. 46–49) or oblong-ovate, mostly 0.3–9.5 cm long 0.4–4.5 cm wide, round or obtuse in apical part, acute to very shortly cuspidate or obtuse to round at the apex, cordate or shortly attenuate or long attenuate at the base, entire to somewhat remotely and irregularly serrate along the margin (the teeth 4–8 in number on each side, nearly straight or convex in the apical side, convex in the basal side, round or obtuse at the apex, 0.5–2 mm long, the sinus between the teeth truncate or round), glabrous, mostly emamillate or rarely minutely mamillate on both surfaces and the margin (the mamilla less than 0.05 mm long), the costa not prominent above and usually slightly raised beneath, the lateral veins obscure, usually 4–8 on each side of costa, diverging. Inflorescences terminal, forming a peculiar corymb, usually 7–100-flowered, bracteate, the primary inflorescence-axes 1–4; peduncles 0.2–3 cm long, epapillate or densely papillate (the papilla 0.2 mm long); pedicels 0.2–1.5 cm long, epapillate or densely papillate; bracts similar to the cauline leaves in shape but smaller, 0.3–5 cm long 0.2–1.8 cm wide, mostly epapillate. Flowers dioecious, late June to August, mostly 5-merous, 4–7 mm across at anthesis. Calyx 1.6–8 mm long, glabrous, purplish red or dull purplish red, the tube 0.8–2.2 mm long, more or less funnel- or saucer-shaped, the lobes 0.8–6 mm long 0.3–1.2 mm wide, 1/2–3/4 (♂) or more or less equalling (♀) the petal in length, narrowly oblong or oblong-ovate or narrowly triangular, entire along the margin, round or obtuse at the apex, erect (♀) or ascending (♂) at anthesis, somewhat round outside, rather flattish inside, the sinus between lobes round or obtuse. Petals distinct, dark purplish-red, in male usually obovate to narrowly obovate or rarely ovate, in female narrowly oblong to oblong or narrowly oblong-ovate, usually 2.8–4 mm long and 1.2–1.6 mm wide (♂), 1.5–3 mm long and 0.5–0.7 mm wide (♀), nearly entire along the margin, round at the apical part, truncate to round and often very shortly mucronulate (♂) or round (♀) at the apex, glabrous, spreading very widely to somewhat reflexed (♂) or ascending to spreading (♀) at anthesis, in the upper 2/3 part shallowly boat-shaped. Stamens usually as long as the petal, ascending or erect at anthesis; filaments subulate, obcompressed, glabrous, usually purplish red, about 0.4 mm wide at the base, the epipetalous ones inserted about 0.5 mm from the base, 2–3.5 mm long, the alternipetalous ones 3–4 mm long; anthers basifixed, ovoidal, round or slightly retuse at the apex, usually 0.5–0.7 mm long, before anthesis dark- or dull-purplish red, after dehiscence turning yellow. Nectar-scales narrowly oblong to oblong (SADT n. 14–15) or rarely broadly oblong (SADT n. 17), round at the apical part, usually shallowly retuse at the apex, usually flattish but often in the upper 1/3 part recurved, shining, dark purplish- or blackish-red, 0.6–1.2 mm long 0.3–0.7 mm wide 0.2 mm thick. Gynoeceum of female plants usually 3.5–9 mm long (mostly 3–5 times as

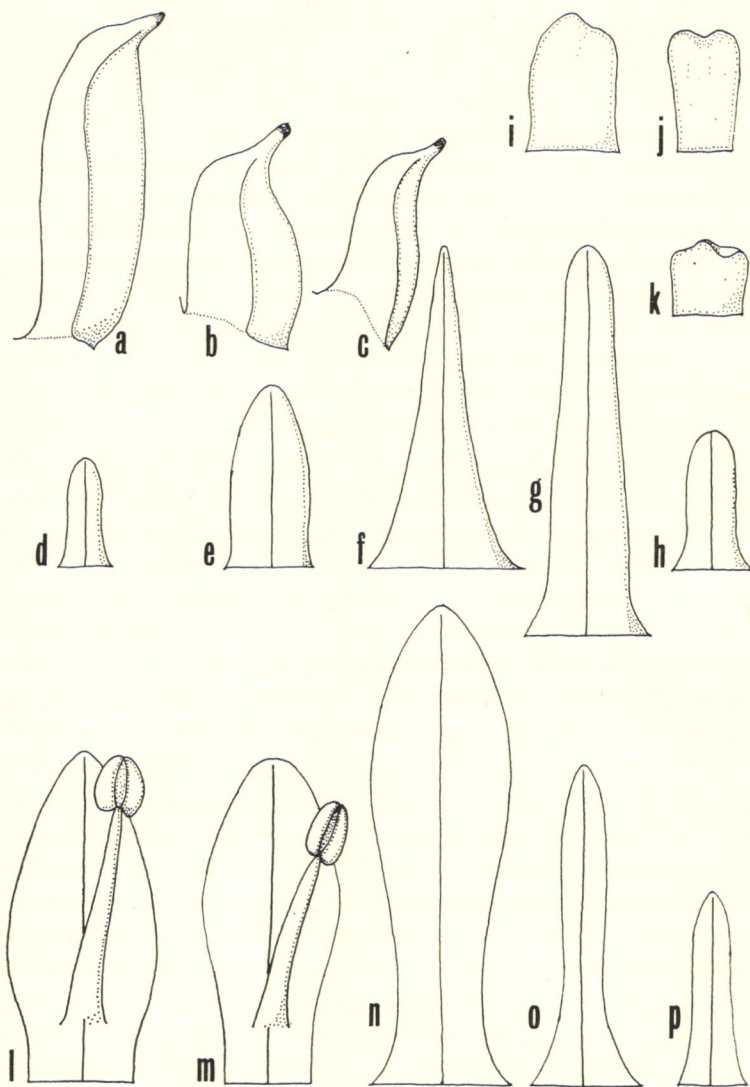


Fig. 43. *Sedum bupleuroides* Wall. ex Hook. f. et Thoms. a-c. Pistils in lateral view, $\times 7.5$, d-k. Calyx-lobes, $\times 15$, i-k. Nectar-scales in dorsal view, $\times 15$, l & m. Petals of male flowers with stamen, $\times 15$, n-p. Petals of female flowers, $\times 15$. (a, f, j & n. Kanai et al. 726029, b, g, i & o. Kanai et al. 726018, c, h & p. Kanai & Shakya 672011, d, k & l. Kanai et al. 672011, e & m. Ludlow, Sherriff & Hicks 16620).

long as the petal), connected 1.2–1.7 mm ventrally from the base, sessile, nearly erect to ascending, usually pale green but often tinged red, dorsally adnate to the calyx-tube; the ovary opposite to the calyx-lobe and nectar-scale, 1–2 mm wide, usually widest near the base, the uppermost part abruptly narrowing and conspicuously outcurved; the style very short, less than 0.3 mm long, usually dark

purple red; the stigma rather distinct, mostly epapillate but rarely minutely papillate (the papilla 0.05 mm long); the placenta nearly marginal. Gynoecium of male plants much smaller, usually 0.8–2 mm long, always shorter than the petals and stamens, similar to the female one in shape, ovules mostly absent. Ovules of female plants 10–16 in each locule, descending, nearly ellipsoidal, 0.7–0.8 mm long, round at the apex, the funicles about 0.2 mm long. Follicles 5–12 mm long, usually ascending or rarely suberect in the upper part, brown. Seeds reddish brown, nearly tubular, round at the apex, usually 1.8–2.5 mm long.

Distr. Nepal, Sikkim, Tibet, Bhutan, Yunnan, and N. W. Burma.

Specimens examined. Nepal. Gosain Than (=Gosainkund) (Wallich 7229, K, BM, CAL—Type collection of *Sedum bupleuroides* Wall. ex Hook. f. et Thoms.); Gosainthan (=Gosainkund) (Wallich 7233A, K, BM, CAL—Type collection of *Sedum elongatum* Wall. ex Hook. f. et Thoms.); Gosainkund, alt. 4000 m (Kanai, Hara & Ohba 726363, TI); Gosainkund–Surjakund, alt. 4350 m (Kanai, Hara & Ohba 726364, TI); Surjakund–Gopte, alt. 3650 m. On exposed rocky banks (Kanai, Hara & Ohba 726365, TI); Gopte–Thale Patil, alt. 3200 m. On exposed rock (Kanai, Hara & Ohba 726366, TI); Thale Patil–Hile Dhap, alt. 3400 m. On exposed bank (Kanai, Hara & Ohba 726367, TI); Thale–Dunche, about 1 km below Dunche, alt. 2000 m. On exposed rock surface (Kanai, Hara & Ohba 726025, TI); Trisuli Khola–Singum Gompa, alt. 2200 m. On rocks (Kanai, Hara & Ohba 726027, TI); Dunche, alt. 6600 ft. On shady and moist rocks. Flowers green (Malla 6577, BM); Chilime Kharka, alt. ca. 16000 ft. (Polunin 1422A, BM); loc. cit. alt. 13000 ft. Rocky places. Flowers red (Polunin 1416, BM); loc. cit. alt. 15–16000 ft. Rock face. Flowers red (Polunin 1273, BM); Oo kharka, alt. 3100 m. On rock. Petal purple (Kanai & Shakya 92, TI); Lantang. Rocky bank in forest. Flowers green (Polunin 598, BM); Lantang–Birdim, alt. 9500 ft. Rocks. Flowers green (Polunin 717, BM); Sringi Himal, Shiar Khola, alt. 15000 ft. (Gardner 631, BM); loc. cit., alt. 17000 ft. Flowers deep wine red (Gardner 637, BM); Taglung, S. of Tukucha, Kali Gandaki, alt. 11000 ft. Open grass slopes. Corolla and filaments dark red (Stainton, Sykes & Williams 1727, BM); Sangdah, N. of Tukucha, alt. 14000 ft. Open stony slopes. Corolla and filaments dark red; anthers green (Stainton, Sykes & Williams 7324, BM); Samargaon, N. of Tukucha, alt. 15500 ft. Open rocky slopes. Inflorescences red (Stainton, Sykes & Williams 7291, BM); Tukucha, Kali Gandaki, alt. 12000 ft. Open grass alp. Inflorescence green externally, red brown internally (Stainton, Sykes & Williams 1180, BM); loc. cit., alt. 12500 ft. Open grassy slopes. Corolla and filaments dark red; anthers green (Stainton, Sykes & Williams 1918, BM); Jargeng Khola, alt. 16000 ft. On rocks. Flowers bright crimson (Lowndes 1142, BM); Thumje, alt. 3300 m (S. Nakao s.n., KYO); Thaple Himal, alt. 4500 m (Nakao s.n., KYO, TNS); Thinigaon, Muktinath Himal, alt. 14500 ft. Open hill side. Inflorescence dark red (Stainton, Sykes & Williams 1259, BM); Bhurchula Lekh, near Jumla, alt. 11–11500 ft. Open slopes. Sepals green; petals green without, red within; filaments red; anthers green (Polunin, Sykes & Williams 4606, BM); Namdo, N. of Mustang, alt. 17000 ft. On gravel at edge of stream. Inflorescence dark red (Stainton, Sykes & Williams 2349, BM); de Beding aux Patuigees, alt. 3900 m. Rochers exp. Sud (Zimmermann

1431, BM); Khangsar, alt. 12500 ft. In tussocky grass on banks of a stream. Flowers reddish green (Lowndes 1233, BM); near Pudamigaon, Suli Gad, alt. 12500 ft. Among rocks. Flowers dull pinkish (Polunin, Sykes & Williams 2242, BM); Rambong, Lamjung Himal, alt. 13500 ft. Growing from rock crevice. Sepals green; petals red; anthers green-yellow (Stainton, Sykes & Williams 6114, BM); Tilicho Pass path, alt. 15800 ft. Growing in wet mud among boulders in river (Barclay & Synge 2627, K); Choker, alt. 16000–18000 ft. Flowers dark red turned black (Dhwoj 382, E); Soongoorey, alt. 13000 ft. (Dhwoj 243, BM); Rambong, Lamjung Himal, alt. 13000 ft. On open slopes. Petals red internally (Stainton, Sykes & Williams 6084, BM, TI); near Bolangra Pass, alt. ca. 13000 ft. Among rocks in crevices of ledges. Flowers red, stems more or less reddish especially near the top. Stamens with greenish anthers (Polunin, Sykes & Williams 2558, BM); Sulo Khola, alt. 15000 ft. Growing on open slopes. Stems red. Leaves glaucous green or tinged red (Polunin, Sykes & Williams 3487, BM); Phoksunde Khola, alt. 12000 ft. (Shrestha 5362, BM); Maharigaon, alt. 10500 ft. Growing on vertical mossy trunks of cliff in *Betula*-forest. Flowers red (Polunin, Sykes & Williams 189, BM); Sabze Khola, alt. 13500 ft. On rocks (Lowndes 1209, BM); loc. cit., alt. 12500 ft. Top of a big boulder. Flowers dull red crimson. Leaves glaucous (Lowndes 1085, BM); near Dogadi Khola, alt. 12500 ft. Open slopes in ravines; among rocks. Flowers brownish (Stainton, Sykes & Williams 3233, BM); near Chalike Pahar, alt. 15000 ft. Grass slope. Flowers reddish (Stainton, Sykes & Williams 3774, BM, TI); above Sauwala Khola, alt. 12500 ft. Rock ledges. Flowers dark red. Pedicels dark red (Stainton, Sykes & Williams 2992, BM); Tinki Dzong, alt. 16500 ft. Stony soil. Flower dull red (Hingston 336, K); Chumba, Khumbu, Phorche Khola, alt. 13000 ft. In crevices or on trees. Flowers dull red (Bowes-Lyon 2154, BM); Maghang Khola, E. of Num., Arun Valley, alt. 10600 ft. On rock ledges. Corolla and filaments red; anthers yellow (Stainton 832, BM); Topke Gola, alt. 3600 m. On mossy rock by stream. Flowers purplish red; anthers before anthesis deep red (Kanai, Ohashi, Iwatsuki, Ohba, & Shakya 726017, TI); Topke Gola–Jalang Chhyongo, alt. 3800 m. On rock. Flowers dark purplish red (K. O. I. O. & S. 726018, TI); Thudam–Lama Chungbu, alt. 3600 m. On rock. Flowers purplish red (K. O. I. O. & S. 726019, TI); Thudam–Kipudonsu, alt. 4000 m. On rocks. Flowers dark purple (K. O. I. O. & S. 726021, TI); Phujeng La–Topke Gola, alt. 3800 m. On exposed rock. Flowers reddish purple (K. O. I. O. & S. 726022, TI); Topke Gola–Shewaden, alt. 3150 m (K. O. I. O. & S. 726024, TI); Sangjin Bhanjyang–Serpagaon, alt. 8500 ft. On shady rocks (Malla 9020, BM); Mahalangur Himal, Khumbu. Moraines of Khumbu Glacier near Lobuche, alt. 4950 m (Poelt 6233, BM); Surkhet, alt. 9500 ft. Herb on shady and moist slope. Flowers pinkish white (Banerji & Shakya 5617, BM); Chiami (King's collector s.n., CAL). Sikkim. 11–12000 ft. (Hooker 878, CAL); regio. temp. alt. 11–13000 ft. (Hooker s.n., K, CAL); Lachung Valley, Meumtong, alt. 11000 ft. (Gammie 987, CAL); Keydoon, alt. 6500 ft. (King's collector s.n., CAL); Tallum Pandong, alt. 12000 ft. (King's collector s.n., CAL); Megutang–Nayatang (Hara, Kanai, Murata, Togashi & Tuyma 6668, TI); Tosa, alt. 14000 ft. (Ribu & Rhomoo 4483, CAL); Narthu La, Chola Range,

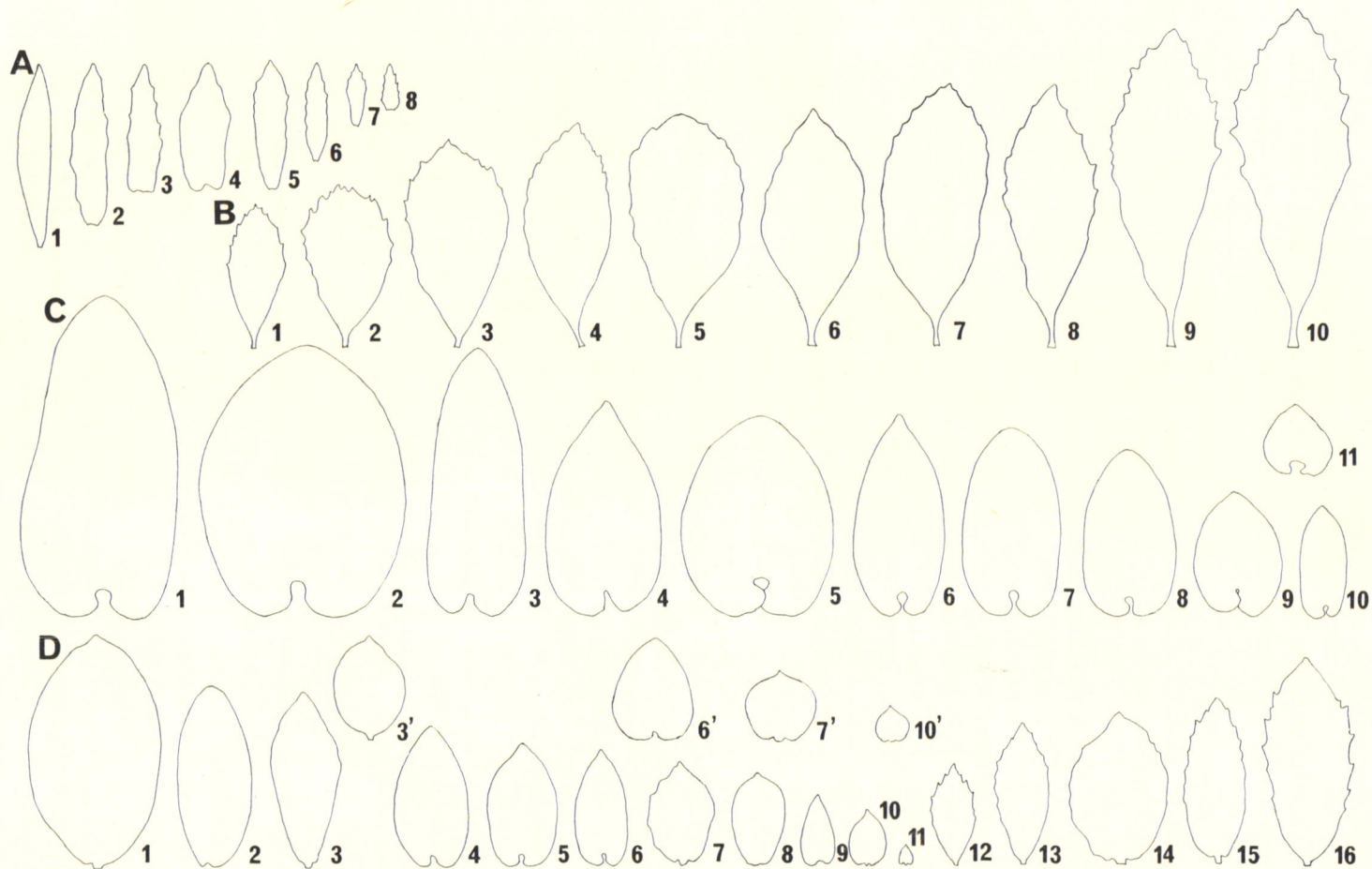


Fig. 44. Variation of leaf in *Sedum bupleuroides* Wall. ex Hook. f. et Thoms., all $\times 1/2$. A₁. Kanai, Hara & Ohba 726363, A₂. Wallich 7233A, A₃. K. H. & O. 726364, A₄. Malla 6577, A₅. Stainton, Sykes & Williams 6114, A₆. S. S. & W. 7271, A₇. Polunin 1416, A₈. Lowndes 1233. B₁₋₁₀. Kanai, Ohashi, Hara, Iwatsuki & Ohba 726025. C₁₋₁₁. Kanai, Hara & Ohba 726025. D₁. Stainton 832, D₂. Banerji & Shakya 5617, D_{3,3'}. Polunin, Sykes & Williams 2558, D₄. Wallich 7229, D₅. Polunin 717, D_{6,6'}. Malla 9020, D_{7,7'}. Stainton, Sykes & Williams 3233, D₈. Polunin 1273, D₉. Polunin 598, D_{10,10'}. S. S. & W. 2349, D₁₁. S. S. & W. 1259, D₁₂. S. S. & W. 3774, D₁₃. S. S. & W. 6084, D₁₄. Polunin, Sykes & Williams 4606, D₁₅. P. S. & W. 189, D₁₆. P. S. & W. 4604.

alt. 14000 ft. (Gammie 1323, CAL); Rishenang, alt. 13000 ft. (Ribu & Rhomoo 4511, CAL); Lacheng Valley (Gammie s.n., CAL); Samdong (Prain's collector 219, CAL); Nuttung (King's collector 4354, CAL); Phalut, alt. 3900 m. Flowers dark red (Hara, Kurosawa & Ohashi s.n., π); loc. cit. On more or less shaded floor of *Rhododendron Hodgsonii*-forest. Flower dark purple or purplish red (Kanai, Ohashi, Hara, Iwatsuki & Ohba 726030, π); loc. cit. On exposed rocky slopes. Flowers dark purple (K. O. H. I. & O. 726029, π); Phalut-Singalila, alt. 3600 m (K. O. H. I. & O. 721411, π). Tibet. (King's collector s.n., CAL); Yem-la. (King's collector s.n., CAL); Yunso near Chumbi. Flowers red (King's collector s.n., CAL); Phari, alt. 14000 ft. (Cave s.n., ϵ); Valley to east of Yangu, alt. ca. 13700 ft. (Younghusband s.n., CAL); Lingmootang, Chumbi (King's collector s.n., CAL); Kambazong (Prain s.n., CAL); Go-ling-te-yang near Chumbi. Flowers red (King's collector s.n., CAL); Kongbo, Tamnyen La, alt. 11500 ft. On mossy banks of stream. Calyx, petals & filaments crimson; anthers reddish brown; glands very dark crimson; carpels crimson (Ludlow, Sherriff & Taylor 4937, BM); Kongbo, Kyikar, alt. 9700 ft. On dry gravelly banks in *Quercus-Ilex*-forest (Ludlow, Sherriff & Taylor 5311, BM); Kongbo, Valley above Tripe, alt. 10000 ft. On dry soil bank. Plant up to 2 feet. Sepals, petals, filaments & carpels green; anthers yellow (Ludlow, Sherriff & Taylor 5392, BM); Kangbo, Tamnyen Chu, alt. 10000 ft. (Ludlow, Sherriff & Taylor 4973, π); near Trashirake (Kawaguchi s.n., π). Bhutan. Cheka-Tremo La, alt. 4000 m (Nishioka s.n., π); Me La, south side, alt. 14500 ft. Scree. Flowers opening brown becoming somewhat yellow (Ludlow, Sherriff & Hicks 20351, π); Chumolari, alt. 16000 ft. (Rohmoo Lepcha 524 & 526, ϵ); head of western branch of Pho Chu, alt. 14000 ft. On wet rocks. Calyx and corolla green at base, tipped dark brown; filaments and anthers yellow; ovary and styles green (Ludlow, Sherriff & Hicks 16620, BM , π); Lunma, Kung Richen Tzo, alt. 16500 ft. Rocky soil. Flowers pale green tipped deep red (Bowes-Lyon 3463, BM). Yunnan. A-tun-tsu, alt. 14500 ft. On rocks, etc. (Kingdon-Ward 985, ϵ); loc. cit., alt. 13000 ft. On rocks (Kingdon-Ward 564A, ϵ); Eastern flank of the Lichiang Range. Lat. 27° 20' N, alt. 9000-10500 ft. Dry, stony, open situations, ledges of cliffs, etc. Flowers reddish-brown; anthers green (Forrest 2441, ϵ); Eastern flank of the Lickiang Range, Lat. 27° 15' N. Open mountain pasture. Flowers deep red (Forrest 5690, ϵ). Burma. Upper Burma, 26° 24' N, 98° 48' E, alt. 13000 ft. On humus covered boulders and ledges of cliffs (Forrest 27114, κ).

Sedum bupleuroides is one of the most polymorphic species in the subgenus *Rhodiola* and has been variously delimited. Moreover, several closely allied species have hitherto been described as distinct from *S. bupleuroides* mainly based on the shape of leaf and the degree of papillation. Praeger (1921) recognized five species as closely allies, i.e. *S. bhutanense* Praeger (or *S. bhutanicum* Praeger), *S. bupleuroides* Wall. ex Hook. f. et Thoms., *S. discolor* Franch., *S. elongatum* Hook. f. et Thoms., non Ledeb. and *S. purpureoviride* Praeger. While Fröderström (1930) considered seven species, i.e. the five species mentioned above plus *S. rotundatum* Hemsley and *S. suboppositum* Maxim., as conspecific and recognized four varieties within *S. bupleuroides* i.e. var. *bupleuroides*, var. *discolor*, var. *purpureoviride* and var. *rotundatum*.

Having examined a large number of materials both in herbaria and in field, I consider that *S. bhutanense* and *S. elongatum* are conspecific with *S. bupleuroides* as already treated by Fröderström (1930), and that both *S. purpureoviride* and *S. discolor* are distinguishable specifically from *S. bupleuroides*. Also, *S. rotundatum* is regarded as conspecific with *S. crenulatum*. But I could not study satisfactorily on *S. suboppositum*.

Variation on the shape and size of leaves of *S. bupleuroides* as defined above are illustrated in Fig. 44. Two examples of the variation within a population are included in the figure (B & C). The C of Fig. 44 shows the variation within a relatively small population of C. Nepal. The population was found on the exposed surface of a sedimental rock along the valley near Dunche (alt. 2100 m) together with such small shrubs and herbs as *Coriaria nepalensis*, *Benthamidia capitata*, *Toricellia tiliaefolia*, *Thalictrum rotundifolium*, *Iris decora*, etc. In the population, the leaves of *S. bupleuroides* are narrowly oblong-ovate to typically oblong-ovate or ovate and always entire along the margin, and their sizes vary from 2 to 9 cm in length and from 1.3 to 5.8 cm in width. These plants quite agree with the type material of *S. bupleuroides*, i.e. Wallich 7229 from 'Gosain Than', as shown in the same figure (Fig. 44, D₄). While, the B of the figure shows the variation within a relatively scattered population. The population was spread on exposed windswept stony grassland and rarely extending continuously in *Rhododendron Hodgsonii*-forest along the ridges of Mt. Singalila near Phalut (alt. 3900 m). The leaves of *S. bupleuroides* in the population are narrowly oblong-obovate or obovate-elliptic with an irregularly serrate margin, and their sizes vary from 4 to 9.6 cm in length and from 1.8 to 3.5 cm in width. These plants well agree with *S. bhutanense*. In these two examples, the variation in the shape of leaves of *S. bupleuroides* is recognizable as relatively stable within each population. However, I could not find any discontinuous populations of the species as shown in the figure.

Sedum discolor Franchet in Journ. de Bot. **10**: 285 (1896)—Praeger in Not. Bot. Gard. Edinb. **13**: 78 (1921), cum add. descript., pro parte; incl. specim. 'Cooper 26 et 128' cit., sed excl. pl 173 etiam excl. specim. 'Forrest 2441 et 5690' cit. quae *Sedum bupleuroides* Wall. ex Hook. f. et Thoms.—Fröd. in Act. Hort. Gothob. **1**: 29 (1924), verisim. [Plate 10c; Fig. 45]

Sedum tibeticum Hook. f. et Thoms. sensu Praeger in Journ. Roy. Hort. Soc. **46**: 49 (1921), incl. fig. 17.

Sedum bupleuroides Wall. ex Hook. f. et Thoms. var. *discolor* (Franch.) Fröd. in Act. Hort. Gothob. **5**: append. 45 (1930); in Hand.-Mzt., Symb. Sin. **7**: 407 (1931).

Rhodiola discolor (Franch.) Fu in Act. Phytotax. Sin. Addit. **1**: 124 (1965).

Sedum euphorbioides Franchet in sched., non Schlecht. ex Ledeb. (1843).

A perennial herb, up to 25 cm high. Rhizomes nearly cylindrical, elongate, usually 0.7–1.4 cm thick, 2–5 cm long, well branched, pale brown, solid, the base continuous to the long cylindrical root (usually up to 15–20 cm), the branches (rhizomatoclastes) slender in the beginnings, cylindrical, 3–4 mm across, but gradually accrescent and branching afterwards, the apical part usually epigaeous, usually ascending but often creeping, covered with scaly leaves. Scaly leaves

chartaceous, deciduous, nearly erect, usually triangular or triangular-ovate, nearly entire along the margin, round or obtuse at the apex, chestnut-brown or blackish-brown, usually much darker inwards, 1.5–4 mm long 1.5–2.5 mm wide. Flowering stems annual, (1–)2–3 in each rhizomatoclad, simple, terete, glabrous, always epapillate, smooth, pale green or often lacking green shade, usually more or less glaucous, 7–28 cm long, 1.5–2.5 mm thick, the former year's stems occasionally remaining. Leaves alternate, arranged throughout the stem, spreading widely, sessile, nearly spurless, thick herbaceous, linear-ovate or narrowly oblong-elliptic, usually (9–)15(–25) mm long 2–4 mm wide, usually 4.2–7 times longer than breadth, flattish, glabrous, epapillate, usually triangular in the apical part, usually acute or rarely obtuse at the apex, mostly truncate at the base, remotely and irregularly denticulate along the margin (the teeth 3–5 in number on each side, round at the apex, convex in the basal side, straight or convex in the apical side), deep aeruginose above, pale green and somewhat to conspicuously glaucous beneath, often slightly reddish at the apex, in the basal leaves usually reddish or brownish on both surfaces, the costa more or less prominent beneath, the lateral veins obscure, 3–5 on each side of the costa, first nearly parallel and diverging from the middle towards the margin, the veinlets anastomosing. Inflorescences terminal, 6–20-flowered, hemispherical or rather flattish, 1.5–3 cm across, more or less bracteate, forming a compound-corymb; the cluster usually 4–7 in number, consisting of (1–)3 flowers; peduncles 2–4 mm long, often reddish, glabrous, epapillate; pedicels usually slightly longer than the peduncle, 3–7 mm long; bracts leafy, comparatively few, very similar to the upper cauline leaves in shape, usually 5–15 mm long 1–3 mm wide. Flowers in middle June to middle August, dioecious, mostly 5-merous, but occasionally 4-merous, 6–8 mm (♂) 4–6 mm (♀) across at anthesis, the alabastrum deep purple or reddish purple, ovoidal. Calyx (3–)3.5–5(–5.5) mm long, glabrous, the tube saucer-shaped (♂) or funnel-shaped (♀), the base more or less tapering to the pedicel, nearly equalling the lobes or shorter, usually green, in female more or less rigid; the lobes 2.5–3 mm long 0.8–1.4 mm wide, usually equalling nearly a half of the petal (♂) or nearly 2/3 of the petal (♀) in length, long- or slightly concaved-triangular or narrowly triangular-ovate or subulate, entire along the margin, usually round or obtuse but rarely truncate or subacute at the apex, somewhat round outside, flattish inside, ascending at anthesis, appressed to the ovaries in female, usually deep red or dark purplish red. Petals distinct, dark purplish red or deep purple, more or less fleshy, usually oblong-elliptic to narrowly oblong-ovate (♂), oblong to narrowly oblong-ovate (♀), usually 5–6 mm long 1.7–2 mm wide (♂), usually 3–4 mm long 0.9–1.2 mm wide (♀), entire along the margin, mostly obtuse at the apex, shallowly boat-shaped (♂) or flattish (♀), glabrous, spreading to widely spreading at anthesis. Stamens distinctly shorter than the petal (equalling the 3/4–5/6 of the petal), ascending or erect at flowering; filaments subulate, more or less fleshy, obcompressed, glabrous, dark purplish red or deep purple, deeper towards the apex, about 0.4 mm wide at the base, the epipetalous ones inserted about 1.2 mm from the base, 3.5–4 mm long, the alternipetalous ones 4.5–5.5 mm long; anthers basifixed, globosal, usually 0.4–0.5 mm across, slightly retuse at the apex, before

anthesis dark purple or dark purplish red, after dehiscence turning yellow. Nectar-scales oblong or square or square-ovate, usually very shallowly retuse at the apex, usually flattish but often recurved in the upper 1/4 part, round inside, concaved outside, conspicuously deep red purple but often pale below a third, 0.7–1.2 mm long 0.4–0.8 mm wide 0.15 mm thick. Gynoecium of female plants usually 7–9 mm long (twice to thrice of the petal in length), sessile, connate ventrally 1.8–2.5 mm from the base, erect, red purple, the connected part adnate to the calyx-tube dorsally; the ovary oppsite to the calyx-lobe and nectar-scale, straight but in the upper part abruptly outcurved ventrally, slightly round dorsally, usually broadest near the middle, 1.5–1.7 mm wide, the style very short, about 0.6 mm long, straight or oblique, very deep purple in the upper half, the stigma inconspicuous, mostly epapillate; the placenta nearly marginal. Gynoecium of male plants usually 2.5–3 mm long, distinctly shorter than the petal and stamen. Ovules of female plants usually 10–14 in each locule, ascending to descending, ellipsoidal, somewhat elongate in the apical part, obtuse at the apex, usually 0.6–0.7 mm long, the funicles about 0.1 mm long; ovules of male plants (0–)2–8 in each locule, about 0.3 mm long, ellipsoidal, round at the apex, probably abortive.

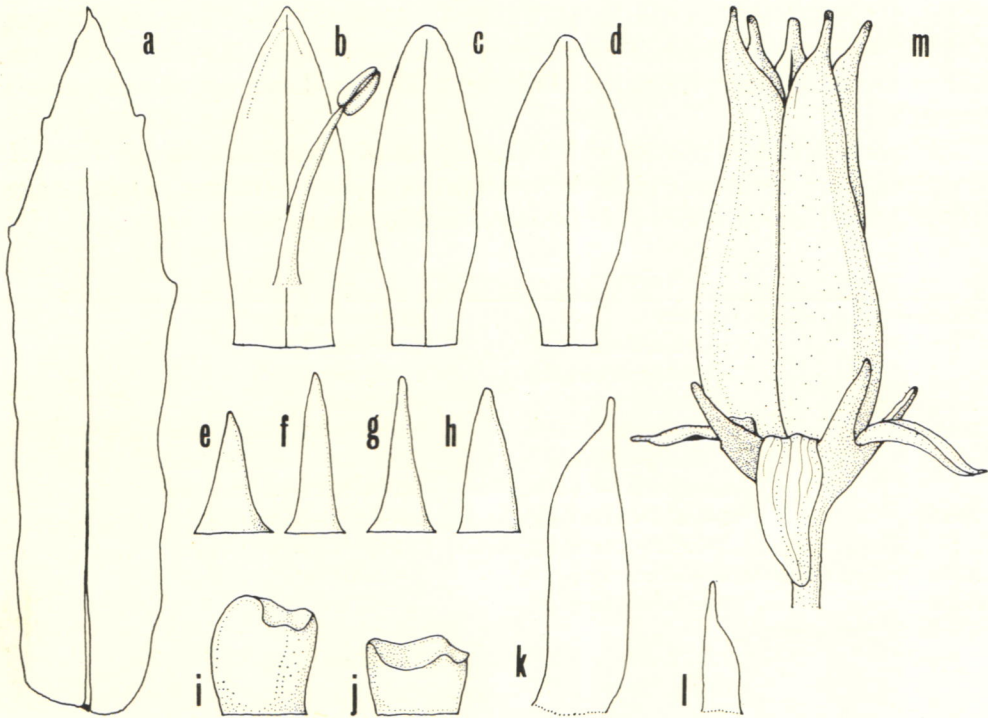


Fig. 45. *Sedum discolor* Franch. a. Leaf, $\times 3.75$, b. Petal of male flower with stamen, $\times 7.5$, c & d. Petals of female flower, $\times 7.5$, e–h. Calyx-lobes, $\times 7.5$, i & j. Nectar-scales in dorsal view, $\times 15$, k. Pistil in lateral view, $\times 7.5$, l. Abortive pistil of male flower in lateral view, $\times 7.5$, m. Female flower, $\times 7.5$. (Kanai et al. 726332).

Follicles 8–10 mm long, erect, reddish brown. Seeds chestnut- or blackish brown, narrowly ellipsoidal with long elongate apex, 2.5–3 mm long.

Distr. Nepal, Sikkim, and Yunnan.

Specimens examined. Nepal. Gosainkund Lake, alt. 4260 m. Stem reddish at the top part (Kanai & Malla 674918 ♀, TI); Gosainkund, alt. 4200 m. On scree (Kanai, Hara & Ohba 726336 ♀, TI); loc. cit. alt. 4400 m. On rocks (Kanai, Hara & Ohba 726338 ♀, TI); Mul Kharka, Chilime Khola, alt. 3800–4100 m. Petals purple (Kanai & Shakya 672268 ♂, TI); Sargadangka, alt. 12000 ft. Flower blue (Sharma E82 ♂, BM); Tangba, alt. 14–15000 ft. (Dhwoj 211 ♂, BM); By Hongku Khola, 27°30' N, 86°45' E, alt. 14000 ft. In short turf. Flowers dark maroon (Mc Cosh 349 ♂, BM, TI); Dudh Kosi, Lumding Khola, 27°88' N, 86°41' E, alt. 12000 ft. On rocks. Flowers dark red (Staiton 4615 ♂, BM, TI); Saju Pokhari, alt. 4000 m (Kanai, Ohashi, Iwatsuki, Ohba & Shakya 726332 ♀, TI); Below Jalang Chhyongo, alt. 3900 m. In dwarf shrubs of *Rhododendron setosum*, *R. Anthopogon*, etc. In moraines. Flowers deep purple-red; glands dark reddish purple; anthers deep red (K. O. I. O. & S. 726333, TI); Kipudonsu–Kipuphu, alt. 4400 m. On boulders (K. O. I. O. & S. 726335 ♂, TI). Sikkim. Changu, alt. 12500 ft. Amongst mossy boulders in old river bed (Cooper 26 ♂, E); Migotang, alt. 3900 m (Hara, Kanai, Murata, Togashi & Tuyama 6677 ♀, TI); along the Choktsering Chu, N. of Jongri, alt. 4000–4500 m (H. K. M. T. & T. 6670 ♀, TI). Yunnan. (Delavay 3691 ♀, P–Syntype of *Sedum discolor* Franch.); Lao-long-tong, Ho-kin, alt. 3500 m. Lisieres des bois. Fleurs rougeatre (Delavay 3771 ♀, P–Lectotype of *Sedum discolor* Franch.).

This species is closely related with *Sedum bupleuroides*, but differs clearly from the latter in having deciduous scaly leaves, narrower leaves, longer petals, longer stamens, etc. These differences are summarized as follows:

	<i>S. discolor</i>	<i>S. bupleuroides</i>
Rhizomes	slender, well branched, ascending or creeping	more or less massive, fewer branched, nearly erect
Scaly leaves	deciduous	persistent
Leaves	linear-ovate or narrowly oblong-elliptic, 0.9–2.5 × 0.2–0.4 cm in size	narrowly to broadly elliptic, ovate or obovate to nearly circular, 0.3–9.5 × 0.4–4.5 cm in size
Petals	5–6 × 1.7–2 mm (♂) 3–4 × 0.9–1.2 mm (♀) in size	2.8–4 × 1.2–1.6 mm (♂) 1.5–3 × 0.5–0.7 mm (♀)
Alternipetalous filaments	4.5–5.5 mm long	3–4 mm long
Anthers	0.4–0.5 mm long	0.5–0.7 mm long
Connected part of gyno- ecia (♀)	1.8–2.5 mm	1.2–1.7 mm

This species is somewhat similar to *S. tibeticum* Hook. f. et Thoms., but differs from the latter in having slenderer and well branched rhizomes, deciduous scaly leaves, thick herbaceous and remotely denticulate leaves, etc.

In E. Nepal, I could find this species on boulder drift occupied by low bushes of *Rhododendron Anthopogon*, *R. setosum*, etc. It is notable that this species was always

found with *Sedum himalense*. While in C. Nepal, I could find this species on steep rocky slopes near the summit of Mt. Gosainkund where are exposed to the strong effect of wind and desiccation, and are commonly occupied by *Astragalus* sp., *Anaphalis* sp., etc. Based on these observation, I consider *S. discolor* is associated with both alpine heath and windward grassland vegetation. This *Sedum*, therefore, seems to be terrestrial.

Sedum callianthum H. Ohba in Journ. Jap. Bot. **49**: 325, fig. 1 g-l (1974).

[Plate 10a; Fig. 46]

A perennial herb up to 20 cm high. Rhizomes nearly cylindrical, solid, up to 3 cm long, 1.2–1.5 cm in diameter, pale lurid, the base tapering to the slender dauciformed root (up to 40 cm long), the upper part densely covered with scaly leaves. Scaly leaves chartaceous, pale rufous, 6–10 mm long 5–12 mm wide, though considerably variable in shape usually triangular to widely or ovate-triangular or depressed trullate, obtuse at the apex, entire along the margin, persistent. Flowering stem annual, 3–5 in number, arising usually 7–10 cm long, 1.7–2 mm thick, nearly erect to ascending, simple, terete, rather sparsely leaved (8–12), glabrous, pale purplish red. Leaves subopposite, petiolate; the petiole 2–3 mm long, almost spurless, somewhat obcompressed, glabrous; the lamina thick herbaceous, flattish, narrowly rhombic-ovate to rhombic-ovate or elliptic to narrowly elliptic, obtuse or deltoid-obtuse at the apex, attenuate and gradually tapering into the petiole at the base, 20–42 mm long 5–20 mm wide, 2–4 times longer than broad, very sparsely minutely papillate (the papillae pellucid and less than 0.1 mm long), glabrous and somewhat lustrous above ca. 2/3 parts crenulate-serrate along the margin but the rest part nearly entire. Inflorescences terminal, bracteate, scatteringly 20–35-flowered, forming a compound-dichasium, the cluster 3, usually with 2–3 dichasia and sometimes a monochasium; peduncles 5–15 mm long, nearly terete, glabrous but under a lens (\times ca. 40) sparsely or scarcely papillate, the papilla less than 0.1 mm long; bracts fewer in number, 3–30 mm long 0.6–12 mm wide, very similar to the upper cauline leaves in shape but often smaller in size linear sessile, round or obtuse at the apex, nearly entire along the margin; pedicels 1.2–2.5 mm long, glabrous, scarcely papillate under a lens (\times ca. 40). Flowers in June, mostly 5- or rarely 4-merous, dioecious(?), about 5 mm in diameter at anthesis. Calyx 1.8–2.4 mm long, fleshy and thick, glabrous, green, the tube about 0.5 mm long, the lobes 1.3–2 mm long 0.6–1.3 mm wide, ovate to narrowly or very broadly or ovately triangular, obtuse to truncate at the apex, entire or often sparsely sinuate upwards along the margin, shallowly convex outside but nearly flattish inside, the veins not prominent. Petals purple, distinct, valvate in bud, spreading horizontally at anthesis, somewhat fleshy, narrowly obovate (SADT n. 46) to obovate (SADT n. 47) or elliptic, round or shortly mucronulate-obtuse at the apex, usually nearly entire but often very minutely erose upwards along the margin, 3–4.5 mm long 0.8–1.5 mm wide, 3–3.3 times longer than breadth. Stamens mostly equalling 2/3–3/4 of the petal, erect or ascending at anthesis; filaments subulate, obcompressed, glabrous, about 0.4 mm at the base, pale purplish, the epipetalous ones inserted about 0.6 mm above the base and 1.5–1.7 mm long, the alternipeta-

lous ones usually 2.5–3 mm long; anthers basifixed, very narrowly ovoidal with nearly round or somewhat retuse apex, 0.5–0.7 mm long, before anthesis deep purplish red, after dehiscence yellowish. Nectar-scales 0.8–1.2 mm long 0.3–0.4 mm wide, narrowly obovate with round apex, flat, entire along the margin, deep purple or purplish red. Gynoecium usually 2–2.5 mm long, connected ventrally about 0.1–0.2 mm from the base, the ovary erect, not gibbous ventrally, dorsally tapering to both ends from the middle, the style indistinguishable, the stigma epapillate; the placenta nearly marginal. Ovules always 2 in each locule, usually descending, ellipsoidal with somewhat elongate apex, the tip itself round, about 0.4 mm long, probably abortive(?).

Distr. C. and E. Nepal.

Specimens examined. Nepal. Rolwaling, 27°55' N, 86°23' E, alt. 14000 ft. In rock ledges. Flowers purplish red (J.D.A. Stainton 4703, BM—Holotype of *Sedum callianthum* H. Ohba, TI—Isotype); Langtang, alt. 12500–13000 ft. Overhanging rock. Flowers brownish red (Polunin 200, BM).

Sedum callianthum is closely related with *S. bupleuroides* Wall. ex Hook. f. et Thoms. in having purplish red flowers, persistent scaly leaves, narrower nectar-scales, etc., but differs in having slenderer rhizomes, broader scaly leaves, narrowly obovate to obovate or elliptic petals, etc. On the contrary, *S. callianthum* is distinguishable

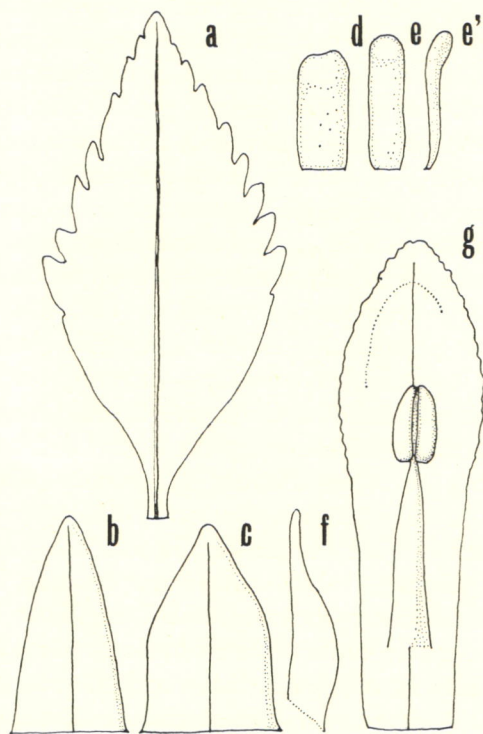


Fig. 46. *Sedum callianthum* H. Ohba. a. Leaf, $\times 1.5$, b & c. Calyx-lobes, $\times 15$, d & e. Nectar-scales in dorsal and lateral (e') views, $\times 15$, f. Pistil in lateral view, $\times 15$, g. Petal with stamen, $\times 15$. (a & b. Polunin 200, c–g. Stainton 4703).

from *S. ovatisepalum* (R.-Hamet) H. Ohba and *S. sacrum* (R.-Hamet) H. Ohba in having purplish red flowers and persistent scaly leaves.

Sedum linearifolium Royle, Ill. Bot. Himal. 222, t. 48, fig. 1 (1835)—Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 100 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 420 (1878), incl. var. *typica* et var. *pauciflorum*—R.-Hamet in Act. Hort. Gothob. **2**: (339–) 394 (1926), pro parte, incl. var. *genuinum* et var. *sinuatum*, sed excl. var. *ovatisepalum*, var. *Balfourii*, var. *Tieghemi*, var. *Dielsianum* et var. *sacrum*—Fröd. in Act. Hort. Gothob. **5**: append. 50 (1930), pro parte, incl. var. *genuinum* et var. *sinuatum*, sed. excl. var. *ovatisepalum*, var. *Balfouri*, var. *Tieghemi*, var. *Dielsianum* et var. *sacrum*—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930), incl. var. *sinuatum*, sed excl. var. *ovatisepalum*, var. *Balfouri*, var. *Tieghemi*, var. *Dielsianum* et var. *sarcum*—Weibel in Candollea **16**: 144 (1958), pro major parte. [Plate 3d; Fig. 47]

Sedum sinuatum Royle [Ill. Bot. Himal. 222 (1835), nom. nud.] ex Edgew. in Trans. Linn. Soc. London **20**: 47 (1846).

Sedum mucronatum Edgew. in Trans. Linn. Soc. London **20**: 48 (1846).

Sedum pauciflorum Edgew. in Trans. Linn. Soc. London **20**: 49 (1846)—Hook. f. et Thoms., loc. cit. 100 (1858).

Sedum trifidum Wall. [Cat. no. 7230 (1832), nom. nud.] ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 100 (1858), nom. illegit., pro major parte—C. B. Clarke, loc. cit. 420 (1878), pro parte—Masters in Gard. Chron. new ser. **10**: 267 (1878), versim. pro minor parte.

Sedum linearifolium Royle var. *pauciflorum* (Edgew.) C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 420 (1878).

Sedum linearifolium Royle var. *sinuatum* (Royle ex Edgew.) R.-Hamet in Act. Hort. Gothob. **2**: 394 (1926)—Fröd., loc. cit. 52 (1930), pro major parte; in Hand.-Mzt., Symb. Sin. **7**: 405 (1931), versim. excl. specim. cit.—Berger, loc. cit. 442 (1930)—Kitamura in Kihara, Fauna Fl. Nepal Himal. 141 (1955), pro parte.

Rhodiola linearifolia (Royle) Fu in Act. Phytotax. Sin. Addit. **1**: 126 (1965), non A. Boriss. (1939).

Rhodiola sinuata (Royle ex Edgew.) Fu in Act. Phytotax. Sin. Addit. **1**: 127 (1965).

Rhodiola trifida (Wall. ex C. B. Clarke) Jacobsen, Sukkulent. Lex. 291 (1970), sine relat. loc.

Rhodiola Fui A. Boriss. in Novit. Syst. Pl. Vasc., Acad. Sci. URSS **6**: 114 (1970), in adnota.

A perennial herb, usually 15–25(–30) cm high. Rhizome slender, the hypogaeous part creeping, up to 20 cm long, 2–5 mm thick, sparsely branched, the epigaeous part usually 1–2 cm long, 3–5 mm thick, but sometimes accrescent more, erect or ascending, the apical part crowned by scale-leaves. Scaly leaves chartaceous rather caducous, triangular or triangular-ovate to shallowly concaved triangular with nearly entire margin, acute or obtuse at the apex, 1.5–3(–5) mm long 1–3(–4) mm wide, blackish brown to chestnut-brown. Flowering stems 1–4(–5) from each apex of rhizome, annual, usually 15–25(–30) cm long, ascending or suberect, simple, terete, glabrous and rather laevis, pale yellowish green, (0.8–)1–2.5

(-2.7) mm thick, the internode always distinctly shorter than the leaf (usually $1/2-3/4$), the old flowering stem hardly persistent. Leaves alternate, remotely or moderately arranged throughout, widely spreading, sessile, spurless, thick herbaceous, flattish, yellowish green, very narrowly obovate (SADT n. 45) to linear-obovate, nearly entire to more or less lobulate in the upper $1/3$ part of the margin, (1-)1.5-3(-3.5) cm long 0.15-2 cm wide, densely papillate or mamillate along the margin (the papilla or mamilla less than 0.1 mm long), glabrous but sparsely or moderately mamillate above (the mamilla less than 0.05 mm high), nearly laevis beneath, usually acute at the apex, mostly long-attenuate at the base; when lobulate the lobes 3(-5) in number, (1-)2-10 mm long 0.8-2(-2.2) mm wide, linear, widely spreading, entire or rarely sinuate along the margin, the upper part acute with round or obtuse apex, the sinus between lobes obtuse or truncate or acute; the costa slightly caved under the upper surface, the veins obscure, the lateral-veins 3-5 on each side of the costa, not reaching the margin. Inflorescences terminal, usually (1-)3-9(-13)-flowered, bracteate, usually forming simple corymb-fascicles or a dichasium; the cluster 3(-4) in number; peduncles 6-10(-12) mm long, glabrous, mostly moderately or densely papillate (the papilla usually 0.1 mm long); pedicels 3-6 mm long, mostly densely or rarely moderately papillate; bracts linear-obovate or linear-ovate, 5-15 mm long 2-4 mm wide, sessile, round or obtuse at the apex, long-attenuate at the base, nearly entire but densely papillate or mamillate along the margin (the papilla or mamilla less than 0.1 mm long), both surfaces glabrous but upper one sparsely papillate. Flowers in late July to middle September, hermaphrodite, mostly 5-merous, 8-18 mm wide at anthesis. Calyx 3-5.5 mm long, yellowish green, the tube usually 0.5-1.2 mm long, glabrous and mostly epapillate, the lobes 2-3.3 mm long (1-)1.5-2.2(-2.5) mm wide, usually ovate to narrowly triangular-ovate, usually entire along the margin, mostly in the upper $1/3$ part more or less abruptly narrowing, round or obtuse at the apex, gibbous outside and hollowed inside in the lower half, slightly convex outside and flat inside in the upper half, sometimes tinged with red near the apex and/or along the margin. Petals spreading at anthesis, distinct, narrowly ovate (SADT n. 37) to ovate (SADT n. 38) or elliptic (SADT n. 2-3), (6-)7-11(-12) mm long 2-4 mm wide, entire along the margin, at the lower $1/3$ part the opposite margins nearly parallel, round or obtuse and often minutely mucronulate at the apex, glabrous and laevis on both surfaces, in the upper $2/3$ part boat-shaped, but flattish in the lower $1/3$ part, milky white inside, pale greenish white or often tinged slightly with red outside. Stamens always shorter (about $4/5$) than the petal, ascending at anthesis; filaments linear-filiform but slightly tapering upward, obcompressed, glabrous, whitish, 0.5-0.7 mm wide at the base, the epipetalous ones inserted usually 2-3 mm from the base and 2.5-3.5 mm long, the alternipetalous ones very shortly (about 0.3 mm) united with the petals or distinct, 5-6.5 mm long; anthers basifixed, ellipsoidal, usually shallowly retuse at the apex, mostly 0.8-1.2 mm long, before anthesis deep red-purple, after dehiscence gradually tinged with deep yellow. Nectar-scales broadly oblong to square, shallowly emarginate or irregularly and minutely retuse or obtusely truncate at the apex, round outside con-

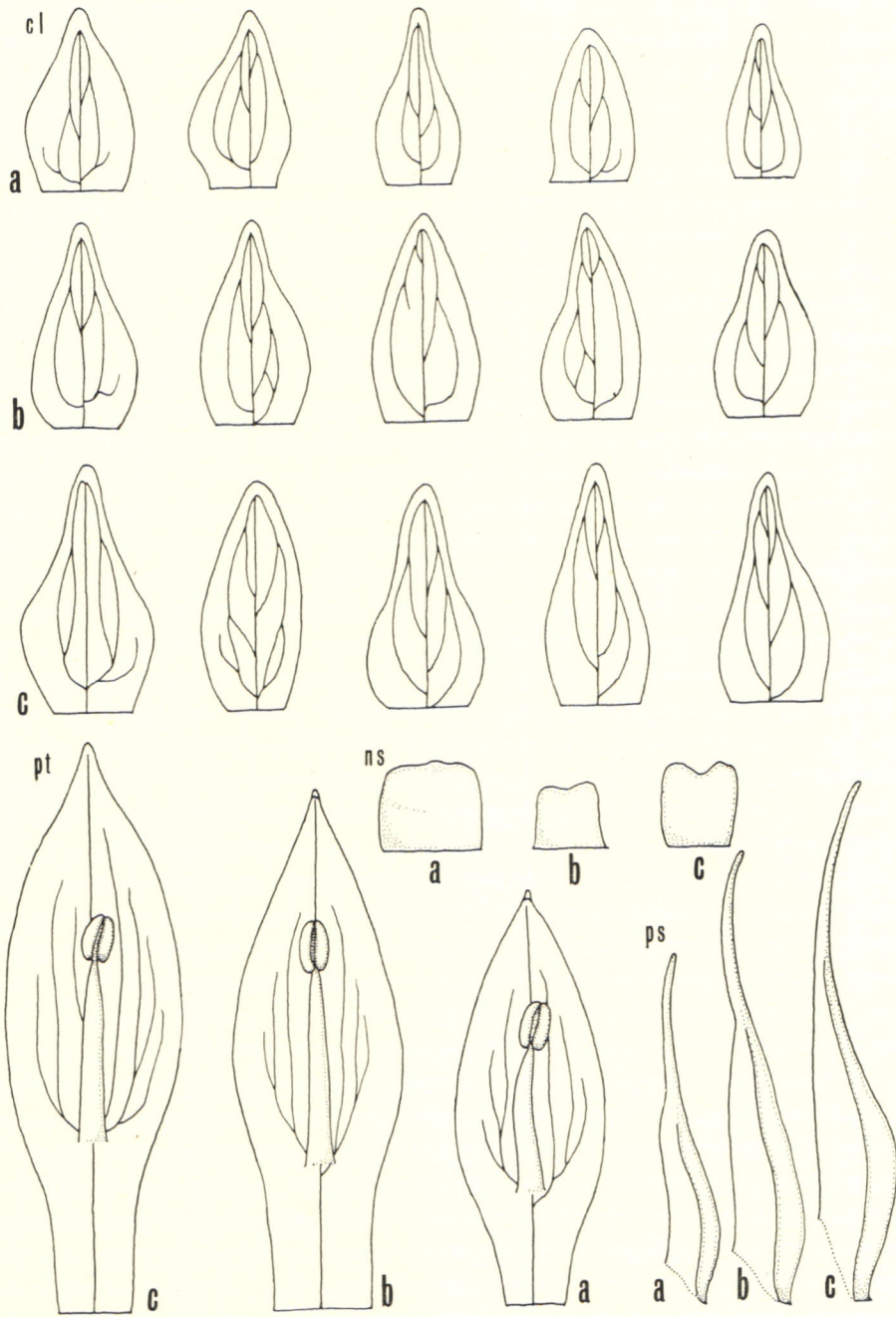


Fig. 47. *Sedum linearifolium* Royle, showing variations of petals, calyx-lobes, nectar-scales and pistils of three flowers within a simple corymb. cl. Calyx-lobes, $\times 7.5$, pt. Petals with stamen, $\times 7.5$, ns. Nectar-scales in dorsal view, $\times 15$, ps. Pistils in lateral view, $\times 7.5$, a & b. Lateral flowers, c. Terminal flower. (Stainton, Sykes & Williams 4709).

caved inside, 0.5–1 mm long 0.4–1.2 mm wide, about 0.2 mm thick, deep or pale yellow. Gynoecium usually 5–10 mm long, white with very slightly greenish shade, slightly connected (0.7–1.5 mm) ventrally at the base, sessile, erect, the ovary not gibbous ventrally, 3.5–5 mm long 0.7–1.3 mm wide, gradually tapering upward from the middle dorsally, the style usually 1.5–3.5 mm long, often slightly outcurved, ending into an epapillate stigma, the placenta nearly marginal. Ovules 12–18 in each locule, descending, ellipsoidal with round or elongate apex, 0.5–0.8 mm long, the funicles about 0.3 mm long.

Distr. Kashmir, Lahore, Kumaon, and Nepal.

Specimens examined. N. W. Himalaya. Kranda, alt. 7–8000 ft. (Edgeworth s.n. in 1844, κ —Lectotype of *Sedum pauciflorum* Edgew.); Sirkanda, alt. 8–10000 ft. (Edgeworth s.n. in 1844, κ —Lectotype of *Sedum mucronatum* Edgew.); Himalaya bor. occ. regio. temp., alt. 6–8000 ped. (Thomson s.n., κ). N. W. India (Herb. Royle, κ —Type collection of *Sedum linearifolium* Royle); Jaunsar Bahar, Rocks above Chukrata, Deoban Range, alt. 7–8000 ft. (Duthie herb. no. 1129, κ). Lahore. Inanali, alt. 7000 ft. On rocks. White flowered (Bor 15318, TNS). Kumaon. (Wallich 7230B, κ —Lectotype of *Sedum trifidum* Wall. ex Hook. f. et Thoms., CAL); Hurdol Pap, alt. 9000 ft. (Strachey & Winterbottom s.n. on Oct. 6, 1848, κ); Ralam, alt. 12000 ft. (Strachey & Winterbottom s.n. on Aug. 24, 1848, κ); Shobala, Darma Valley (Inayat 24434, κ); Mahasu, alt. 6000–10000 ped. On trees (Edgeworth s.n. in 1844, κ); Garhwal, Bhyundar Valley, alt. 2400 m. On mossy rock. Flowers white (Bhattacharyya 29340, τ); Mussooree (Herb. Falconer in Herb. late E. India Company no. 477, κ); loc. cit., alt. 7000 ped. (Bacon s.n. in 1844, κ); loc. cit. Flowers pale pink (Lal s.n., τ); loc. cit. Flowers yellow (Sen s.n., TNS). Nepal. Chaurkot, S.E. of Jumla, alt. 10000 ft. Growing from shady rock crevices. Stems tinged red. Petals white with pink tips. Filaments white, anthers orange (Polunin, Sykes & Williams 5430A, BM); Between Jumla and Garjigath, alt. 10000 ft. Growing from rock crevices. Petals white. Filaments white; anthers brown (Polunin, Sykes & Williams 5022, BM); Near Seng Khola, alt. 11000 ft. Exposed cliff upon ridge. Leaves reddish and succulent. Flowers white, tipped pink (Stainton, Sykes & Williams 4709, BM); Lomgtang, 28°13' N 85°30' E, alt. 3200 m. Sur rochers. Fl. blanches (Dobremez 1017, BM); Pongsing, alt. 15000 ft. (Dhwoj 109, BM); Lantang village area, alt. 11500 ft. Walls. Flowers yellow green (Polunin 1603, BM); Between Kurpani and Ghorai, alt. 4000 ft. Growing on rock faces. Flowers white, anthers brown, styles pale mauve (Polunin, Sykes & Williams 1328, BM); Gangja La—Palchock Danda, alt. 10000 ft. Rocks (Polunin 1966, BM); Audessus de Simigaon, en direction du col, alt. 2700 m. Rochers maussus. Fleurs blanches (Zimmermann 1320, BM); loc. cit., alt. 2340 m. Fleurs blanches (Zimmermann 1306, BM)*; Bagmati Zone, Rasuwa District, East Khangyin, alt. 3750 m (Nicolson 2611, BM); Dudkunda, alt. 13000 ft. (Bailey's collector s.n., BM); Kunde, Khumbu, alt. 12750 ft. On rock. Petals white, tipped pink (Horsfall 13, BM)*; Kyangchin Gomba, 28° 13' N 85° 44' E, alt. 3750 m. Pelouse. Fleurs blanches (Dobremez 1054, BM)*; Launkinayak, alt. 12000 ft. On open slope of mossy rocks. Flowers reddish white (Shrestha & Shakya 3804, BM)*; Bagmati Zone, Sindhu Palchok District, below Helumbu, alt. 2500 m.

Locally abundant on moss covered rock. Plants reddish with cream flowers (Nicolson 2660, BM, KATH)*; Beding, 27°55' N, 86°21' E, alt. 3600 m. Rochers. Fleurs roses (Zimmermann 1405, BM)*; loc. cit., alt. 12000–13000 ft. Flowers white (Dhwoj 269, BM)*; Bhut Pokhni, alt. 16000–17000 ft. Flowers white and pink (Dhwoj 476, BM)*; Dudk Kosi valley, Khumbu below Namche Bazar, alt. ca. 10000 ft. On wet rocks (Horsfall 68, BM)*; Thale–Thale Bisauna, alt. 2600 m. On rock. Flowers white. Anthers red. Ovaries white. Glands yellowish (Kanai, Chuma & Nagano 672808, TI)*; Gopte–Thale Patil, alt. 3300 m. On rock surface. Flowers white (Kanai, Hara & Ohba 726008, TI)*; Gotiora, Gosainkund, alt. 3280 m. On rock in open place. Petals white, sometimes red margined, anthers dark red (Kanai & Malla 674779, TI)*; Tinjure–Tinjure Phedi, alt. 2900 m. On rocks (Kanai, Ohashi, Iwatsuki, Ohba, & Shakya 726007, TI)*; Singum Gompa–Gosainkund, alt. 3600 m. On rocks. Flowers white (Kanai, Hara & Ohba 726014, TI).

This species is clearly distinguished from its closest ally, *Sedum ovatisepalum* (R.-Hamet) H. Ohba, by narrower leaves (very narrowly obovate or linear-obovate with more or less deeply lobulate above a third or nearly entire margin), pauciflorous inflorescences, longer calyx and petals, etc. Geographically *S. linearifolium* ranges from Kashmir to Nepal while *S. ovatisepalum* ranges from Nepal to N. W. Burma through Sikkim, S. Tibet and Bhutan. These two species occur in central and eastern Nepal where no intermediate plant has been found.

S. linearifolium is considerably variable in both vegetative and floral characters. From western Himalaya Edgeworth (1846) validly published three species, i.e. *S. pauciflorum*, *S. mucronatum* and Royle's *S. sinuatum*. Hooker and Thomson (1858) published Wallich's *S. trifidum* with description and an earlier name as synonym, i.e. *S. sinuatum* Royle ex Edgew. *S. mucronatum* was reduced to a synonym of *S. paucifolium* by Hooker and Thomson. R.-Hamet (1926) considered all of these species to be conspecific with *S. linearifolium* Royle. Examining authentic specimens of these species, I came to the same conclusion except for the treatment of *S. sinuatum*. R.-Hamet has recognized *S. sinuatum* as a variety, but I consider the species indistinguishable from *S. linearifolium* even as a variety.

During my field study in E. and C. Nepal, I came across a plant resembling *S. linearifolium*. The plant is very small (5–10 cm high) and has relatively large flowers. Specimens which exactly agree with this plant have been obtained from several localities in C. and E. Nepal and are cited above with an asterisk. As compared with *S. linearifolium*, s. str. the plant differs as follows:

Flowering stem 5–15 from each apex of rhizome, 5–10 cm long, about 0.3–0.6 mm thick. Leaves linear to very narrowly oblong or very narrowly elliptic or rarely ovate, entire or nearly entire along the margin, 0.5–1.3 × 0.08–0.15 cm in size, emamillate. Inflorescence simple corymb, peduncles nearly 0–3 mm long, pedicels 0–1.2 mm long. Calyx 4.5–5.5 mm long, the lobes narrowly triangular-ovate, 4–5 × 0.9–1.3 mm in size. Petals narrowly elliptic to elliptic, 5–7.5 × 1.7–2 mm in size. Stamens 4.2–4.7 mm long, anthers about 0.5 mm long. Gynoecium 5–6 mm long *Sedum* aff. *linearifolium*
 Flowering stem 1–5, 15–30 cm long 0.8–2.7 mm thick. Leaves very narrowly

obovate to linear-obovate, more or less lobulate at the upper a third of the margin or nearly entire, 1–3.5 × 0.15–2 cm, sparsely to moderately mamillate above. Inflorescence simple corymb-fascicles, peduncles 6–12 mm long, pedicels 3–6 mm long. Calyx 3–5.5 mm long, the lobes usually ovate to narrowly triangular-ovate, 2–3.3 × 1–2.5 mm. Petals narrowly ovate to ovate or elliptic, 6–12 × 2–4 mm. Stamens 5–6.5 mm long, anthers 0.8–1.2 mm long. Gynoecium 5–10 mm long *S. linearifolium*, s. str.

The plant collected also resembles *S. fastigiatum*, but quite differs from the species in having hermaphrodite flowers, larger calyx, shorter gynoecium and lacking remains of the former year's flowering stems. This is described as follows:

A perennial herb, up to 10 cm high. Rhizome dauciformed or slender, usually 3–10 mm thick, sparsely bunched, the epigeaeous part usually 1–2.5 cm long, sometimes accrescent more and branched, usually erect or ascending, the apical part crowned by scaly leaves. Scaly leaves deciduous, linear-triangular to narrowly triangular-ovate, acute at the apex, entire along the margin, blackish brown to chestnut-brown, 1.7–2.5 mm long 1.2–1.8 mm wide. Flowering stems 5–15 from each of the apex of rhizome, more or less fastigiate, usually 5–10 cm long, simple, terete, glabrous, nearly smooth to sparsely mamillate (the mamilla pellucid about 0.1 mm long), green or pale green, about 0.3–0.6 mm thick, the old flowering stem not persistent. Leaves alternate, densely arranged throughout, widely spreading, sessile, spurless or often very slightly spurred (about 0.3 mm), thick herbaceous, very slightly convex or flattish, green or pale green or yellowish green, linear to very narrowly oblong (SADT n. 13) or very narrowly elliptic (SADT n. 1) or linear-ovate, acute above with round or obtuse apex, entire or nearly entire but under a lens (×40) usually minutely mamillate along the upper half of margin (the mamilla pellucid about 0.05 mm long), (5–)6–12 (–13) mm long 0.8–1.5 mm wide, 6.3–9.5 times longer than broad, glabrous and rather smooth on both surfaces, the costa not prominent, the lateral veins 1–3 on each side of the costa, nearly parallel to the costa, not reaching the margin. Inflorescence terminal, 1–3(–5)-flowered, bracteate, usually forming a simple-corymb; peduncles nearly 0–3 mm long, usually minutely mamillate (the mamilla about 0.05 mm long); bracts leafy, very similar to the upper cauline leaves in shape but smaller, usually 3–5 mm long 0.5–1 mm wide; pedicels 0–1.2 mm long, usually minutely mamillate. Flowers in middle August to late September, hermaphrodite, mostly 5-merous, 6–10 mm wide at anthesis, the alabastrum reddish. Calyx 4.5–5.5 mm long, usually equalling 4/5 of the petals in length, green, glabrous, the tube usually less than 0.5 mm long; the lobes 4–5 mm long 0.9–1.3 mm wide, narrowly triangular-ovate, entire along the margin, convex in the lower and concave in the upper half of the margin, gibbous outside and hollowed inside in the lower half, slightly round outside and slightly concave or flattish inside, round or obtuse at the apex, sometimes tinged with red near the apex and/or along the margin. Petals distinct, white or often reddish near the apex, somewhat fleshy, glabrous, spreading at anthesis, usually narrowly elliptic (SADT n. 2) to elliptic (SADT n. 3), acute or acuminate in the apical part, obtuse and often minutely mucronulate at the apex, boat-shaped, entire along the margin, 5–7.5 mm long

1.7–2 mm wide. Stamens distinctly shorter than the petal, ascending or erect at anthesis; filaments subulate, somewhat fleshy, obcompressed, glabrous, white, 0.3–0.4 mm wide at the base, the epipetalous ones inserted usually 1–2 mm from the base, and 3–3.5 mm long, the alternipetalous ones 4.2–4.7 mm long; anthers basifixed, ellipsoidal, round or shallowly retuse at the apex, usually about 0.5 mm long, before anthesis purplish red, after dehiscence yellow. Nectar-scales broadly oblong to square, but irregularly and minutely retuse at the apex, often slightly convex on the lateral side, 0.6–1 mm long 0.7–1.2 mm wide about 0.2 mm thick, mostly pale yellow. Gynoecium 5–6 mm long, white, usually 0.7–0.8 mm connate ventrally from the base, sessile, erect, the ovaries not gibbous ventrally, 3.5–3.7 mm long 1.1–1.3 mm wide, usually gradually tapering upwards from the middle dorsally, the style often slightly outcurved, about 1.5 mm long, the stigma epapillate, the placenta nearly marginal. Ovules 12–18 in each loculus, mostly descending, ellipsoidal with round apex, 0.5–0.7 mm long, the funicles less than 0.3 mm long.

Sedum ovatisepalum (R.-Hamet) H. Ohba, stat. nov. [Fig. 48a–e]

Sedum linearifolium Royle var. *ovatisepalum* R.-Hamet in Act. Hort. Gothob. **2**: 394 (1926)–Fröd. in Act. Hort. Gothob. **5**: append. 52, fig. 189–192 (1930)–Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930)–Hara, Fl. E. Himal. 107 (1966).

Sedum trifidum Wall. ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 100 (1858), nom. illegit., pro minore parte, excl. pl. ex Simla et excl. syn. cit.–C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 420 (1878), pro parte, excl. syn. cit.–Masters in Gard. Chron. new ser. **10**: 267 (1878), pro parte–W. W. Smith et Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911)–W. W. Smith in Rec. Bot. Surv. Ind. **4**: 372 (1913)–Praeger in Journ. Roy. Hort. Soc. **46**: 63, fig. 25, 26 (1921), pro major parte; in Not. Bot. Gard. Edinb. **13**: 96 (1921), excl. specim. cit.

Sedum linearifolium Royle sensu Weibel in Candollea **16**: 144 (1958), pro parte.

Rhodiola ovatisepala (R.-Hamet) Fu in Act. Phytotax. Sin. Addit. **1**: 127 (1965).

Sedum sinuatum Royle ex Edgew. var. *ovatisepalum* (R.-Hamet) H. Ohba in sched.

A perennial herb, usually 5–20(–25) cm high. Rhizomes slender, the hypogaeous part creeping, up to 20 cm long, 2–5 mm thick, sparsely branched, often surculos, the epigaeous part usually 1–2 cm long 3–5 mm thick, but sometimes accrescent more, ascending or erect, the apical part crowned by scaly leaves. Scaly leaves chartaceous, rather caducous, triangular or triangular-ovate to shallowly triangular-ovate with entire margin, acute or obtuse at the apex, 1.5–3(–5) mm long 1–3(–4) mm wide, blackish brown to chestnut-brown. Flowering stems (1–)2–4(–5) in each apex of rhizome, annual, usually 5–20(–25) cm long, ascending or suberect, simple, terete, glabrous and rather laevis, pale yellowish green, (0.8–)1–2.7(–3) mm thick, the dead stem hardly persistent. Leaves alternate, aggregated on the upper 1/4–1/3 part of stem, widely spreading, mostly sessile, spurless, thick herbaceous, flattish, yellowish green, ovate to oblong-obovate and more or less imparilobulate or sinuate upper half of the margin, (1–)1.5–7(–8) cm long, 0.2–2(–2.3) cm wide, densely papillate or mamillate along the margin (the papilla or mamilla less than 0.1 mm long), glabrous, but sparsely or moderately mamillate above (the mamilla less than 0.05 mm high), laevis beneath, obtuse to

round at the apex, mostly very long-attenuate at the base; the lobes (0-)3-7(-9) in number, narrowly triangular-ovate to distorted linear-ovate or narrowly triangular, usually spreading, (1.5-)2-10(-12) mm long 0.8-5(-6) mm wide, obliquely obtuse or round at the apex, entire to shallowly and very remotely sinuate along the margin; the sinus between the lobes usually acute or often obtuse with round or obtuse apex; the costa slightly caved under the upper surface, the veins obscure, the lateral-veins 3-5 on each side of the costa. Inflorescences terminal, usually 20-40-flowered, bracteate, forming a more or less flaccid compound-dichasium or rarely dichasium-fascicles; the cluster 3(-4) in number, 1-5(-7.5) cm long, with (1-)3-7(-9) dichasia, sometimes having secondary axis with 1-3 dichasia or monochasia; peduncles 3-6 mm long, terete, glabrous, mostly laevis; pedicels 4-10 mm long, glabrous but often very sparsely papillate (the papilla about 0.1 mm long); bracts linear-obovate or linear-ovate, 5-17 mm long 2-5 mm wide, sessile, round or obtuse at the apex, long-attenuate at the base, nearly entire but densely papillate or mamillate along the margin (the papilla or mamilla less than 0.1 mm long), both surfaces glabrous but sparsely papillate above. Flowers in late July to middle September, hermaphrodite, mostly 5-merous, 8-18 mm wide at anthesis. Calyx 1.7-2.5(-3.5) mm long, yellowish green, the tube usually 0.5-1.2 mm long, glabrous and mostly epapillate, the lobes 1.5-2.5 mm long 1.3-1.5 mm wide, usually ovate, entire along the margin, round at the apex, round outside and flattish or rarely concaved inside, usually 0.4 mm thick near the base, often reddish at the tip and/or along the margin. Petals spreading at anthesis, distinct, very narrowly oblong-ovate, (5.5-)6.2-7.5 mm long 1.1-1.3 mm wide, entire along the margin, nearly parallel in the lower half, round or obtuse and always mucronulate at the apex (the mucro 0.2-0.3 mm long with round apex), mostly milky white inside, pale greenish white or often slightly tinged with red outside, both surfaces glabrous and laevis, in the upper 2/3 part round and slightly keeled outside and concave or flattish inside, but in the lower 1/3 part flattish. Stamens slightly shorter or longer than the petal, ascending at anthesis; filaments linear-filiform but slightly tapering above, obcompressed, glabrous, whitish, about 0.4 mm wide at the base, the epipetalous ones inserted usually 1.3-1.5 mm from the base, 3.5-4.5 mm long, the alternipetalous ones very shortly (about 0.3 mm) united with the petals, 5-6.5 mm long; anthers basifixed, ellipsoidal, usually shallowly retuse at the apex, mostly 0.8-1.2 mm long, before anthesis deep red-purple, after dehiscence gradually tinged with deep yellow. Nectar-scales rectangular, shallowly emarginate or obtusely truncate at the apex, round outside and concave inside, 0.5-0.7 mm long 0.4-0.6 mm wide, about 0.2 mm thick, deep to pale yellow. Gynoecia usually 5-7 mm long, white with very slightly greenish shade, usually connected 0.3-0.6 mm from the base ventrally, sessile, erect, the ovary 4-5 mm long 0.7-1.2 mm wide, nearly straight ventrally, gradually tapering upward from the middle dorsally, the style usually 0.8-2 mm long, often slightly outcurved, the stigma epapillate, the placenta nearly marginal. Ovules 8-12(-14) in each locule, descending, ellipsoidal with round or elongate apex, 0.6-0.8 mm long, the funiculus about 0.2 mm long.

Distr. Nepal, Sikkim, S. Tibet, Bhutan, and N. W. Burma.

Specimens examined. Nepal. Jumla–Gargigath, alt. 11000 ft. Growing in moss on tree trunk in evergreen oak and conifer forest. Petals white, filaments white, anthers fawn, styles white (Polunin, Sykes & Williams 5032, BM); Johbesi (27°36' N, 86°32' E), alt. 9000 ft. On mossy rocks. Flowers white (Stainton 6555, BM); Ckhintapu (27°06' N, 87°58' E), alt. 2900 m. Rochers moussus. Fleurs blanches (Dobremez 1266, BM); Ratamata, Chakare Lekh, alt. 10000 ft. Growing on mossy tree trunks. Flowers white; anthers salmon-coloured (Polunin, Sykes & Williams 398, BM); North of Barse, alt. 12000 ft. Epiphytic on boulders of trees. Flowers white, anthers fawn (Stainton, Sykes & Williams 3852, BM, TI); Pongsing, alt. 15000 ft. (Dhwoj 108, BM); Thama–Thami valley, Khumbu, alt. ca. 12500 ft. In moss on rocks near river (Horsfall 59, BM); Tukucha, Kali Gandaki, alt. 10000 ft. In wood. Petals and filaments white, anthers red (Stainton, Sykes & Williams 7487, BM); Lete, S. of Tukucha, Kali Gandaki, alt. 10500 ft. On rocks in wood. Petals and filaments white, anthers black (Stainton, Sykes & Williams 7907, BM, TI); Bhusenge–Thawrebas, alt. 8000 ft. (Shrestha & Upadlyay 3005, KATH). Sikkim. (Kurz s.n., BO; Thosmson s.n., BO); Chiyabanjyang–Phalut, alt. 3100–

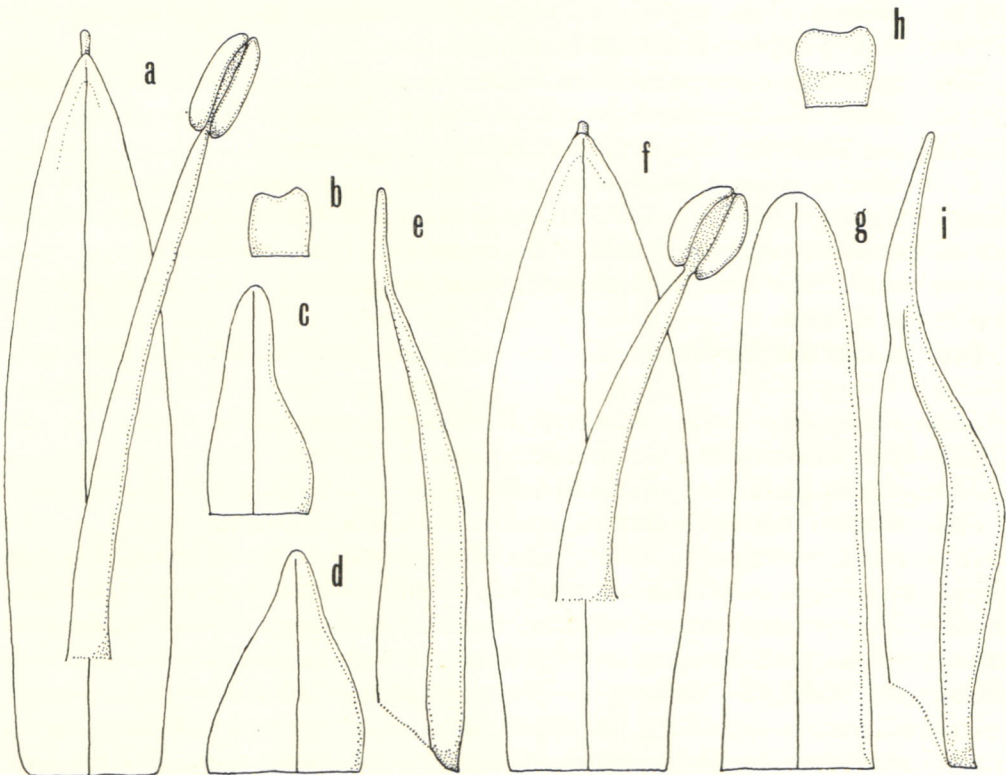


Fig. 48. *Sedum ovatisepalum* (R.-Hamet) H. Ohba (a–e). a. Petal with stamen, b. Nectar-scale in dorsal view, c. and d. Calyx-lobes, e. Pistil in lateral view. *Sedum sacrum* (R.-Hamet) H. Ohba (f–i), f. Petal with stamen, g. Calyx-lobe, h. Nectar-scale in dorsal view, i. Pistil in lateral view, All $\times 15$. (a–e. Kanai et al. 726009, f–i. Kanai, Hara & Ohba 726362. All drawing from the alcoholic material).

3400 m (Hara, Kanai, Murata, Togashi & Tuyama 6660, τ , κ); Phalut, alt. 3500 m. On tree (H., K., M., T. & T. 6659, τ); loc. cit., alt. 3600 m. On mossy tree trunks. Petals white but often tinged red outside, calyx green (Kanai, Ohashi, Hara, Iwatuski & Ohba 726006; 726009, τ); Phalut-Sabargam, alt. 3400 m. On trees (Hara, Kurosawa & Ohashi 69683, τ); Phalut-Sandakphu. On trees (Hara, Kanai, Murata, Togashi & Tuyama 6661, τ); Sandakphu-Sabargam, alt. 3200-3600 m. On mossy tree trunks. Flowers white, anthers before anthesis muddy red, after dehiscence yellowish (Kanai, Ohashi, Hara, Iwatsuki & Ohba 726003; 726004; 726005, τ); Sandakphu, alt. 3600 m. On rocks. (Hara s.n., τ); loc. cit. On tree trunks (Kanai, Ohashi, Hara, Iwatsuki & Ohba 726002, τ); Sandakphu-Gairibas (Hara s.n., τ); Gairibas-Kala Pokhari. Flowers white (Hara s.n., τ); Kala Pokhari-Sandakphu, alt. 3200 m. On trees or rocks. (Kanai, Ohashi, Hara, Iwatsuki & Ohba 726000, τ); Lechieng, alt. 9000 ft. (Gammie 363, ν). Bhutan. Tzatogang-Dotanang, alt. 3000 m. On rock (Kanai, Murata, Ohashi, Tanaka & Yamazaki 1777, τ). N. W. Burma. Southern Chin Hills, Mt. Victoria region. Subalpine, top-section, alt. 9500 ft. On grassy slopes. (Alsterlund s.n., ν); Mt. Victoria, alt. 10000 ft. On rocks, on the south (grass) slope. The seeds germinate in the capsule (Kingdon-Ward 22427, ν); loc. cit. Summit. Flowers pink (Kingdon-Ward 22810, ν).

This species has often been called *Sedum trifidum* Wall. ex Hook. f. et Thoms., but the name is a superfluous one of *S. sinuatum* Royle ex Edgeworth, because Hooker and Thomson cited the latter species as a synonym of *S. trifidum*.

I was able to observe this species in Singalila range where the species occurs abundantly from 3000 m to 3500 m in altitudes. The species grows with mosses on sedimental or pegmatitic rocks or on branches of living *Rhododendron* spp., etc., and seems to prefer sunny and exposed places. Its leaves are very variable in size but rather uniform.

Sedum sacrum (R.-Hamet) H. Ohba in Journ. Jap. Bot. **49**: 321 (1974).

[Fig. 48f-i]

Sedum linearifolium Royle var. *sacrum* R.-Hamet in Act. Hort. Gothob. **2**: 395 (1926)-Fröd. in Act. Hort. Gothob. **5**: append. 53 (1930).

Rhodiola sacra (R.-Hamet) Fu in Act. Phytotax. Sin. Addit. **1**: 127 (1935).

Sedum sacrum Prain in R.-Hamet, loc. cit. 395 (1926), pro syn.

A perennial herb, up to 20 cm high. Root slender or dauciformed, 2-4 mm thick, sparsely branched. Rhizomes thick, usually 1-3 cm long 1.5-2 cm thick, more or less epigeous, accrescent and branched, ascending or suberect, the base tapering to the root. Rhizomatoclares usually 1-4 in number, fleshy, subcylindrical, solid, usually 2-7 cm long 0.5-1 cm thick, usually dull yellow-orange, mostly epigeous, erect to ascending, the upper part densely covered with scaly leaves. Scaly leaves chartaceous, caducous, triangular with acute apex, 3-6 mm long 2-4 mm wide, entire and slightly convex along the margin, chestnut-brown to pale rusty. Flowering stems 2-5(-6) from each rhizomatoclade, annual, usually 10-18 cm long, ascending or suberect, simple, terete, glabrous but under a lens (\times ca. 40) densely (especially in the upper part) to sparsely papillate (the papilla pellucid, 0.1-0.05 mm long 0.15-0.1 mm in diameter), green, remotely

foliferous (12–16-leaved), the internodes usually shorter than the leaf, the old flowering stem more or less (not over a year) or hardly persistent. Leaves alternate, spreading, almost sessile, almost spurless or very slightly spurred (about 0.5 mm long), thick herbaceous, flat, yellowish green, ovate to oblong-ovate or elliptic, (12–)15–25 mm long 7–17 mm wide, 1.4 to 2.8 times longer than breadth, sparsely or moderately papillate above (the papilla pellucid, 0.05–0.1 mm long 0.15–0.1 mm in diameter), glabrous and rather smooth beneath, round at the apex, shortly attenuate or attenuate at the base, crenulate-serrate or minutely lobulate and moreover very densely papillate along the margin, the teeth oblique with round apex, the sinus round or often angulate (the angle 60°–100°), the costa and the veins not prominent, the lateral-veins 3–4 on each side of the costa and not reaching the margin. Inflorescences terminal, 4–12-flowered, bracteate, usually forming a dichasium-fascicle consisting of mostly 3–4 dichasia or occasionally of monochasia or rarely a smaller compound-dichasium, having 3 primary lateral axes (5–10 mm long) with 1–3 dichasia; peduncles 2–5 mm long, densely papillate (the papilla less than 0.1 mm long), terete; bracts 4–9 mm long 1.5–3.5 mm wide, sessile, elliptic with round apex, shortly attenuate at the base, nearly entire or rarely repand along the margin, the upper surface and the margin sparsely or densely papillate (the papilla less than 0.1 mm long), the under surface glabrous and smooth; pedicels 1–2(–3) mm long, nearly terete, mostly very densely papillate. Flowers in late July to August, hermaphrodite, mostly 5-merous, 5–7 mm wide. Calyx 4.8–6 mm long, usually equalling the 2/3 of the petal in length, green, the tube usually 1 mm long, glabrous; the lobes 3.5–5 mm long 1.1–1.4 mm wide, oblong to oblong-ovate, round at the apex, entire along the margin, upper half of the margin densely papillate and the rest nearly epapillate, slightly convex and sparsely papillate outside, nearly flattish and smooth inside, in colour deeper upwards, the papilla less than 0.1 mm long. Petals white and often reddish along the margin, distinct, sessile, somewhat fleshy, glabrous, widely spreading at anthesis, usually narrowly ob-ovate, mucronulate or obtuse at the apex, entire along the margin, round and very slightly keeled outside, concave inside, 5–7 mm long 1.2–2 mm wide. Stamen slightly shorter than the petal or nearly equalling it, ascending at the anthesis; filaments subulate, somewhat fleshy, obcompressed, glabrous, whitish except the red tip, about 0.6 mm wide at the base, the epipetalous ones inserted usually 1.5 mm from the base, 2.8–3.2 mm long, the alternipetalous ones 4.5–5 mm long; anthers basifixed, ovoidal, usually shallowly retuse but very rarely having a very short projection at the apex, mostly 0.8 mm long, before anthesis deep purplish red, after dehiscence gradually tinged with yellow or yellowish green. Nectar-scales ovate-rectangular with emarginate apex, flattish, 0.6–1 mm long 0.5–0.8 mm wide, about 0.2 mm thick, rosy but in the lower central part dark orange. Gynocia 4.5–6 mm long, white, usually 0.6–0.8(–1) mm connected ventrally at the base, sessile, erect, the ovary straight ventrally, dorsally round and tapering towards the apex from the middle, 3–3.5 mm long, broadest at the middle, 1–1.2 mm wide, the style usually 1.2–1.6 mm long, slightly outcurved or straight, the stigma epapillate, the placenta nearly marginal. Ovules 14–20 in each locule,

descending, ellipsoidal with elongate apex, usually 0.5–0.7 mm long, the funiculus 0.2–0.3 mm long.

Distr. Nepal and Tibet.

Specimens examined: Tibet. Kambajong (Prain s.n. in Sept. 1903, CAL—Isotype of *Sedum linearifolium* var. *sacrum* R.-Hamet); Gyangtse (Walton s.n. in 1904, CAL); Gyangtse Hills (Stewart s.n. in Aug. 1907, CAL); without special locality (King's collector 187, CAL; unknown collector 296 in 1884, CAL). Nepal. Marsiandi Valley, alt. 8500 ft. Shady moss covered boulders and cliffs. Flowers white. Leaves fleshy and bright yellow green (Lowndes 1399, BM): Phulchoki, S. Kathmandu, alt. 2600 m (Kanai 673427, TI); loc. cit. On mossy rocks in *Quercus semecarpifolia*-forest. (Ohashi & Ohba 726360, TI); loc. cit. On mossy rocks. Flowers white (Hara, Iwatsuki, Ohba & Iwatsuki 726361, TI); Singum Gompa, alt. 3000 m (Hara, Kanai, Kurosawa & Ohashi 6358, TI); loc. cit. On rock surface. Calyx pale green, petals somewhat boat-shaped, white but margin above half reddish, anthers and the tip of filaments dark red purple, ovary white, gland dark orange (Kanai, Hara & Ohba 726362, TI); North west of Gurjakhani, alt. 10750 ft. On rocks in *Quercus* forest. Flowers whitish (Stainton, Sykes & Williams 3683, BM, TI); Below Garjigoth, Dori Lekh, W. of Jumla, alt. 10000 ft. Growing in moss on rock beside stream. Leaves pale green beneath. Sepals pale green. Petals white. Filaments white, anthers pale green. Ovaries white (Polunin, Sykes & Williams 5049, BM, TI); On way to Bumra, alt. 8–9000 ft. On shady and rocky places. Fls. small and green (Malla 10708, BM).

Sedum sacrum closely resembles *S. ovatisepalum* (R.-Hamet) H. Ohba, but is distinguishable from the latter species by the leaf arrangement, calyx-lobes and petals; the leaves scattered throughout the stem in *S. sacrum* while more or less aggregate in *S. ovatisepalum*; calyx-lobes oblong to oblong-ovate, 3.5–5 × 1.1–1.4 mm in size and papillate against ovate, 1.5–2.5 × 1.3–1.5 mm and epapillate; petals usually narrowly obovate and 5–7 × 1.2–2 mm in size against very narrowly oblong-ovate and 5.5–7.5 × 1.1–1.3 mm.

Subsect. **Chamaerhodiola** (A. Schrenk) H. Ohba, stat. nov.

Rhodiola sect. Chamaerhodiola A. Schrenk, Enum. Pl. Nov. 1: 69 (1841).

Sect. *Rhodiola* ser. *Rhodiolae* group. 2 Himalenses Praeger in Journ. Roy. Hort. Soc. 46: 27 (1921).

Sect. *Rhodiola* subsect. *Eurhodiola* § 2. Himalensia (Praeg.) Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. 18a: 442 (1930), excl. *S. Smithii* et *S. gelidum*.

Sect. *Rhodiola* group 2. Chamae-*Rhodiola* (A. Schrenk) Fröd. in Act. Hort. Gothob. 5: append. 26 (1930), excl. *S. gelidum*, *S. algidum* et *S. crassipes*; 15: 3 (1942), ut Chamae-*Rhodiola* (Fisch. et Mey.).

Chamaerhodiola (A. Schrenk) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, 1: 27 (1934), pro parte.

Rhizomes protected by the former years' dead flowering stems forming a tuft. Annotinous flowering stems numerous, usually more than 6 in number.

Type species: *Sedum quadrifidum* Pallas.

This subsection is highly differentiated in the Himalayan regions and also in

N. W. China.

Sedum quadrifidum Pallas, *Reise* **3**: 730, t. 6, fig. 1 (1776)—Hook. f. et Thoms. in *Journ. Linn. Soc. Bot.* **2**: 97 (1858), cum var. α , β , γ . *scoparium*, δ . *coccineum* (Royle) et ϵ . *acuminatum*—C. B. Clarke in Hook. f., *Fl. Brit. Ind.* **2**: 418 (1878)—Maxim. in *Bull. Acad. Sci. St.-Pétersb.* **29**: 125 (1883)—Hemsley in *Journ. Linn. Soc. Bot.* **35**: 177 (1902)—W. W. Smith et Cave in *Rec. Bot. Surv. Ind.* **4**: 197 (1911), pro parte—W. W. Smith in *Rec. Bot. Surv. Ind.* **4**: 259 (1911) et 371 (1913), pro parte—Praeger in *Journ. Roy. Hort. Soc.* **46**: 51 (1921)—Limpricht in Fedde, *Repert. Beih.* **12**: 392 (1922)—Fröd. in *Act. Hort. Gothob.* **1**: 26 (1924); **5**: append. 28 (1930), pro parte, excl. var. et Pl. 2-1; in *Hand.-Mzt., Symb. Sin.* **7**: 405 (1931); in *Bull. Fan Mem. Inst. Biol. Bot.* **7**: 11 (1935); in *Act. Hort. Gothob.* **15**: 3 (1942) et in *Ark. Bot.* **30A(9)**: 2 (1943)—Berger in *Engl. et Prantl, Nat. Pfl.-fam.* 2 Aufl. **18a**: 442 (1930)—Baehni, Bonner et Vautier in *Candollea* **13**: 227 (1951), verisim. [Fig. 49]

Rhodiola asiatica D. Don, *Prodr. Fl. Nepal.* 213 (1825).

Sedum asiaticum (Don) DC., *Prodr.* **3**: 401 (1828)—C. B. Clarke in Hook. f., *Fl. Brit. Ind.* **2**: 419 (1878), pro parte. Fide Fröd. in *Act. Hort. Gothob.* **5**: append. 30 (1930), in nota *S. quadrifidum* et in *Hand.-Mzt. Symb. Sin.* **7**: 407 (1931), in nota *S. crassipes*.

Sedum coccineum Royle, *Ill. Bot. Himal.* 223, t. 48, fig. 3 (1835).

Rhodiola quadrifida (Pallas) Fischer et Meyer in Schrenk, *Enum. Pl. Nov.* **1**: 69 (1841)—A. Boriss. in *Kamarov, Fl. USSR* **9**: 39 (1939)—Webb in *Fl. Europ.* **1**: 363 (1964).

Sedum quadrifidum Pallas var. *coccineum* (Royle) Hook. f. et Thoms. in *Journ. Linn. Soc. Bot.* **2**: 97 (1858).

Sedum scabridum Franchet sensu Praeger in *Not. Bot. Gard. Edinb.* **13**: 94 (1921).

Chamaerhodiola quadrifida (Pallas) Nakai apud Nakai et Kitagawa in *Rep. 1st Sci. Exped. Manch. Sect. IV*, **1**: 29 (1934).

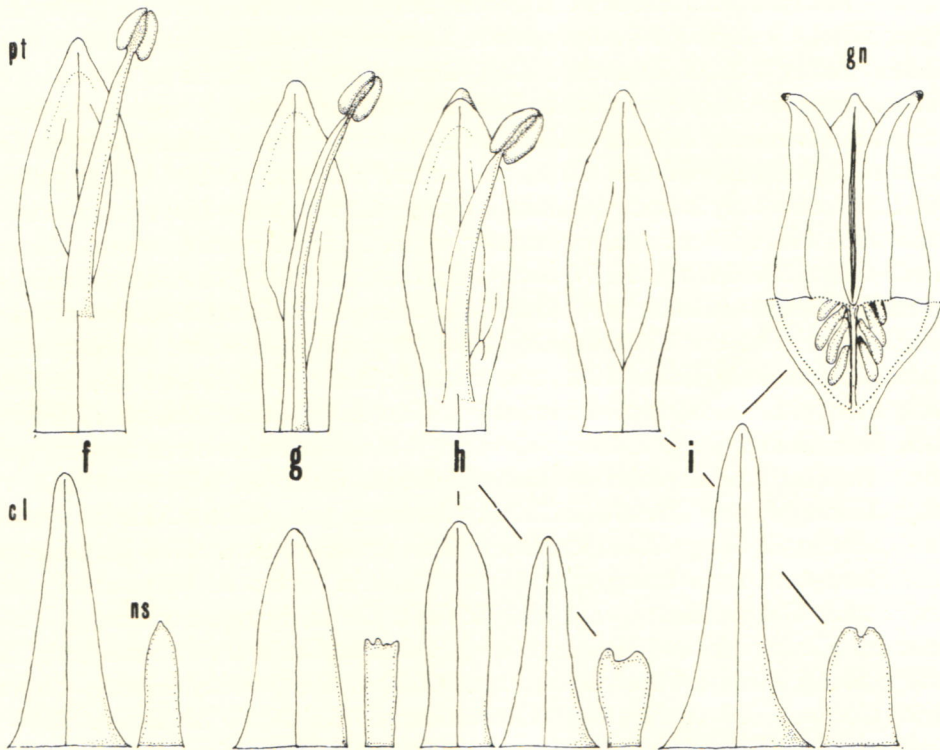
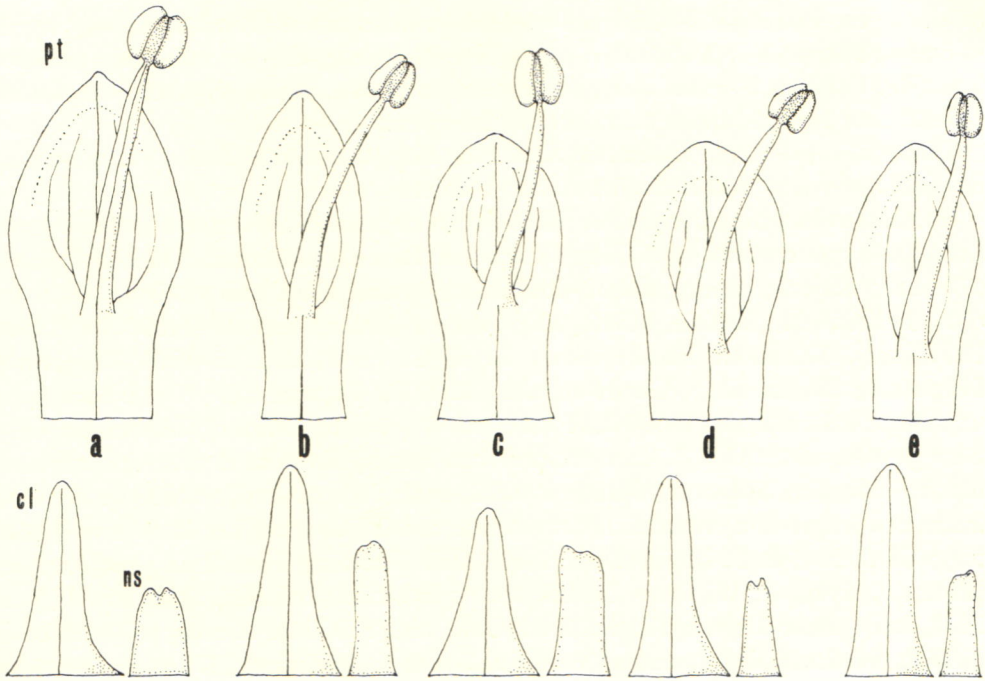
Chamaerhodiola asiatica (D. Don) Nakai apud Nakai et Kitagawa in *Rep. 1st Sci. Exped. Manch. Sect. IV*, **1**: 29 (1934).

Rhodiola coccinea (Royle) A. Boriss. in *Komarov, Fl. USSR* **9**: 41 (1939).

A perennial cushion plant, usually less than 5 cm high in the aerial parts. Rhizomes thick, stout or elongate, nearly obconical or nearly cylindrical, solid, the base continuously tapering to the dauciformed or long and slender roots (up to 20 cm long), conspicuously or well branched; the rhizomatoclares densely protected by the remains of the former years' flowering stem, usually 0.5–8 cm long 1–3 cm across including the former years' old flowering stem, more or less accrescent towards the apex, usually dark brownish, the apical part more or less epigaeous, densely scaly. Scaly leaves chartaceous, more or less persistent, usually narrowly triangular, narrowly ovate (SADT n. 37), narrowly triangular-ovate or triangular-ovate, acute or obtuse at the apex, entire along the margin, 4–8 mm long, 1.5–4 mm wide, ferruginous in the beginning, chestnut- or blackish brown later. Flowering stems 2–10 in number, nearly erect, simple, nearly terete, glabrous, emamillate to moderately mamillate (the mamilla about 0.05 mm long), usually 1–5 cm long, about 1 mm thick at anthesis, slightly accrescent later, remaining over

3 or 4 years, the remains more or less wiry, suberect or ascending, somewhat incurved, umber or pale dirty brown. Leaves alternate, arranged throughout, spreading widely, sessile, spurless or very slightly spurred (about 0.1 mm long, round), thick herbaceous, flat, usually linear or linear-elliptic, usually 3–7 mm long, 0.6–0.8 mm wide, round or obtuse at the apex, entire but often mamillate (the mamilla less than 0.1 mm long) along the margin, attenuate or shortly attenuate at the base, glabrous, nearly emamillate, the costa not prominent, the lateral veins usually 2–4 on each side of costa, nearly parallel, not reaching the margin. Inflorescences usually reduced to a single terminal flower, but rarely consisting of a dichasium, very shortly pedicelate (pedicels less than 2 mm long), bracteate or ebracteate, bracts relatively a few, very similar to the cauline leaves. Flowers dioecious, in late June to August, mostly 4-merous but rarely 3- or 5-meous, 3–4 mm across at anthesis. Calyx 2.5–3.5 mm long, glabrous; the tube funnel-shaped, green, 0.6–1.2 mm long; the lobes 0.75–1.1 times longer than the petals, 1.4–2.5 mm long 0.5–1.2 mm wide, usually linear-ovate or very narrowly triangular (SADT n. 73), round or obtuse at the apex, entire along the margin, suberect or ascending at anthesis, somewhat round outside, flattish inside, green but often reddish; the sinus between lobes usually obtuse (♂) or truncate or round (♀). Petals distinct, red or yellow, usually oblong-elliptic or ovate, 2.5–3.5 mm long 0.8–1.7 mm wide, entire along the margin, round or obtuse at the apex, glabrous, spreading (♂) or suberect to spreading (♀) at anthesis, shallowly boat-shaped. Stamens slightly (about 1.2 times) longer than the petal, ascending or suberect at anthesis; filaments linear-filiform, somewhat fleshy, obcompressed, glabrous, about 0.3 mm wide at the base, the epipetalous ones inserted 0.5–1.2 mm from the base, 1.7–2.5 mm long, the alternipetalous ones 3–4 mm long; anthers basifixed, ellipsoidal or ovoidal, usually 0.5 mm long, slightly retuse at the apex, before anthesis red, after dehiscence turning yellow. Nectar-scales usually narrowly oblong or narrowly oblong-triangular, round and usually very shallowly retuse at the apex, more or less adherent to the ovary, yellow, 0.6–1.3 mm long 0.3–0.5 mm wide, about 0.2 mm thick. Gynoecium of female plants 4–6 mm long, usually 1.5–2 times longer than the petal, connected ventrally about 1.5 mm from the base, sessile, erect, pale reddish, the connected part adnate to the calyx-tube dorsally, the ovary not gibbous ventrally, opposite to the calyx-lobe and nectar-scale, usually widest at the lower 1/3 part, 1–1.5 mm wide, and abruptly narrowing and outcurved in the upper part, the style indistinct, the stigma epapillate, the placenta nearly marginal. Gynoecia of male plants 2–3.5 mm long, usually shorter than the petal, connected usually 0.5–1 mm ventrally, tapering from the middle to the apex dorsally, nearly straight ventrally, having a short style. Ovules of female plants mostly 6 in each locule, usually descending, ellipsoidal, round

Fig. 49. *Sedum quadrifidum* Pallas, showing variations of petals (pt), calyx-lobes (cl) and nectar-scales (ns), all $\times 15$, and pistils in longitudinal section (gn), $\times 7.5$. a. Stainton, Sykes & Williams 1308, b. Gardner 639, c. Williams 2356, d & e. Stainton, Sykes & Williams 3103, f. Barclay & Synge 2636, g. Duthie 13240, h. Duthie 11009, i. Kanai, Hara & Ohba 726354.



at the apex, usually 0.6–0.7 mm long, the funicles less than 0.1 mm long; ovules of male plants mostly 2 but often 3 or 4 in each locule, 0.3–0.5 mm long, probably abortive. Follicles 6–7 mm long, erect, reddish brown. Seeds bright brown, usually 1.6–1.8 mm long, ellipsoidal, round at the apex.

Distr. Central Asia, Kashmir, Kumaon, Nepal, Sikkim, Tibet, N. W. China, Mongolia, Siberia and Eurasian Arctic Circle.

Specimens examined from the Himalayan region. N. W. India. (Herb. Royle s.n., LE—Type collection of *Sedum coccineum* Royle). Kashmir. (Herb. Falconer 475, LE); Kajnag range, alt. 12–13000 ft. (Duthie 11009, BM); above Gulmarg, alt. 11–12000 ft. (Duthie 11345, LE); Musjid Valley, alt. 13–14000 ft. (Duthie 13240 BM). Kumaon. Rhudugheru, Tehri Garhwal, alt. 15–16000 ft. (Duthie 875, CAL); Pathar Kori, Garhwal, alt. 10500 ft. (Strachey & Winterbottom 19, LE). Nepal. Saipal, alt. 15500 ft. Rock crevices (Arnold 120, BM); Bhurchula Lekh, near Jumla, alt. 12500 ft. In rock crevices. Petals, filament & styles red; anthers black (Polunin, Sykes & Williams 4522, BM); loc. cit., alt. 13000 ft. Growing from rock ledges and crevices. Inflorescence red (Polunin, Sykes & Williams 4683, BM); Chaurkot, S. E. of Jumla, alt. 10000 ft. Growing from shady rock crevices (Polunin, Sykes & Williams 5430B, BM)*; loc. cit. (Polunin, Sykes & Williams 5430, BM); near Dojam Khola, Suli Gad, alt. 15000 ft. Among cliffs. Flowers pinkish red including stamens (Polunin, Sykes & Williams 2278, BM, KATH, TI); loc. cit. Forming clumps on rock faces. Flowers yellow (Polunin, Sykes & Williams 2287, BM, KATH)*; Ya-la, Lantang Valley, alt. 3600 m (Maire 247, BM); Langsisa Kharka, alt. 15500 ft. Flowers reddish brown (Polunin 379, BM); Jargeng Khola, alt. 16000 ft. Bare scree. Flowers yellow (Lowndes 1110, BM)*; "Hidden Valley", N. of Tukucha, Kali Gandaki, 83°35' E, 28°48' N, alt. 16–17000 ft. In grass in old moraines. Flowers yellow (Albury & Smith 16, BM)*; Thinigaon, Muktinath Himal, alt. 15500 ft. On scree slopes. Inflorescence yellow (Stainton, Sykes & Williams 1308, BM, KATH)*; Namdo, N. of Mustang, alt. 17000 ft. Open stony slopes (Stainton, Sykes & Williams 2359, BM, KATH)*; Gosainkund, alt. 4200 m. Among rock crevices. Follicles reddish brown (Kanai, Hara & Ohba 726354, TI); N. West of Gurjakani, alt. 14800 ft. Among rocks and bare earth. Flowers yellow-green (Stainton, Sykes & Williams 3103, BM, KATH)*; Balangra Pass, alt. ca. 15000 ft. On peaty slopes. Petals white, sepals reddish (Polunin, Sykes & Williams 1038, BM, KATH)*; Near Seng Khola, alt. 15000 ft. Among short grass. Flowers pink (Stainton, Sykes & Williams 3238, BM); Mukdem Khola, Gharkabkot, alt. 19000 ft. Growing on consolidated scree and compact peaty turf. Petals pink; calyx reddish (Polunin, Sykes & Williams 1187, BM, KATH); Tilicho Pass path, alt. 16200 ft. On steep yak pastures. Flowers small, yellow (Barclay & Syngé 2636, κ); Basia Bhanjygang, alt. ca. 18500 ft. On peaty slopes. Plant forming a compact cushions (Polunin, Sykes & Williams 53, BM); KATH)*; near Gangla Bhanjyang, alt. 15500 ft. On fairly recently formed rather bare scree. Flowers yellow (lemon yellow) (Polunin, Sykes & Williams 2356, BM, KATH)*; Sringi Himal, Shiar Khola, alt. 17000 ft. Steep rocky hillside. Flowers yellow (Gardner 640 & 641, BM)*; Rolwaling, 27°55' N, 86°23' E, alt. 15500 ft. On old moraine. Flowers red (Stainton 4727A, BM); Dudh Kosi, Pujyah, 27° 39'

N, 86° 43' E, alt. 14700 ft. On rocks in exposed positions. Flowers deep red (Bowes Lyon 2085, BM); Lumbasamba alp. 87°37' E, 27° 45' N (Smith 79, BM); Arun-Tamur watershed, Thagla Bhangjyang, N. of Topke Gola, alt. 15000 ft. Amongst rocks. Inflorescence pink (Stainton 994, BM). Sikkim. regio. alt. 16–18000 ped. (Hooker 20, CAL); Yeumtso La, alt. 14500 ft. (Hooker 186, except the plant at the right, CAL); Chamnago alt. 14000 ft. Flowers yellowish (Smith 3785, CAL); Nathui La, alt. 14000 ft. (Smith 3471, CAL); loc. cit., alt. 15000 ft. (Smith 3458, CAL); Sherabthang, alt. 14000 ft. (Smith 3448, CAL); Chongu, alt. 12–13000 ft. (Smith 3191, CAL); below Kanchunjunga (King's collector s.n., CAL); Ronga, Llonok, alt. 15000 ft. (Smith & Cave 2026, CAL). East Himalaya. Chakalung La, alt. 16000 ft. (Rohmoo Lepcha 341, E).

In the subject. *Chamaerhodiola*, this species has the widest range of distribution in the alpine and arctic regions of Eurasia, i.e. from Kashmir through Kumaon, Nepal to Sikkim, Tibet, N. W. China, and Mongolia to the Arctic Circle of Eurasia. The species usually grows in the Himalayas between 4500 m and 5000 m in altitude but sometimes ascends up to 6300 m. The species is very variable in both vegetative and floral characters, as already stated by Hooker f. & Thomson (1858): “*Planta variabilis, oujus exemplaria juniora . . .*”. The Himalayan plants are often considered as a separate species from the Arctic-Siberian plants. Borissova (1939) excluded the Himalayan regions from the distribution range of *Sedum quadrifidum*. Webb (1964) stated: “The plants from Tibet and Himalaya often cited under this name (*S. quadrifidum*) appear to be different”. But he did not clarify any diagnostic features between the two species. As compared with the Himalayan plants, the Arctic-Siberian plants are usually relatively robust, larger in leaves and often conspicuously gemmiferous. In the appearance, these Siberian plants rather resemble *S. fastigiatum*, but in having obovate petals and narrowly oblong nectar-scales they agree with the Himalayan *S. quadrifidum*. On the shape of petals, Pallas (1776) stated that “petala . . . lanceolata”, but I could not find a plant having lanceolate petals among specimens from the Arctic-Siberia examined, e.g. Polyarny Ural, Berezovo (Sukachev 130, LE), Irkutsk, Mt. Sayansk (Komarov in 1902, LE), etc.

Hooker & Thomson's description of *S. quadrifidum* somewhat differs from the original one, and is much more accurate for the Himalayan plants. They stated that “floribus 4–5-meris” against “flores quadrifidi” in the original description, “folliculis apice recurvis” against “incapsulas acuminatas”, “Flores purpureae, parvae” against “petala . . . flava” and “stamina pleurumque petalis longiora, sed interdum (floribus vere gelatis?) abbreviatis” against “filamentis petala aequiantibus” and added characters on nectar-scales as “glandulis hypogynis subquadratis retusis emarginatis truncatisve”. Actually, flowers of the Himalayan plant are not only yellow but red, and often 5-merous. The filaments in the most case are slightly longer than the petals. The Himalayan plants may be separable into two forms as follows:

Flowers yellow. Rhizomatoclasts nearly equalling each other in size and age, very densely tufted by the remains of the former years' flowering stems. The remains nearly erect or rarely ascending. ?Cushion plant Form 1

Flowers reddish or purplish red. Rhizomatoclastes irregular in size and age, relatively densely tufted by the remains of the former years' flowering stems.

The remains ascending. Dwarf but not cushion Form 2

Specimens asterisked in the citation belong to the Form 1, and the others are the Form 2. It seems uncertain, however, whether these two forms belong to different taxa or not. Therefore, further studies are needed based on ample materials both from Himalaya and from in Arctic-Siberia.

Differences between *S. quadrifidum* and *S. fastigiatum* will be discussed under the note of the latter species.

Sedum fastigiatum Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 98 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 419 (1878)—Hemsley in Journ. Linn. Soc. Bot. **35**: 177 (1902), versim.—W. W. Smith & Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911)—R.-Hamet in Not. Bot. Gard. Edinb. **24**: 121 (1912)—Praeger in Journ. Roy. Hort. Soc. **46**: 53, fig. 19 (1921); in Not. Bot. Gard. Edinb. **13**: 82 (1921)—Limpricht in Fedde, Repert. Beih. **12**: 392 (1922), versim.—Fröd. in Act. Hort. Gothob. **1**: 26 (1924); in Hand.-Mzt., Symb. Sin. **7**: 405 (1931) et in Ark. Bot. **30A**(9): 2 (1943), versim.—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930)—Kitamura in Kihara, Fauna Fl. Nepal Himal. 140 (1955)—Weibel in Candollea **16**: 144 (1958). [Figs. 50, 51]

Sedum quadrifidum Pallas sensu C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 418 (1878), pro minuta parte—sensu Fröd. in Act. Hort. Gothob. **5**: append. 28 (1930), pro parte—sensu W. W. Smith et Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911), pro parte—W. W. Smith, loc. cit., **4**: 259 (1911) & 371 (1913), pro parte.

Sedum quadrifidum Pallas var. *fastigiatum* (Hook. f. et Thoms.) Fröd. in Act. Hort. Gothob. **5**: append 30, fig. 61–67 (1930), excl. syn. cit.

Chamaerhodiola fastigiata (Hook. f. et Thoms.) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 30 (1934).

Rhodiola coccinea (non Royle) A. Boriss. in Komarov, Fl. USSR **9**: 41 (1939), pro minuta parte et excl. basinonym.

Rhodiola fastigiata (Hook. f. et Thoms.) Fu in Act. Phytotax. Sin. Addit. **1**: 121 (1965)—Acad. Sin. Iconogr. Cormophyt. Sin. **2**: 80, fig. 1889 (1972).

A perennial herb, usually 6–13 cm high. Rhizomes long elongate, nearly cylindrical, accrescent towards the apex, solid, usually 0.5–0.8 mm across in the first year branch or the younger plants, and 2–3 cm across in the well developed plants, up to 15 cm long, sparsely branched, slightly greyish brown or dark reddish brown, usually ascending or suberect, the scar of flowering stem not conspicuous, the base continuously tapering to the root, the upper part epigaeous, densely or sparsely armed with the remains of the former year's flowering stem, the apical part densely covered with scaly leaves. Scaly leaves chartaceous, rather caducous or persistent, triangular-ovate or oblong-ovate or triangular, obtuse at the apex, entire along the margin, ferruginous in the beginning but chestnut- or pale blackish brown in the central part later, 5–10 mm long 3–7 mm wide. Flowering stems (6–)8–15(–20) in number, annual, fastigiate, simple, nearly terete, usually green but rarely reddish, usually sparsely papillate or mamillate (the projection less than 0.1 mm long) or lacking projection, 5–11 cm long, 0.8–2 mm thick, not or slightly

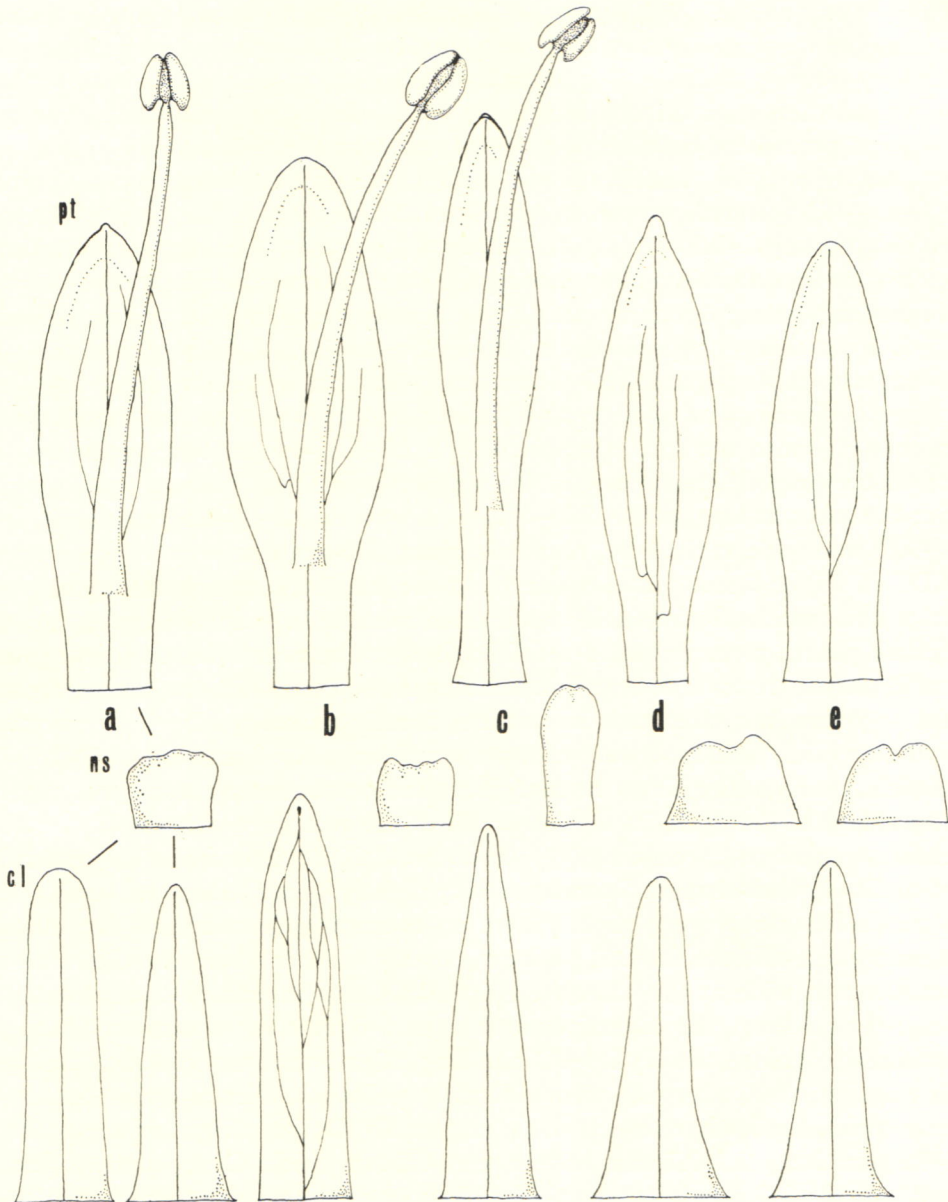


Fig. 50. *Sedum fastigiatum* Hook. f. et Thoms., showing variations of petals (pt), calyx-lobes (cl) and nectar-scales in dorsal view (ns), all $\times 15$. a & e. Mc Cosh 339. b. Polunin, Sykes & Williams 4244. c & d. Hooker s.n.

accrescent later, the remains of the former years' flowering stems usually dark red or stramineous. Leaves alternate, densely arranged throughout, loosely imbricate, spreading widely, sessile, very slightly spurred (the spur 0.3 mm long, round), thick herbaceous, flattish, linear-ovate or linear-obovate or very narrowly ovate (SADT n. 36), usually 8–12 mm long 1.2–1.5 mm wide, usually round but often

acutely obtuse at the apex, nearly entire along the margin, attenuate or shortly attenuate at the base, usually light or yellowish green, glabrous, epapillate but often very sparsely to moderately mamillate along the costal part on both surfaces (the mamilla less than 0.1 mm long), the costa usually very shallowly depressed above, not prominent beneath, the lateral veins usually 3–5 on each side of the costa, nearly parallel, usually anastomosing 1 or 2 times. Inflorescences terminal, (4–)6–14(–17)-flowered, bracteate, usually much compact in the male plant, obconoidal, usually 1–1.5 cm (♂) 1.5–2.5 cm (♀) across, forming monochasium-fascicles, the monochasium often lacking the lateral flower; peduncles and pedicels 1–4 mm long, nearly terete, moderately or densely papillate (the papilla pellucid, 0.05–0.15 mm long) or epapillate; bracts few in number, leafy, very similar to the cauline leaves in shape, usually 2–4 mm long 1–1.8 mm wide. Flowers in late June to August, dioecious or often gyno-dioecious, mostly 5-merous, but occasionally 4-merous, 4–8 mm across at anthesis. Calyx 2.8–3.5(–4) mm long, glabrous, the tube saucer-shaped, green, mostly 0.5 mm long, in female flower more or less rigid; the lobes as long as the $\frac{2}{3}$ – $\frac{5}{7}$ of the petal, 2.3–3(–3.5) mm long, 0.6–1.4(–1.8) mm wide at the base, narrowly triangular-ovate or very narrowly ovate (SADT n. 36) or linear-ovate, entire along the margin, round at the apex, somewhat round outside, flattish inside, ascending, more or less adpressed to the ovaries in female plants, green but often reddish; the sinus between lobes obtuse or round in male plants, truncate or round in female plants. Petals distinct, sessile, creamy white or yellow but often reddish outside, usually narrowly elliptic or narrowly obovate or rarely linear-obovate or narrowly oblong, 3.5–6 mm long, (1–)1.3–1.7 mm wide, nearly entire along the margin, round or obtuse and sometimes slightly mucronulate at the apex, in the lower $\frac{1}{4}$ of the margin nearly parallel, rather herbaceous, glabrous, ascending (♂) or suberect (♀) at anthesis, in the upper $\frac{3}{4}$ part shallowly boat-shaped. Stamens usually slightly longer (about 1.1 times) than the petal, but rarely very slightly shorter, ascending or suberect at anthesis; filaments linear-filiform, flattish, glabrous, creamy white or white but often reddish, about 0.4 mm wide at the base, the epipetalous ones inserted 1–2 mm from the base, 3–4 mm long, the alternipetalous ones 4–6 mm long; anthers basifixed, ellipsoidal or ovoidal, usually 0.4–0.7 mm long, slightly retuse or round at the apex, before anthesis red, after dehiscence turning yellowish. Nectar-scales square or square-ovate, shallowly retuse at the apex, usually flattish, bright or deep yellow, 0.6–0.8 mm long 0.5–0.7 mm wide about 0.2 mm thick. Gynoecium of female plants usually 6–8 mm long (mostly 1.5–2 times of the petal), connected 0.3–0.5 mm ventrally from the base, sessile, erect to suberect, creamy white but often reddish, not gibbous ventrally, dorsally adnate to the calyx-tube, opposite to the calyx-lobe and nectar-scale; ovary usually 1.5 mm wide at the middle, nearly straight ventrally, slightly tapering to the both end dorsally; the style very short, about 1 mm long, slightly outcurved; the stigma rather distinct, very minutely papillate (the papilla less than 0.05 mm long), just below the stigma somewhat swelling and usually dark red; the placenta nearly marginal. Gynoecium of male plants much smaller, usually 1.5–4 mm long, always shorter than the petal and stamen, similar to that of female plants in shape. Ovules of female plants 14–16

in each locule, descending, ellipsoidal, somewhat elongate in the apical part, round at the apex, about 1 mm long, the funicles about 0.1 mm long; ovules of male plants 2–8 in each locule, descending, usually 0.4–0.6 mm long, ellipsoidal, round at the apex, probably mostly abortive but rarely fertile. Follicles 8–10 mm long, suberect, reddish-brown. Seeds reddish or chestnut-brown, narrowly oblong-ellipsoidal with elongate apex, 1.5–2.5 mm long, the testa longitudinally striate minutely.

Distr. Kashmir, Nepal, Sikkim, Tibet, Bhutan, and Yunnan.

Specimens examined. Kashmir. Gurys Pap–Kashmir, alt. 12000 ft. (Winterbottom 494 1/2, κ). Nepal. Dolpo, Karang, 29°20' N, 83°04' E, alt. 16000 ft. On stony slopes. Flowers white; anthers and calyx red (Stainton 4347, BM, TI); Bhurchula Lekh, near Jumla, alt. 13000 ft. Growing from rock ledges and crevices. Sepals red; petals cream, becoming red; filaments white; anthers brown (Polunin, Sykes & Williams 4682, BM); Dozam Khola, near Sinikot, alt. 12500 ft. Sandy banks beside river. sepals pale green; petals cream; filaments cream; anthers red (Polunin, Sykes & Williams 4244, BM); Thaple Himal, alt. 4900 m (Nakao s.n., KYO); Langtang, alt. 13500 ft. Flowers white (Polunin 223, BM); Lantang Valley, alt. 14000 ft. Scree. Flowers whitish (Polunin 660, BM); Godkje–Surjakund, alt. 4450 m (Malla & Kanai 15098, TI); Gosainkund–Surjakund, alt. 4200 m (Kanai, Hara & Ohba 726355, TI); Mul Kharka, Chilime Khola, alt. 4100 m. Flowers pale yellow white (Kanai & Shakya 672278, TI); Thinigaon, Mukutinath Himal, alt. 15000 ft. Open stony slopes. Calyx & anthers red; petals & filament pale pink (Stainton, Sykes & Williams 1363, BM); Khangsar, alt. 15500 ft. Clumps on tussocks in stony streams. Flowers bright cerise pink (Loundes 1270, BM); near Pudamigaon, alt. 13500 ft. Moist soil near snow in ravines. Flowers whitish; stamens & anthers red (Polunin, Sykes & Williams 2249, BM); Saldanggaon, ca. 4 miles S. W., alt. 18500 ft. On shady scree, forming compact tufts. Petals white; calyx reddish; anthers reddish (Polunin, Sykes & Williams 6, BM); Chumbu, Tsola

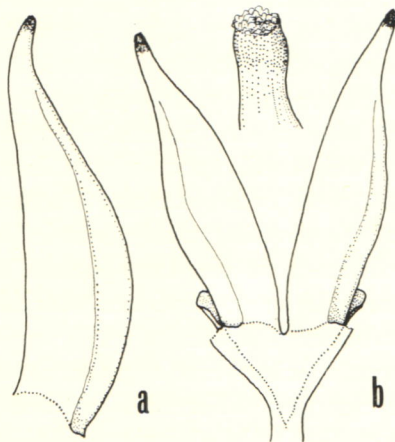


Fig. 51. Pistils of *Sedum fastigiatum* Hook. f. et Thoms., in lateral view, $\times 7.5$. (a. Hooker s.n., b. McCosh 339).

Khola, alt. 15800 ft. In mid streams. Flowers dull red (Bowes-Lyon 2092, BM); Inukhu Khola, ridge of Dudh Kosi, alt. 14700 ft. On rocks. Flowers pale yellow (Bowes-Lyon 2084, BM); Hongu Khola, Mera Mathi, 27°30' N, 86°45' E, alt. 16500 ft. On bare shores of alpine tarn. Flowers white (Mc Cosh 339, BM, TI); Chairam, 27°33' N, 87°58' E, alt. 13500 ft. Among boulders. Flowers cream (Williams 887, BM); near Sauwala Khola, alt. 12500 ft. Among boulders in ravines. Flowers reddish, petals creamy inside (Stainton, Sykes & Williams 2972, BM, TI); Tukucha, Kali Gandaki, alt. 12000 ft. On open grazing alp. Petals & filaments pinkish white (Stainton, Sykes & Williams 1165, BM); Ganesh Himal, Shiar Khola, alt. 14500 ft. Flowers white-pink-red (Gardner 1350, the above & below left., BM); Rambrong, Lamjung Himal, alt. 13500 ft. On boulders. Sepals reddish; petals cream (Stainton, Sykes & Williams 6105, BM, TI); Choker, alt. 16-18000 ft. Flowers pink white (Dhwoj 389, BM, E); Laurivinayak, alt. 12500 ft. Petals white; calyx green (Malla 9544, BM); Banduke Pokhari, alt. 4200 m. Among rock crevices. Hermaphrodite; petals white; sepals yellow; anthers dark red (Kanai, Ohashi, Iwatsuki, Ohba & Shakya 720399, TI); Saju Pokhari, alt. 4200 m. Among crevices in streams. Flowers creamy white (K.O.I.O. & S. 726356, TI); Jalang Chhyongo, alt. 4300 m. On rock surface. Flowers pinkish white (K.O.I.O. & S. 726349, TI); Kipudonsu-Kipuphu, alt. 4300 m. Flowers white (K.O.I.O. & S. 726351, TI); Kipuphu-Phujeng La, alt. 4500-4800 m. On just thawing moist scree. Flowers reddish (K.O.I.O. & S. 726350, TI). Sikkim. Kankola, (Lama Kangra), alt. 15000 ft. (Hooker s.n. on Aug. 21, 1849, κ. (in Herb. Hook.)—Lectotype (♂) and Lectoallotype (♀) of *Sedum fastigiatum* Hook. f. et Thoms.); Oma La-Migotang. (Hara, Kanai, Murata, Togashi & Tuyama 6656, TI); Migotang, alt. 3800 m (H.K.M.T. & T. 6657, TI, KYO). Tibet. (King's collector 117, κ, CAL); N. of Sringsi Himal, alt. 17500 ft. Petals greenish white, sepals red (Gardner 660, BM); loc. cit. Scree slopes. Petals pinkish white; sepals red (Gardner 661, BM); Sang La, 29° 42' N, 94°47' E, alt. 14000 ft. (Ludlow, Sherriff & Taylor 5065, TI); Raj Koti, alt. 15000 ft. (Strachey & Winterbottom 17, κ); Rakas Tal, alt. 15000 ft. (Strachey & Winterbottom 17, LE); Chumbi, Phla-ri-tung. Flowers yellowish white (King's collector s.n., CAL); Tokoo La, Chumbi. Flowers yellowish red (Dungboo s.n., CAL); Lonok (Younghusband 219, CAL). Bhutan. Bomtang, Dhur Chu, alt. 15400 ft. On rocks. Flowers greenish yellow (Bowes-Lyon 3408, BM).

This species is very variable in size probably by the influence of the climatic and edaphic conditions as well as difference of age. Especially by age, this species is considerably different, stated by Hooker and Thomson (1858) as general case of the Himalayan *Sedum*: "We have invariably been led to regard the seedling and young specimens as very different species from the old".

Actually this species resembles so closely *Sedum quadrifidum* Pallas, especially when relatively young, that I wonder if it can be really specifically distinct from the latter. Moreover, these two species occur together in altitudes between 4000 m and 6000 m. And I can not find differences between both species except such characters, i.e. the leaves 8-12 × 1.2-1.5 mm in *S. fastigiatum* vs. 3-7 × 0.6-0.8 mm in *S. quadrifidum*; petals 3.5-6 × 1-1.7 mm vs. 2.5-3.5 × 0.8-1.7 mm; gynoecia in female plant 6-8mm vs. 4-6 mm in length. However I tentatively

keep *S. fastigiatum* separate from *S. quadrifidum* as a species until further studies are made.

S. fastigiatum resembles *S. scabridum* Franch., *S. nobile* Franch. and its relatives, and the dwarf form of *S. himalense* D. Don. From *S. scabridum*, *S. fastigiatum* is hardly distinguishable except the colour of flowering stem, i.e. dark purplish red against pale green in *S. fastigiatum*. Therefore, these two species may not be specifically distinct. From *S. nobile* and its relatives, i.e. *S. atuntsuense* Praeger, *S. venustum* Praeger, *S. concinnum* Praeger and *S. horridum* Praeger, *S. fastigiatum* slightly differs in shape of leaves and size of flowers. From the dwarf form of *S. himalense*, *S. fastigiatum* is distinguished by papillation and colour of flowering stems i.e. the flowering stem densely papillate and shining purplish red in *S. himalense* while epapillate or sparsely papillate or mamillate and green or rarely pale reddish in *S. fastigiatum*. In altitudes between 4000 m and ca. 5600 m, these three closely related species, i.e. *S. quadrifidum*, *S. fastigiatum* and *S. himalense*, occur together and grow in similar habitat.

In the original description, Hooker and Thomson cited no specimen, but C. B. Clarke cited a single specimen from Kankola, Lama Kangra collected by Hooker. In Herbarium Hookerianum (Kew), there is the specimen cited by Clarke bearing the name '*S. fastigiatum*' in Hooker's own handwriting conserved. The specimen, consisting of both male and female plants, well agrees with the original description, namely "glandulis hypogynis in fl. ♀ quadratis, in fl. ♂ lineari-oblongis". As the very narrowly oblong (i.e. lineari-oblongis) nectar-scales are rather exceptional in *S. fastigiatum*, they apparently described *S. fastigiatum* based on this specimen. Under these circumstances I choose the male plant of this specimen as the lectotype and the female plant as the lectoallotype.

Sedum himalense D. Don, Prodr. Fl. Nepal. 212 (1825)—DC, Prodr. **3**: 402 (1828)—Hook. f. et Thoms. in Journ. Linn. Soc. Bot. **2**: 97 (1858)—C. B. Clarke in Hook. f., Fl. Brit. Ind. **2**: 418 (1878)—Maxim. in Bull. Acad. Sci. St.-Petersb. **29**: 131 (1883), in adnota—W. W. Smith et Cave in Rec. Bot. Surv. Ind. **4**: 197 (1911)—W. W. Smith in Rec. Bot. Surv. Ind. **4**: 259 (1911) et 371 (1913)—Praeger in Journ. Roy. Hort. Soc. **46**: 51 (1921), pro parte et excl. fig. 18—Fröd. in Act. Hort. Gothob. **1**: 26 (1924) et in Ark. Bot **30A(9)**: 2 (1943)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930)—Kitamura in Kihara, Fauna Fl. Nepal Himal. 140 (1955) ut '*himalaiense*'—Weibel in Candollea **16**: 144 (1958)—Jacobsen, Handb. Succ. Pl., Engl. ed. **2**: 781 (1960), ut '*himalense* Praeg.'—Hara in Spring Fl. Sikkim Himal. 118, fig. 23 (1963); Fl. E. Himal. 107 (1966)—Banerji in Rec. Bot. Sur. Ind. **19**: 45 (1965)—Schilling in Journ. Roy. Hort. Soc. **94**: 230 (1969).

[Fig. 52a-i]

Sedum quadrifidum Pallas var. *himalense* (D. Don) Fröd. in Act. Hort. Gothob. **5**: append. 31 (1930).

Chamaerhodiola himalensis (D. Don) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 30 (1934).

Rhodiola himalensis (D. Don) Fu in Act. Phytotax. Sin. Addit. **1**: 121 (1965).

Sedum himalayanum Wall., Cat. no. 7236 (1832), nom. nud.

Sedum hypericifolium Wall., Cat. no. 7237 (1832), nom. nud.

A perennial herb, up to 30 cm high. Rizomes long elongate, nearly cylindrical, solid, usually (1.5-)2-3(-4) cm thick, up to 40 cm long, usually sparsely branched, brownish, marked by transversely elliptic or orbiculate scars of flowering stems, creeping except the ascending or suberect upper part, the upper part mostly epigaeous, densely armed with the former years' flowering stems, the apical part densely covered with scaly leaves. Scaly leaves chartaceous, rigidulous, persistent, linear-triangular to triangular or rarely concave-triangular, acute or acuminate at the apex, entire along the margin, ferruginous in the beginning, chestnut- or pale blackish brown later, 5-20 mm long 1.7-9 mm wide. Flowering stems 12-25 in number, annual, fastigiate, simple, nearly terete, usually reddish or red purplish, densely or moderately papillate (the papilla pellucid, often capitellate, about 0.2 mm long), usually 20-30 cm long, 2.2-3.3 mm thick at anthesis, not or slightly accrescent later, remaining over one year after death, the remains of former years' flowering stem reddish brown, hollow. Leaves alternate, relatively densely arranged throughout, loosely imbricate, spreading widely, sessile, slightly spurred (the spur 0.3 mm long, round), thick herbaceous, flat, narrowly obovate (SADT n. 45 or 46) or narrowly elliptic (SADT n. 1 or 2), usually 6-20 mm long 2.5-7 mm wide, usually obtuse but often acute at the apex, attenuate or shortly attenuate at the base, remotely and irregularly crenulate-denticulate or nearly entire along the upper half of the margin (the teeth 6-12 in number, usually concave or straight in the apical side, convex in the basal side, round at the apex, 0.2-0.3 mm long) or usually entire along the lower half, dark or deep green above, slightly glaucous or pale green beneath, densely papillate along the margin, sparsely to moderately papillate above (the papilla pellucid, round at the apex, usually 0.05-0.15 mm long), epapillate beneath, the costa shallowly depressed above, distinctly raised beneath, the lateral veins obscure, usually 4-6 on each side of the costa, nearly parallel, densely anastomosing towards the margin. Inflorescences terminal, usually 10-50-flowered, bracteate, usually dense in male plants and rather loose in female plants, nearly hemispherical, usually 2.5-4 cm (σ), 4-10 cm (ρ) across, forming a compound-corymb, the cluster (4-)3-5(-6) in number, usually 1.5-2 cm (σ), 3-5 cm (ρ) long; peduncles usually 1-1.5 cm (σ), 1.5-2 cm (ρ) long; pedicels 0.8-3 mm long, nearly terete, mostly densely or rarely moderately papillate (the papilla about 0.1 mm long, pellucid), reddish or red purplish; bracts leafy, very similar to the upper cauline leaves in shape, usually 3-10 mm long 1-4 mm wide. Flowers in middle June to August, dioecious, mostly 5-merous, but occasionally commixed 4-merous (15-46% in each flowering stem), 6-8 mm (σ), 4-5 mm (ρ) across at flowering, the alabastrum dark purplish red or deep red, oblong. Calyx (3-)4-5(-5.5) mm long, glabrous, the tube funnel-shaped, green, 2-3.5 mm long, nearly equalling the lobes in length, in female plants more or less rigid and slightly thickening; the lobes $5/7-3/4$ as long as the petal, 1.5-2.7(-3) mm long 0.4-0.6 mm wide at the base, narrowly triangular or subulate, nearly entire along the margin, round at the apex, somewhat round outside, flattish inside, spreading in male plants, ascending or suberect and appressed to the ovaries in female plants, green but often reddish or dark purplish red; the sinus between lobes round (σ) or truncate (ρ). Petals distinct,

sessile, dark red purple or deep red, deeper towards the margin, somewhat yellowish in the lower half of inside, usually oblong-ovate or narrowly oblong-ovate, 2.5–4.5 mm long, 1.3–1.8 mm wide, nearly entire or often gnawed or minutely erose along the margin, round or obtuse at the apex, somewhat fleshy, glabrous, spreading widely (♂) suberect (♀) at flowering, flattish or very slightly round outside, slightly concave inside. Stamens distinctly shorter than the petal (about $2/3$ of the petal-length), ascending or suberect at anthesis; filaments subulate, nearly terete but slightly obcompressed towards the base, fleshy, glabrous, reddish or pale purplish red (deeper towards the apex), about 0.5 mm wide at the base, the epipetalous ones inserted about 0.8 mm from the base, 1.2–2.4 mm long, the alternipetalous ones 2–3 mm long; anthers basifixed, ovoidal, usually 0.7–0.8 mm long, slightly retuse at the apex, before anthesis purplish red, just before the dehiscence deep red-purple, after dehiscence turning yellow. Nectar-scales square or square-ovate, very shallowly retuse at the apex, usually recurved in the upper $1/3$ part, blackish purple or dark purplish red, usually 0.7–0.9 mm long 0.6–0.7 mm wide 0.3 mm thick. Gynoecium of female plants usually 4.5–5.5 mm long, twice to thrice of the petal, connected about 1.5 mm ventrally at the base, the connected part adnate to the calyx-tube dorsally, sessile, erect, red-purplish, the ovary more or less straight ventrally, dorsally tapering to both ends from the middle, opposite to the calyx-lobe and nectar-scale, usually 1.2–1.7 mm wide at the middle, the style very short, about 0.5 mm long, usually somewhat outcurved, the stigma very slightly swelling, epapillate, often dark purplish red; the placenta nearly marginal. Gynoecium of male plants usually 2–2.5 mm long or rarely absent, distinctly shorter than the stamens. Ovules of female plants 10–14 in each locule, mostly descending, ellipsoidal, somewhat elongate in the apical part, obtuse at the apex, usually 0.8–1 mm long, the funicles about 0.2 mm long; ovules of male plants 2–4 in each locule, about 0.4 mm long, ellipsoidal, round at the apex, probably abortive. Follicles 7–8 mm long, erect, brown. Seeds chestnut-brown, 2.5–3 mm long, ellipsoidal with elongate apex.

Distr. Nepal, Sikkim, Tibet, Bhutan, and Yunnan.

Specimens examined. Nepal. Lantang, alt. 12500–13000 ft. (Polunin 205, BM); Lantang Valley, alt. 13000 ft. Flowers dark red (Schilling, Sayers & Bista 379 ♀, KATH); Mul Kharka, Chilime Khola, alt. 4100 m (Kanai & Shakya 672265 ♂, TI, KATH); Gosainkund, alt. 4000 m. On exposed rocks. Flowers dark shining red (Kanai, Hara & Ohba 726289 ♀, TI); Patuiages de Kunde–Khumsung, alt. 3810 m. Sur un bloc de rocker parmi les *Rhododendron*. Fleurs blanches ponctuées de pouipse, exposition sud (Zimmermann 701, BM); Bhurchula Lekh, near Jumla, alt. 12500 ft. On rock ledges. Inflorescence red except for sepals which are green externally (Polunin, Sykes & Williams 4657 ♀, BM, KATH); Near Pudamigaon, Suli Gad, alt. 12500 ft. Among rocks, growing in moist soil, exposed. Flowers dull reddish, stamens with yellowish anthers (Polunin, Sykes & Williams 2243, BM, KATH); Taglung, S. of Tukucha, Kali Gandaki, alt. 12000 ft. Open rocky slopes. Corolla & filaments dark red (Stainton, Sykes & Williams 1728 ♀, BM, KATH) Thorungse Pass, Muktinath, alt. 14500 ft. Open rocky slopes. Petals and filaments dark red (Stainton, Sykes & Williams 1478, KATH); Thinigaon, Muk-

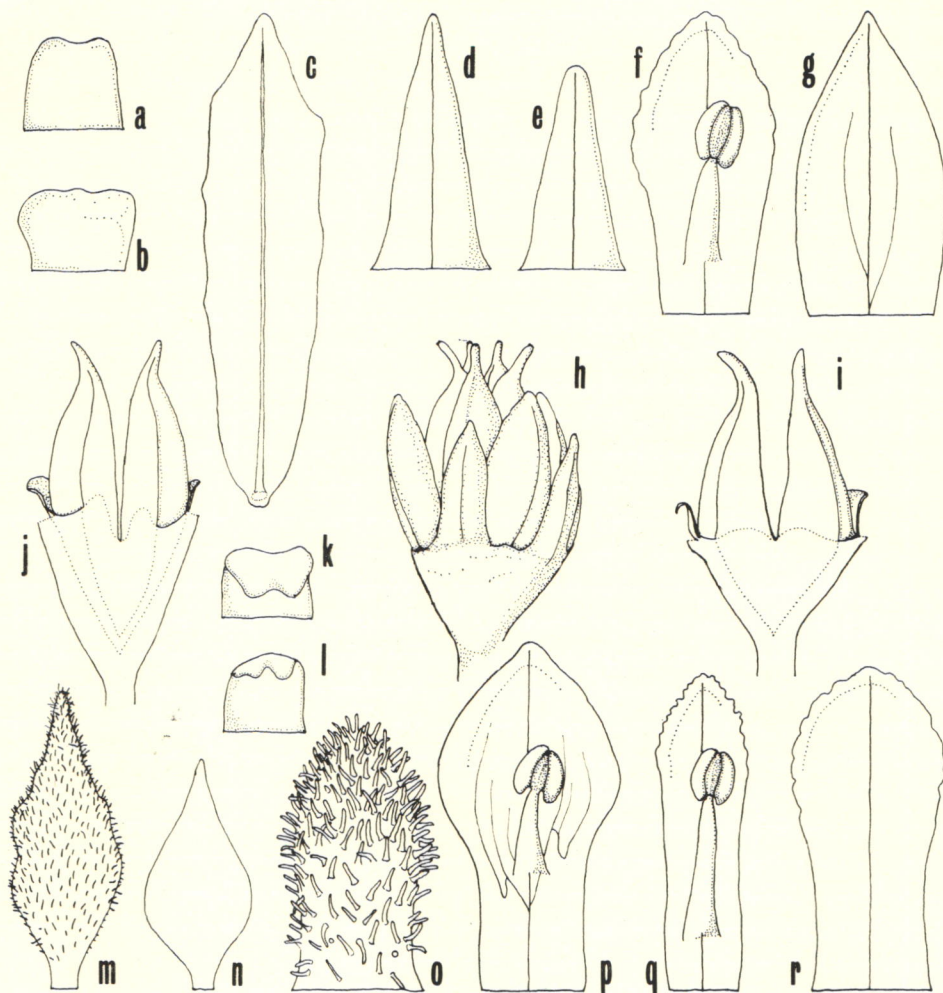


Fig. 52. *Sedum himalense* D. Don (a-i). a & b. Nectar-scales in dorsal view, $\times 15$, c. Cauline leaf, $\times 3.75$, d & e. Calyx-lobes, $\times 7.5$, f. Petal of male flower with stamen, $\times 7.5$, g. Petal of female flower, $\times 7.5$, h. Female flower, $\times 7.5$, i. Pistils in longitudinal section, $\times 7.5$. *Sedum Bouvieri* R.-Hamet (j-r), j. Pistils in longitudinal section, $\times 7.5$, k & l. Nectar-scales in dorsal view, $\times 15$, m & n. Cauline leaves, $\times 3.75$, o. Calyx-lobe, $\times 7.5$, p & q. Petals of male flowers, $\times 7.5$, r. Petal of female flower, $\times 7.5$. (a, d, g-i. Kanai et al. 726325, b, c, e & f. Stainton 376, j, l, m, o & r. Duthie 5565 in κ , k, n & p. Duthie 5565 in BM, q. Presented by Reid in κ).

inath Himal, alt. 13500 ft. At edge of stream. Inflorescence and stem red (Stainton, Sykes & Williams 1332 ♀, BM, KATH); Balangra Pass, alt. ca. 13500 ft. Among boulders and rocks. Flowers reddish (Polunin, Sykes & Williams 1041, BM, KATH); Jargeng Khola, alt. 14000 ft. Among dwarf bushes on open hillside. Flowers crimson to carmine; leaves green (Lowndes 1120, BM); Manaslu (Nakao s.n.,

кво); Kangrang La, 27° 25' N, 88° 03' E, alt. 12700 ft. On rock ledges. Stem and flowers red (Williams 697, BM, TI); Changyam Khola, alt. 14000 ft. Shrubland. flowers (♀) red (Gardner 736 & 740, BM, TI); Kyanchin Gomba, 28° 13' N, 85° 44' E, alt. 3700 m (Dobremez 1066, BM); Solu Khola, N. of Junbesi, 27° 30' N, 86° 30' E, alt. 13000 ft. Among dwarf *Rhododendron*. Tufted habit (Mc Cosh 254, BM, TI); Rolwaling, 27° 55' N, 86° 23' E, alt. 15500 ft. Flowers red (Stainton 4727, BM); Bagmati Zone, Rasuwa District, E. of Khangyin, alt. 3700 m. South facing slope among *Berberis* along track. Red colored (Nicolson 2607, BM, KATH); Jangba, alt. 14–15000 ft. Fls. black-red (Dhwoj 210, BM); Jata Pokhari, alt. 14–15000 ft. Flowers dark (Dhwoj 630, BM); Thudam, Arun Valley, E. of Chyamtang, alt. 12500 ft. Amongst rock and small shrubs. Petals & filaments dark red (Stainton 376, BM, TI); Kyangin Kharka areas, alt. 13000 ft. On rock. Stem red (Malla 9178, BM); Gosa-Banduke Pokhari, alt. 4100–4200 m. On mossy rock (Kanai, Ohashi, Iwatsuki, Ohba & Shakya 726326, TI); Banduke Pokhari-Saju Pokhari, alt. 4000–4200 m. On mossy rocks or margin of dwarf *Rhododendron* shrubs. Flowers dark purple red (K.O.I.O. & S. 726319–22 ♂, 726328–29 ♂, TI); Saju Pokhari-Topke Gola, alt. 4300–3700 m. Abundant on stony bed or rocks by stream (K.O.I.O. & S. 726323 ♀, TI); Topke Gola, alt. 3600 m (K.O.I.O. & S. 726324 ♂ & 726325 ♀, TI); Janga La-Thudam, alt. 4200–3400 m. Abundant along streams. Flowers red purple (K.O.I.O. & S. 726330 ♂ & 726331 ♀, TI); Thudam-Lama Chungbu, alt. 3400–4200 m. Abundant on exposed or more or less shaded rocks by or near streams. Flowers red purple (K.O.I.O. & S. 726299 & 726300 ♀, TI); Lama Chungbu-Samdan, alt. 4200–4400 m. Stony floor of shrubs near streams. Flowers reddish (K.O.I.O. & S. 726301–726312, TI); Thudam-Kipudonsu, alt. 3400–4200 m. Abundant along streams (K.O.I.O. & S. 726287 ♂ & 726288 ♀, TI); Phujeng La-Topke Gola, alt. 3800 m. Abundant along streams (K.O.I.O. & S. 726314–726318, TI). Sikkim. regio. alp. alt. 12–17000 ped. (Hooker s.n., CAL); alt. 16500 ft. (Gammie 903, CAL); above Lung too Sha-Can bee (King's collector s.n., CAL); Jongri to Alokting, alt. 13–15000 ft. (Anderson 600, CAL); Jongri, alt. 14000 ft. (Gammie 158, CAL); Jongri-Gamotang, alt. 3600–4200 m. Flower dark purple-red (Hara, Kanai, Murata, Togashi & Tuyama 6665, TI); Gamotang-Megutang, alt. 3900 m (H.K.M. & T., T. 6678, TI); along the Choksering Chu, north of Jongri, alt. 4000–4500 m. Flower dark purple-red (H.K.M.T. & T. 6664, TI); Rishenong, alt. 13000 ft. (Ribu & Rhomoo 4505 ♀, CAL). Tibet. Phari, alt. 14–15000 ft. (Bigenld 44 ♀, CAL). Bhutan. (Dungboo s.n., CAL); Bhorntang, Dhur Chu, alt. 15200 ft. Among rocks. Abundant. Flowers dark red & showy (Bowes Lyon 3388 ♂, BM); Parshary Zempur, alt. 12500 ft. On scree. (Cooper 3020, BM); Laum Thang-Chawa Gassar, alt. 4700 m (Hara, Kanai, Murata, Ohashi, Tanaka & Yamazaki s.n. ♀, TI); Laya-Laum Thang, alt. 3800 m (H.K.M.O.T. & Y. s.n. ♂, TI); Bhumthang, alt. 15000 ft. (Chaubin 147, TI).

Sedum himalense is easily distinguishable from other species by the reddish and densely papillate flowering stems, dark red petals and shining blackish purple nectar-scales, etc.

In my field observations in E. and C. Nepal, this species seems to characterize the vegetation of such exposed habitats as scree, boulder drift and stream side and

the rock- or soil-floor of dense bushes of *Rhododendron Anthopogon*, *R. setosum* and *R. lepidotum* in altitudes from 3600 m to 4600 m. Moreover, from 3600 m to 3800 m *S. himalense* often grows on shady rocks along ravines in broad-leaved deciduous forests containing *Salix*, *Prunus*, *Acer*, etc. *S. himalense* was found in most localities with mosses belonging to the genera *Breuteria*, *Dicranum*, *Plagiochila*, *Tortula*, *Calliergonella?*, *Thuidium*, *Campylopus*, *Actinothuidium*, *Plagiothecium*, *Onchophorus*, *Rhacomitrium*, etc.

Sedum Bouvieri R.-Hamet in Journ. Bot. **54**: suppl. 11 (1916)—Praeger in Not. Bot. Gard. Edinb. **13**: 74 (1921)—Berger in Engl. et Prantl, Nat. Pfl.-fam. 2 Aufl. **18a**: 442 (1930). [Fig. 52 j-r]

Sedum quadrifidum Pallas var. *Bouvieri* (R.-Hamet) Fröd. in Act. Hort. Gothob. **5**: append. 32 (1930).

Chamaerhodiola Bouvieri (R.-Hamet) Nakai apud Nakai et Kitagawa in Rep. 1st Sci. Exped. Manch. Sect. IV, **1**: 30 (1934).

A perennial herb, up to 15 cm high. Rhizomes more or less elongate, nearly cylindrical, solid, usually 0.5–1.2 cm thick, up to 7 cm long, bifurcate when well developed, ascending to nearly erect, the upper part epigaeous, densely armed with the remains of the former years' flowering stem, the apical part densely covered with scaly leaves. Scaly leaves thick chartaceous, somewhat rigid, long persistent, triangular or triangular-semicircular or broadly triangular-ovate, entire along the margin, attenuate or obtuse at the apex, 3.5–7 mm long 1.8–6.5 mm wide, dark or chestnut-brown. Flowering stems 4–10 in number, annual but remaining over one year after death, fastigate, simple, nearly terete, usually pale reddish, very densely papillate (the papilla pellucid, persistent, (0.1–)0.2–0.4(–0.5) mm long), usually 4–9 cm long 0.7–0.8 mm thick at anthesis; the remains of the former years' stem pale reddish but gradually changed straw-coloured. Leaves alternate or often nearly opposite, more or less remotely arranged throughout, spreading widely, nearly sessile, spurless, thick herbaceous, flat, usually ovate, entire or very shallowly repandous along the margin, usually attenuate or acute at the apex, usually shortly attenuate at the base, 5–12 mm long 2.2–5.3 mm wide, very densely papillate (the papilla pellucid, 0.2–0.3(–0.4) mm long, conspicuous, 15–25/mm along the margin, 30–50/mm² on both surfaces), the costa not prominent. Inflorescences terminal, usually (3–)5–6(–7)-flowered, bracteate, usually 3–12 mm long 5–20 mm wide, forming a simple- or monochasial-corymb; peduncles 4–7 mm long, nearly terete, densely or moderately papillate; pedicels usually nearly 0–1(–2) mm long, densely or moderately papillate (the papilla 0.1–0.3 mm long); bracts leafy, very similar to the upper cauline leaves in shape, usually 2–4 mm long 1.1–2 mm wide. Flowers in July, dioecious, mostly 5-merous, usually 3.5–4 mm across at anthesis. Calyx 2.5–3.8 mm long, moderately papillate outside (the papilla pellucid, 0.2–0.3 mm long) the tube usually 0.8–1.5 mm long, gradually or somewhat abruptly narrowed towards the base; the lobes usually 1.7–2.5 mm long, 0.7–1.5 mm wide, narrowly oblong (SADT n. 14) or narrowly oblong-ovate, mostly entire along the margin, round or triangularly round in the apical part, round or obtuse at the apex, nearly parallel in the lower half, more or less fleshy, slightly convex outside, flat inside, ascending at anthesis, the papilla

dense towards the margin and apex, the sinus between lobes obtuse or truncate. Petals distinct, sessile, reddish(?), usually narrowly oblong-spathulate or narrowly oblong-obovate, usually 2.7–3.2 mm long 0.8–1.9 mm wide, broadest at the 2/3 from the base, round in the apical part, round and usually more or less bitten at the apex, nearly entire or erose along the margin, shallowly boat-shaped, somewhat fleshy, glabrous, epapillate inside but usually sparsely or moderately papillate along the costa outside (the papilla pellucid, usually 0.1–0.2 mm long), spreading at anthesis. Stamens distinctly shorter than the petal, suberect or ascending at anthesis; filaments subulate, fleshy, obcompressed, glabrous, epapillate, about 0.5 mm wide at the base, the epipetalous ones inserted 0.3–0.7 mm from the base, 1.2–1.4 mm long, the alternipetalous ones 1.5–1.7 mm long; anthers basifixed, nearly globose, usually 0.4–0.6 mm long, round or very slightly retuse at the apex, before anthesis reddish(?), after dehiscence yellow. Nectar-scales nearly square or obovate, very shallowly retuse at the apex, recurved in the upper 1/5 part, probably reddish, usually 0.5–0.7 mm long 0.4–0.6 mm wide 0.15 mm thick. Gynoecium of female plants usually 3.7–4.5 mm long, 1.4–1.7 times longer than the petal, usually connected ventrally 0.7–1.3 mm from the base, erect, the ovary straight ventrally, tapering from the base of the distinct part, connected part more or less adnate to the calyx-tube dorsally, 1–1.2 mm wide, opposite to the calyx-lobe, the style short, usually 0.5–0.7 mm long, tapering from the base, more or less outcurved, the stigma very minutely mamillate, the placenta nearly marginal. Gynoecium of male plants usually 0.9–1.8 mm long, distinctly shorter than the stamens. Ovules 10–14 (♀) or 2 (♂) in each locule, mostly descending, very narrowly oblong, usually 0.5–0.6 mm (♀) or 0.4 mm (♂) long, round at the apex; those of male plants probably abortive. Follicles usually 4–5 mm long, erect, dark brown.

Distr. Nepal.

Specimens examined. Nepal. Rocks in Nampe Gadh, alt. 13000 ft. (Duthie on July 27, 1886, No. 5565, BM, κ-Type collection of *Sedum Bouvieri* R.-Hamet); Height above Chahlek, Byans, alt. ca. 12000 ft. (unknown collector s.n., presented by Reid, E).

In having conspicuous papillae on stems, leaves, calyx and petals, this species easily distinguishable from other species. *Sedum coriaceum*¹⁾ resembles this species in having puberulous leaves, but seems to differ in the shape of leaf, i.e. obovate against ovate in the latter. By courtesy of Prof. Hara, I was able to examine the photograph of the holotype of *S. coriaceum* in κ. The type specimen, i.e. Wallich 7328, seems to be remarkably robust than *S. Bouvieri*. However *S. coriaceum* should be remain for further studies based on the authentic specimens.

1) *Sedum coriaceum* Wall. [Cat. no. 7328 (1832), nom. nud.] ex Hook. f. et Thoms. in Journ. Linn. Soc. Bot. 2: 99 (1858)–C. B. Clarke in Hook. f., Fl. Brit. Ind. 2: 419 (1878).

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