

EUTREMA R. Brown, Chlor. Melvill., 193. 1823.

Ihsan A. Al-Shehbaz

Tribe: Eutremeae, Al-Shehbaz, Beilstein & E.A. Kellogg, Pl. Syst. Evol. 259. 112. 2006.

Name derivation: from Greek *eu*, well, and *trema*, opening, in reference to the perforation in the fruit septum.

Type species: *E. edwardsii* R. Brown.

Esquirolia H. Léveillé, Mondes Plantes, ser. 2, 18: 31. 1916. Type species: *E. violifolia* (H. Léveillé) H. Léveillé (based on *Martinella violifolia* H. Léveillé).

Glaribraya H. Hara, J. Jap. Bot. 53: 135. 1978. Type species: *G. lowndesii* H. Hara.

Martinella H. Léveillé Bull. Soc. Bot. France 60: 290. 1904; not *Martinella* Baillon, Hist. Pl. 10: 30. 1891; not *Martinella* (Cooke & Masee ex Cooke) Saccardo, Syll. Fung. 10: 409. 1892.

Type species: *M. violifolia* H. Léveillé.

Neomartinella Pilger in Engler & Prantl, Nat. Pflanzenfam. Nachtr. 3: 134. 1906. Type species: *N. violifolia* (H. Léveillé) Pilger (based on *Martinella violifolia* H. Léveillé).

Platycraspedum O. E. Schulz, Repert. Sp. Nov. Regni Veg. Beih. 12: 386. 1922. Type species: *P. tibeticum* O. E. Schulz.

Taphrospermum C. A. Meyer in Ledebour, Fl. Altaic. 3: 172. 1831. Type species: *T. altaicum* C. A. Meyer.

Thellungiella O. E. Schulz in Engler, Pflanzenreich IV. 105 (Heft 86): 251. 1924. Lectotype species designated by German (2002:): *T. salsuginea* (Pallas) O. E. Schulz (based on *Sisymbrium salsugineum* Pallas).

Wasabia Matsumura, Bot. Mag. (Tokyo) 13: 71. 1899. Type species: Matsumura (1899) did not designate a type among his two species: *W. pungens* Matsumura and *W. hederifolia* (Franchet & Savatier) Matsumura. The former is illegitimate because it lists the earlier published *Lunaria japonica* Miguel as a synonym.

Herbs, annual, biennial, or perennial, with slender or fleshy and fusiform roots, rhizomes, or caudex. **Trichomes** absent or simple. **Multicellular glands** absent. **Stems** erect or ascending to decumbent or prostrate, simple or branched at base and/or apically, leafy or rarely leafless. **Basal leaves** petiolate, rosulate or not, simple, entire, dentate, or pinnately or palmately lobed; cauline leaves petiolate or sessile and cuneate or auriculate to amplexicaul at base, entire, dentate, or crenate, lowermost alternate or rarely verticillate; ultimate veins ending or not with apiculate callosities. **Racemes** bracteate throughout or basally, or ebracteate, elongated considerably or not in fruit; fruiting pedicels erect and subappressed to stem, ascending, or divaricate, persistent. **Sepals** ovate or oblong, free, deciduous or rarely persistent, erect, equal, base of inner pair not saccate; petals white or rarely pink to purple, longer or shorter than sepals, rarely absent; blade spatulate, obovate, oblong, or obcordate, apex obtuse, rounded to emarginate; claw undifferentiated from blade; stamens 6, exserted or included, tetradynamous to subequal in length, erect to spreading; filaments wingless or rarely flattened and laterally toothed, unappendages, glabrous, free; anthers ovate or oblong, obtuse or apiculate at apex; nectar glands lateral or confluent and subtending bases of all stamens, median glands present or absent; ovules 2–96 per ovary; placentation parietal. **Fruit** dehiscent, siliques or silicles, linear, oblong, ovoid, obcordate, conical, ovate, or lanceolate, terete, slightly 4-angled, latiseptate or angustiseptate, not inflated, unsegmented; valves papery, with an obscure or prominent midvein, glabrous or rarely papillate, smooth or torulose, not keeled, wingless; gynophore obsolete or to 5 mm; replum terete or flattened throughout or only basally; septum complete or rarely perforated and reduced to rim or absent, veinless; style obsolete or distinct and up to 3 mm, slender or clavate; stigma capitate, entire or rarely 2-lobed, unappendaged. **Seeds** uniseriate or biseriate, wingless, oblong to ovate,

plump or flattened; seed coat obscurely reticulate to foveolate or papillate, slightly mucilaginous or not when wetted; cotyledons incumbent, oblique or rarely accumbent.

Twenty-six species: Eurasia, North America.

References: Al-Shehbaz (2000b, 2000i, 2007b), Al-Shehbaz & Warwick (2005), Al-Shehbaz et al. (2000b), Warwick et al. (2006a).

[SEE INTERACTIVE KEY TO THE SPECIES](#)

1. *Eutrema altaicum* (C. A. Mey.) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 132. 2005; *Taphrospermum altaicum* C. A. Meyer in Ledebour, Fl. Altaic. 3: 173. 1831; *Cochlearia altaica* (C. A. Meyer) J. D. Hooker & Anderson, Fl. Brit. India 1(1): 145. 1872. TYPE: Russia. Tschuja (Chuya) River near mouth of Tschegan (Chegan) River, *Bunge s.n.* (Holotype: LE!).

Taphrospermum altaicum var. *macrocarpum* Z. X. An, Acta Phytotax. Sin. 23: 396. 1985.

TYPE: China, Xinjiang, Bogda Shan, *Xinjinag College Botanical Expedition 15152* (holotype, XJU!).

Herbs, perennial, with narrowly fusiform roots, glabrous throughout except for puberulent fruit. Stems (4–)10–23(–30) cm, prostrate, sometimes ascending to erect, few to numerous from base. Leaves not rosulate, somewhat fleshy, petiolate; petioles of basal and lowermost leaves 1–4(–9) cm, gradually shorter upward; leaf blade suborbiculate to subcordate or ovate to oblong, (0.5–)1–2.5 × (0.4–)0.7–2 cm, gradually reduced in size upward, base obtuse to subcordate, margin entire or rarely repand, apex obtuse or rounded. Racemes densely flowered, elongated considerably in fruit, bracteate throughout; bracts leafy and representing all cauline leaves; lowermost flowers near stem base. Sepals oblong, 0.8–1.5(–2) × 0.5–0.8(–1) mm, persistent or caducous shortly after fruit maturation, membranous at margin; petals white, obovate, (1.5–)2–2.5(–3) × (0.5–)0.8–1.5 mm, cuneate to a clawlike base less than 0.5 mm, apex rounded to slightly emarginated; filaments white, 0.8–1.2 mm, inner pairs distinctly dilated and to 0.3 mm wide at base; anthers ovate, 0.2–0.3 mm; ovules 3–5(or 6) per locule. Fruiting pedicels glabrous, slender, strongly recurved or nearly forming a loop, (3–)5–8(–12) mm. Fruit narrowly conical, strongly torulose, slightly to strongly angustiseptate at least basally, (4–)7–10(–12) mm, base cordate to truncate and (1.8–)2–2.5(–3) mm wide, apex acuminate; valves membranous, sparsely puberulent with papillae to 0.3 mm, rarely subglabrous, distinctly veined; replum broadly expanded at base, narrowly flattened elsewhere; septum complete or rarely perforate and reduced to a rim, membranous; style slender, (0.5–)0.7–1.2(–1.5) mm. Seeds 2–4 per locule, brown, oblong, plump, 1.4–1.8 × 0.8–1.2 mm; cotyledons incumbent or oblique.

Flowering: Jun–Aug.

Habitat: Mountain meadows, forest margins, gravelly ridges, open slopes, roadsides

Elevation: 2000–4000 m.

Distribution: China (Gansu, Qinghai, Xinjiang, Xizang, Yunnan), Kazakstan, Kyrgyzstan, Mongolia, Russia (Siberia), Tajikistan.

2. *Eutrema botschantzevii* (D. German) Al-Shehbaz & S.I. Warwick, Harvard Pap. Bot. 10: 132. 2005; *Thellungiella botschantzevii* D. German, Turczaninowia 5(2): 36. 2002. TYPE: Russia, Novosibirsk, Dovoln, pr. pag. Starogornostaly, in ripa dextra fl. Chulym, 54°38' N, 79°06' E, 16 Jun 1993, *D. N. Schaulo, V. M. Khanminchun & O.N. Snytko s.n.* (holotype, NS; isotype, SSBG).

Herbs, annual or biennial, glabrous throughout, often glaucous. Stems 15–42 cm, erect, simple or branched. Basal leaves rosulate; petiole to 10 mm; leaf blade spatulate, to 10 × 8 mm, margin entire or obscurely repand-dentate, apex rounded; middle cauline oblong-ovate, sessile, to 20 × 8 mm, base amplexicaul, margin entire, apex acute. Raceme elongated in fruit, 15–50-flowered; rachis straight; fruiting pedicels slender, divaricate-ascending, 5–8(–15) mm. Sepals oblong, 1.6–1.9 × 0.6–0.7 mm; petals white, oblong-obovate, 2–2.5 × 1–1.1 mm; ovules 30–44 per ovary. Fruit 1.2–2 cm × 0.5–0.6 mm, subtorulose, sessile; valves obscurely veined; style obsolete. Seeds reddish brown, oblong, uniseriate, ca. 0.6 × 0.3 mm.

Flowering: Jun.

Distribution: Russia (SW Siberia).

3. *Eutrema bouffordii* Al-Shehbaz, Harvard Pap. 11: 277. 2007. TYPE: China, Sichuan, Serxu Xian, NW of the city of Shiqu (Serxu), vicinity of Anbala Shan at Ya Kou (Ya Pass), border of Sichuan and Qinghai provinces, 33°8'24"N, 97°29'53"E, 4560–4875 m, gravelly disturbed area near pass, 26 Jul 2005, *D. E. Boufford, J. H. Chen, K. Fujikawa, S. L. Kelley, R. H. Ree, H. Sun, J. P. Yue & Y. H. Zhang* 3352 (holotype, A!; isotypes, KUN, MO!).

Herbs, perennial, sparsely to moderately pubescent, with narrowly fusiform roots. Stems 5–11(–20) cm tall, solitary or many branched just above base, prostrate to decumbent, rarely erect, sparsely to densely pubescent with retrorse or spreading trichomes 0.3–0.6 mm, often glabrous on the side of leaf attachment. Leaves not rosulate; petioles of lowermost leaves (0.5–)1.0–3.6 cm, gradually becoming shorter upwards; leaf blade ovate to oblong, 0.7–2.0 cm × 3–7 mm, base obtuse or cuneate, margin entire to repand or sparsely dentate. Racemes densely flowered, slightly elongated in fruit, bracteate throughout; bracts leafy, smaller than cauline leaves; fruiting pedicels 2.5–7.0 mm, ascending, straight, pubescent adaxially. Sepals oblong, 1.3–1.7(–2.0) × 0.7–1.0 mm, persistent, membranous at margin, sparsely pubescent below apex; petals white or lavender, obovate or spatulate, 2–3 × 0.5–1.0(–1.4) mm, attenuate to a clawlike base 1–2 mm, apex slightly emarginate; filaments 1.5–2.0 mm, dilated at base; anthers ovate, 0.15–0.20 mm; ovules 4–8 per ovary. Fruit broadly to narrowly obcordate, slightly angustiseptate, (2–)3–5 × (4–)5–7 mm, emarginate at apex; valves membranous, densely or rarely sparsely puberulent with trichomes to 0.5 mm, papillate-tuberculate; replum widely and evenly expanded throughout; septum absent; style slender, 1–3 mm. Seeds dark brown, oblong, foveolate, plump, 1.2–1.6 × 0.8–1.1 mm; cotyledons accumbent.

Flowering: Jul.

Habitat: gravelly disturbed areas.

Elevation 4500–4900 m.

Distribution: China (Qinghai, Sichuan).

4. *Eutrema cordifolium* Turczaninow ex Ledebour, Fl. Ross. 1: 198. 1841; *Smelowskia cordifolia* (Turczaninow) Walpers, Repert. 2: 761. 1843. TYPE: Russia. Baikal, Zhemchug River (in Tunkinsk valley of E Sayan), *Turczaninow s.n.* (holotype, LE).

Herbs, perennial, glabrous throughout, with a short rhizome. Stems 40–60 cm tall, erect, simple at base, branched above. Basal leaves rosulate, long petiolate; leaf blade broadly cordate, to 13 × 10 cm, base cordate or rounded, margin crenate-serrate, apex obtuse; middle cauline leaves broadly ovate, cuneate at base, not auriculate, uppermost rhombic. Raceme ebracteate, lax; fruiting pedicels divaricate, 8–13 mm. Sepals ovate, 2–2.2 mm, deciduous; petals white, spatulate, 5–6 mm; ovules 4 per ovary. Fruit oblong, 7–9 × ca. 3 mm, slightly 4-angled, not torulose; valves gradually cuneate to base, abruptly narrowed to apex, with a prominent midvein;

septum perforate. Seeds oblong, plump, $2-2.5 \times 1.2-1.5$ mm.

Habitat: mountain meadows in coniferous forests.

Distribution: Russia (Siberia).

5. *Eutrema deltoideum* (J. D. Hooker & Thomson) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 35. 1924; *Sisymbrium deltoideum* J. D. Hooker & Thomson, J. Proc. Linn. Soc., Bot. 5: 163. 1861; *Hesperis deltoidea* (J. D. Hooker & Thomson) Kuntze, Revis. Gen. Pl. 2: 934. 1891. TYPE: Sikkim, 11000–13000 ft, J. D. Hooker s.n. (holotype, K!; isotype, P!).

Eutrema deltoideum var. *grandiflorum* O. E. Schulz, Notizbl. Bot. Gart. Berlin-Dahlem 9: 476. 1926. TYPE: China. NW Yunnan, Peimeishan, Mekong-Yangtze divide between Atuntze and Pungtzera, July 1923, Rock 9944 (holotype, B!; isotypes, E!, GH!, P!).

Herbs, perennial, sparsely pilose to glabrous, with a short rhizome. Stems (7–)20–75(–110) cm tall, erect, simple at base, branched above. Basal leaves rosulate, somewhat fleshy; petiole (1.5–)3.5–10(–15) cm; leaf blade ovate, deltoid, or oblong, (1–)2–5(–8) $\times$ (0.5–)1–3(–5) cm, base cordate or rounded, margin dentate or rarely subentire, apex obtuse to subacute; middle cauline leaves with petioles (0.3–)1–2.5(–3.5) cm; leaf blade broadly ovate to ovate-deltoid or rhomboid, (1.5–)3–6(–10) $\times$ (0.3–)2–4.5(–6) cm, palmately veined, base truncate or cordate, margin dentate, apex obtuse to acute. Raceme ebracteate, lax in fruit, main branch 6–15 cm; fruiting pedicels ascending to suberect, 5–1.2(–15) mm. Sepals ovate, 2–3 $\times$ 1.5–2.5 mm, deciduous; petals white to pink, spatulate to obovate, (5–)6–8 $\times$ 2.5–4 mm; filaments white, 1.5–2.5 mm, slightly dilated at base; anthers oblong, 0.5–1 mm; ovules 2–4 per ovary. Fruit lanceolate to oblong or ovoid, 7–10 $\times$ 2–3 mm, often subappressed to rachis, slightly 4-angled, not torulose; valves with a prominent midvein; gynophore to 1 mm; septum perforated or complete; style obsolete to 1 mm. Seeds oblong, plump, $2.5-3.5 \times 1-1.5$ mm.

Flowering: Jul–Aug.

Habitat: rock crevices, among shrubs, steep slopes, moist meadows, *Betula-Rhododendron* forests, stream beds.

Elevation: 3600–4700 m.

Distribution: Bhutan, China (Xizang, Yunnan), India (Sikkim).

6. *Eutrema edwardsii* R. Brown, Chlor. Melvill.: 9. 1823; *Sisymbrium edwardsii* (R. Brown) Trautvetter, Trudy Imp. S.-Peterburgsk. Bot. Sada 1: 59. 1871. TYPE: Canada, Melville Island, *Edwardss.n.* (holotype, BM!).

Draba laevigata Chamisso & Schlechtendal, Linnaea 1: 25. 1826.

Eutrema intermedium Turczaninow, Bull. Soc. Imp. Naturalistes Moscou 15: 283. 1842; *E. edwardsii* R. Brown var. *intermedium* (Turczaninow) A. L. Ebel, Turczaninowia 3(3): 30. 2000.

Eutrema labradoricum Turczaninow, Bull. Soc. Imp. Naturalistes Moscou 27: 305. 1854. TYPE: xx.

Eutrema penlandii Rollins, Contr. Gray Herb. 171: 51. 1950; *Eutrema edwardsii* subsp.

penlandii (Rollins) W. A. Weber, Phytologia 58: 383. 1985. TYPE: United States, Colorado, Park Co., Hoosier Pass, 12,300 ft, 27 Jul 1935, C.W. T. Penland 1305 (holotype, GH!).

Herbs, perennial, glabrous throughout, with simple or few-branched caudex and fleshy roots. Stems (3–)8–30(–45) cm, erect, simple, 1 to several from caudex. Basal leaves rosulate, somewhat fleshy, soon withering; petiole 1–4.5(–6) cm; leaf blade ovate, lanceolate, or oblong, (0.3–)0.8–2(–2.5) cm $\times$ (1–)4–14(–18) mm, base truncate, obtuse, or cuneate, sometimes oblique,

margin entire, apex obtuse; cauline leaves 3–7(–10), lowermost petiolate, upper ones sessile, ovate, lanceolate, oblong, or linear, (0.7–)1–3(–4) cm x (1–)3–10(–14) mm, base cuneate, margin entire, apex subacute. Racemes corymbose, elongated considerably in fruit, 3–15 cm; fruiting pedicels divaricate to ascending, curved upward or sometimes straight, (1.5–)3–10(–15) mm. Sepals ovate, 1.5–3 x 1–1.5 mm, caducous, margin membranous; petals white, spatulate, 3–5 x 1.5–3 mm; filaments 2–2.5 mm, slightly dilated at base; anthers ovate, 0.2–0.4 mm; ovules (6–)8–12(–14) per ovary. Fruit linear to narrowly oblong, (0.7–)1–2(–2.5) cm x 2–3 mm, slightly 4-angled, not torulose; valves cuneate at both ends, with a prominent midvein; gynophore 0.2–1 mm, rarely obsolete; septum mostly perforate; style 0.2–1 mm. Seeds oblong or rarely ovate, plump, (1.5–)2–3 x (0.7–)1–1.5 mm. $2n = 18, 28, 42, 56$.

Flowering: Jun–Aug.

Habitat: talus slopes, tundra, glaciated hills, grassy margin of streams, wet areas of peat ridges.

Elevation: 0–3900 m.

Distribution: Canada (British Columbia, Northwest Territories, Nunavut, Quebec, Yukon), Greenland, Mongolia, Russia (Far East, Siberia), United States (Alaska, Colorado).

7. *Eutrema fontanum* (Maximowicz) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 132. 2005.

Herbs, perennial, sparsely to moderately pubescent, rarely glabrous; root narrowly fusiform-linear, fleshy, base with minute scalelike leaves usually less than 2 mm. Stems (2–)5–14(–20) cm, solitary from fleshy root then producing a few prostrate or rarely ascending to erect branches, sparsely to densely pubescent with retrorse to spreading trichomes to 0.5 mm, rarely glabrous.

Leaves not rosulate; petioles of basal and lowermost leaves (0.3–)0.6–2(–3) cm, gradually shorter upward; leaf blade ovate to oblong, (2–)4–10(–13) x (1–)2–4(–7) mm, gradually reduced in size upward, base obtuse to cuneate, margin entire to repand, apex obtuse or rounded.

Racemes densely flowered, elongated slightly to considerably in fruit, bracteate throughout; bracts leafy, smaller than cauline leaves. Sepals oblong, 1.5–3 x 0.8–1.5 mm, persistent, membranous at margin, sparsely ciliolate near apex with trichome ca. 0.05 mm, sparsely hairy distally with trichomes to 0.5 mm. Petals white or lavender, obovate to spatulate, 2–6 x (0.5–)0.7–3.5(–4) mm, attenuate to base, apex slightly emarginate. Filaments white to lavender, 1.5–3 mm, dilated at base; anthers ovate, 0.3–0.4 mm. Ovules 4–8 per ovary. Fruit pedicels glabrous or pubescent adaxially, slender, straight or curved, (1.5–)3–10(–20) mm. Fruit broadly to narrowly obcordate, strongly to slightly angustiseptate, not torulose, (2–)3–5 x (4–)5–7 mm, obtuse to cuneate at base; valves membranous, sparsely to densely puberulent with trichomes to 0.5 mm, rarely subglabrous, often distinctly veined, smooth or tuberculate; replum broadly and evenly expanded throughout; septum absent; style slender, (1–)2–3 mm. Seeds 3–8, brown, oblong, foveolate, compressed, 1.2–2.2 x 0.8–1.5 mm; cotyledons accumbent.

Flowering: Jun–Sep.

Habitat: Moist turf, alpine permafrost swamps, damp shingle by rivers, open gravel, slate and schist scree, disturbed alpine meadows, degraded alpine pastures, *Kobresia* turf and cushions, slopes with dwarf bushes.

Elevation: (3200–)3600–5300 m.

Distribution: China (Gansu, Qinghai, Sichuan, Xinjiang, Xizang [Tibet]).

Two subspecies.

1. Petals 4.5–6 x 2.5–3.5(–4) mm; fruit valves glabrous or sparsely puberulent,

- mooth, not tuberculate; seeds $(1.5-1.8-2.2 \times (1.1-1.2-1.5 \text{ mm} \dots\dots\dots 4a. \text{ subsp. } fontanum$
1. Petals $2-3 \times (0.5-0.7-1.2(-1.4) \text{ mm}$; fruit valves densely or rarely sparsely puberulent, often tuberculate; seeds $1.2-1.6 \times 0.8-1.1 \text{ mm} \dots\dots\dots 4b. \text{ subsp. } microspermum$

7a. Eutrema fontanum subsp. **fontanum**; *Dilophia fontana* Maximowicz, Bull. Acad. St. Petersb. 26: 423. 1880; *Taphrospermum fontanum* (Maximowicz) Al-Shehbaz & G. Yang, Harvard Pap. Bot. 5(1): 104. 2000. TYPE: China, Gansu, Terra Tangutorum, 1–13 Jul 1872, Przewalski 202 (holotype, LE !; isotype, PE !).

Dilophia macrosperma O. E. Schulz in W. Limpricht, Repert. Sp. Nov. Regni Veg. Beih. 12: 385. 1922. LECTOTYPE (here designated): China. Tibet. Batang-Litang, Pungtschamu-Taschü, 5260 m, 22 August 1914, W. Limpricht 2235 (type, WRS!; isolectotype, WU!).

Sepals 2.5–3 mm; petals 4.5–6 mm, 2.5–3.5(–4) mm wide; filaments 2.5–3 mm. Fruit valves glabrous or sparsely puberulent, smooth, not tuberculate. Seeds 3 or 4 per fruit, $(1.5-1.8-2.2 \times (1.1-1.2-1.5 \text{ mm}$.

Flowering: Jun–Sep.

Habitat: Moist turf, alpine permafrost swamps, damp shingle by rivers, open gravel, slate and schist scree.

Elevation: (3200–)3600–5300 m.

Distribution: China (Gansu, Qinghai, Sichuan, Xizang [Tibet]).

7b. Eutrema fontanum subsp. **microspermum** (Al-Shehbaz & G. Yang) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 132. 2005; *Taphrospermum fontanum* (Maximowicz) Al-Shehbaz & G. Yang subsp. *microspermum* Al-Shehbaz & G. Yang, Harvard Pap. Bot. 5(1): 105. 2000. TYPE: China, Qinghai, Magin Xian, Ehema, Dawu Xiang, along Gequ He, S of Maqin on road to Gande, 30 Jul 1993, $34^{\circ}20'43'' \text{ N}$, $100^{\circ}15'18'' \text{ E}$, Ho, Bartholomew & Gilbert 570 (holotype, MO!; isotypes, BM!, CAS!, HNWP).

Dilophia fontana Maximowicz var. *trichocarpa* W. T. Wang, Acta Bot. Yunnan. 9: 3. 1987.

TYPE: China. Xizang, Amda, 4750 m, 14 August 1963, Yang Jinxiang 2222a (holotype, PE).

Sepals 1.5–2 mm; petals 2–3 mm, $(0.5-0.7-1.2(-1.4) \text{ mm}$ wide; filaments 1.5–2 mm. Fruit valves densely or rarely sparsely puberulent, often tuberculate. Seeds 2–8 per fruit, 1.2–1.6 mm, 0.8–1.1 mm wide.

Flowering: Jul–Aug.

Habitat: Disturbed alpine meadows, degraded alpine pastures, *Kobresia* turf and cushions, slopes with dwarf bushes.

Elevation: 3900–5000 m.

Distribution: China (Qinghai, Xinjiang, and Xizang).

8. Eutrema grandiflorum (Al-Shehbaz) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 132. 2005; *Neomartinella grandiflora* Al-Shehbaz, Novon 10: 339. 2000. TYPE: China, Hunan, Jiulongan, damp places by stream banks, 600 m, 17 Apr 1985, Luo Yibo 2121 (holotype, PE!).

Herbs, annual, scapose, glabrous throughout. Stems ca. 15 cm tall, erect, simple, leafless, few from base. Basal leaves rosulate; petiole 4–12 cm; leaf blade broadly ovate to suborbicular, $2-6 \times 1.5-3.5 \text{ cm}$, base subcordate to subtruncate, margin crenate-repand, with to apiculate callosities to 0.5 mm, apex rounded; cauline leaves absent. Raceme ebracteate, elongated in fruit; fruiting pedicels suberect to ascending, 1–1.5 cm, all on raceme. Sepals oblong, ca. $3.5 \times 1.5 \text{ mm}$; petals

white, narrowly obcordate, ca. 8×3 mm; filaments white, ca. 3.5 mm; anthers ovate, ca. 0.6 mm; ovules 30–40 per ovary. Immature fruit linear, ca. $2 \text{ cm} \times 1 \text{ mm}$, subtorulose; style slender, 1–1.2 mm. Mature seeds not seen.

Flowering: Apr.

Elevation: ca. 600 m.

Distribution: China (Hunan, Sichuan).

9. *Eutrema halophilum* (C. A. Meyer) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 132. 2005; *Sisymbrium halophilum* C. A. Meyer in Ledebour, Fl. Altaic. 3: 143. 1831; *Hesperis halophila* (C. A. Meyer) Kuntze, Revis. Gen. Pl. 2: 934. 1891; *Stenophragma halophila* (C. A. Meyer) B. Fedtschenko, Rastit. Turkestan 457. 1915; *Thellungiella halophila* (C. A. Meyer) O. E. Schulz in Engler, Pflanzenreich IV. 105 (Heft 86): 253. 1924. TYPE: Kazakhstan, “In locis limoso-salsis humidis deserti soongoro-kirghisici occidentalis trans fl. Irtysh” (holotype, LE).

Herbs, annual or biennial, glabrous throughout, often glaucous. Stems 10–15 cm, erect, branched from base. Basal leaves rosulate; petiole to 10 mm; leaf blade narrowly obovate, coarsely dentate to pinnatifid; middle cauline oblong, sessile, base subamplexicaul or not auriculate, margin entire, apex acute. Raceme elongated in fruit; rachis straight; fruiting pedicels slender, divaricate-ascending, 3.5–6 mm. Sepals oblong, ca. 1.5 mm; petals white, oblong, ca. 3 mm; ovules xx–xx per ovary. Fruit 0.7–1.6 cm $\times$ 0.7–0.8 mm, subtorulose, sessile; valves obscurely veined; style obsolete. Seeds brown, oblong, uniseriate.

Flowering: Jul.

Distribution: Kazakhstan.

10. *Eutrema heterophyllum* (W.W. Smith) H. Hara, J. Jap. Bot. 48: 97. 1973; *Braya heterophylla* W. W. Smith, Notes Roy. Bot. Gard. Edinburgh 11: 201. 1919; *Eutrema edwardsii* R. Brown var. *heterophyllum* (W. W. Smith) W. T. Wang, Acta Bot. Yunnan. 9: 18. 1987. TYPE: China. Yunnan: Bei-ma Shan, 14,000 ft, $28^{\circ}12' \text{ N}$, July 1917, G. Forrest 14385 (holotype, E!; isotype, P!).

Eutrema compactum O. E. Schulz, Repert. Sp. Nov. Regni Veg. Beih. 12: 387. 1922; *E. edwardsii* R. Brown subsp. *compactum* (O. E. Schulz) A. L. Ebel, Turczaninowia 3(3): 30. 2000. TYPE: Tibet, Ta tsein lu-Dawo, W Dshara, 4700 m, Limpricht 1824 (holotype, WRS!, n.v.).

Eutrema obliquum Kuan & Z. X. An, Fl. Xizangica 2: 399. 1985. TYPE: China. Xizang: Biru, Wentangshan, 4900–5100 m, 13 September 1976, Qinghai-Xizang Team 11397 (holotype, PE!).

Herbs, perennial, glabrous throughout or rarely puberulent, with a caudex and fleshy root. Stems 2–15(–25) cm tall, erect, simple, often few from caudex. Basal leaves rosulate, somewhat fleshy; petiole (0.5–)1–5.5(–7.5) cm; leaf blade ovate, suborbicular, lanceolate or rhombic, (0.3–)0.5–2(–2.5) cm $\times$ (2–)4–10(–15) mm, base cordate, truncate, to cuneate, sometimes distinctly oblique, margin entire, apex obtuse to subacute; middle cauline leaves lanceolate, ovate, or linear-lanceolate, 0.7–2.5(–3) cm $\times$ 2–9 mm, pinnately veined, sessile, base cuneate, margin entire, apex subacute. Raceme ebracteate, compact, subumbellate, little or not expanded in fruit, 0.2–2(–3.5) cm; fruiting pedicels divaricate to slightly reflexed, 1–4(–5) mm. Sepals ovate, $1.5\text{--}2 \times$ ca. 1 mm, persistent through fruit maturity; petals white, spatulate, $2\text{--}3.5 \times 1\text{--}1.7$ mm; filaments white, 1–2 mm, slightly dilated at base; anthers ovate, 0.2–0.3 mm; ovules 4–10

per ovary. Fruit linear to oblong, (4–)5–10(–12) × 1.5–2 mm, slightly 4-angled, not torulose; valves cuneate at both ends, with a prominent midvein; gynophore to 0.5 mm; septum mostly perforate; style obsolete to 0.6 mm. Seeds oblong, plump, 1.5–2 × ca. 1 mm.

Flowering: Jun–Jul.

Habitat: sspine meadows, scree, grassy slopes, near glaciers, Kobresia turf, alpine mats, sandstone ridges.

Elevation: 2500–5400 m.

Distribution: Bhutan, China (Gansu, Hebei, Qinghai, Shaanxi, Sichuan, Xinjiang, Xizang [Tibet], Yunnan), Kazakhstan, Kyrgyzstan, Nepal, Tajikistan.

11. *Eutrema himalaicum* J. D. Hooker & Thomson, J. Proc. Linn. Soc., Bot. 5: 164. 1861.

TYPE: India, Sikkim, 10,000–13,000 ft, *J. D. Hooker s.n.* (holotype, K!; isotype, K!).

Goldbachia lancifolia Franchet, Bull. Soc. Bot. Fr. 33: 408. 1886; *Eutrema lancifolium* (Franchet) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 35. 1924. TYPE: China. Yunnan, Likiang, 3800 m, 11 July 1884, *Delavay 701* (as 781 in the protologue)(holotype, P!; isotype, P!).

Sisymbrium hookeri Fournier, Recherch. Crucif. 120. 1865 [nomen illeg., cited *E. himalaicum* in synonymy].

Sisymbrium spectabile J. D. Hooker & Thomson ex Fournier, Recherch. Crucif. 121. 1865; *Hesperis spectabilis* (J. D. Hooker & Thomson ex Fournier) Kuntze, Revis. Gen. Pl. 2: 935. 1891. TYPE: Sikkim, *J. D. Hooker s.n.* (holotype, P!; isotypes, B!, K!).

Herbs perennial, sparsely to densely crisped pilose at least along leaf margin and midvein, with a short rhizome. Stems 30–80(–110) cm tall, erect, simple at base, branched above. Basal leaves rosulate, somewhat fleshy; petiole (2.5–)4–12(–17) cm; leaf blade ovate, oblong, or lanceolate, (1–)2–6(–8) × (0.7–)1.5–4(–5) cm, base cordate or rounded to cuneate, margin entire, apex obtuse to subacute; middle cauline leaves lanceolate to oblong-lanceolate or ovate, 3–6(–8) × 0.7–2(–3) cm, pinnately veined, sessile, base rounded to auriculate, margin denticulate or sparsely so near base, apex acuminate to acute. Raceme ebracteate, lax, main branch 10–25(–40) cm; fruiting pedicels divaricate, (0.5–)0.7–1.8(–2.2) cm. Sepals ovate, 2–2.5 × 1–1.5 mm, deciduous; petals white, spatulate, 4–5 × 2.5–3 mm; filaments white, 1.5–2 mm, slightly dilated at base; anthers oblong, ca. 0.5 mm; ovules 4–8 per ovary. Fruit linear or rarely oblong, (0.8–)1.2–2(–2.5) cm × 1.5–3 mm, slightly 4-angled, subtorulose; valves cuneate at both ends, with a prominent midvein; gynophore to 0.5 mm; septum perforated or complete; style 0.5–1 mm. Seeds oblong, plump, 2–3 × 1–1.5 mm.

Flowering: May–Aug.

Habitat: stream banks, swampy or alpine meadows, among rocks

Elevation: 3300–4400 m.

Distribution: Bhutan, China (Sichuan, Xizang [Tibet], Yunnan), India (Sikkim).

12. *Eutrema hookeri* Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 133. 2005;

Cochlearia himalaica J. D. Hooker & Thomson, J. Proc. Linn. Soc., Bot. 5: 154. 1861, non

Eutrema himalaicum J. D. Hooker & Thomson, J. Proc. Linn. Soc., Bot. 5: 164. 1861;

Taphrospermum himalaicum (J. D. Hooker & Thomson) Al-Shehbaz, Arai & H. Ohba, Harvard Pap. Bot. 5(1): 102. 2000. TYPE: India, Sikkim, 14,000–16,000 ft, 25 Jun, *J. D. Hooker s.n.* (holotype, K!; isotypes, B!, P!).

Herbs, perennial, glabrous throughout except for sparsely puberulent fruit and distal portion of calyx; root narrowly fusiform-linear, fleshy, apex with minute scalelike leaves. Stems (2–)5–10(–15) cm, solitary from fleshy root then producing a rosette with prostrate or rarely ascending to erect branches. Leaves not rosulate; petioles of basal and lowermost leaves (0.5–)1–2.5(–4) cm, gradually shorter upward; leaf blade broadly ovate to oblong, 4–10(–15) × 2–6(–10) mm, gradually reduced in size upward, base obtuse to subcordate, margin lobed or toothed to repand or entire, apex obtuse or rounded. Racemes bracteate throughout, densely flowered, elongated considerably or not elongated in fruit; bracts leafy and representing all cauline leaves; fruiting pedicels glabrous, slender, straight or strongly recurved and fruits appearing geocarpic, 4–9(–13) mm. Sepals oblong, 1.2–2 × 0.8–1 mm, persistent, membranous at margin, sparsely hairy distally; petals white, obovate to spatulate, 2.5–4(–6) × 1.5–2.5(–3.5) mm, attenuate to base, apex slightly emarginate; filaments white, 1.5–2 mm, median dilated at base; anthers ovate, 0.2–0.4 mm; ovules 4–12 per ovary. Fruit ovoid to oblong, latiseptate, not torulose, (2–)4–8(–10) × (1.5–)2–3.4(–4) mm, obtuse at both ends; valves membranous, sparsely puberulent with papillae to 0.5 mm, rarely subglabrous, obscurely veined; replum broadly expanded throughout; septum absent; style slender, 0.5–1(–1.2) mm. Seeds (2–)6–8(–12), brown, oblong, 1–1.5 × 0.8–1 mm; cotyledons obliquely accumbent.

Flowering: Jun–Sep.

Habitat: Rocky ground on exposed slope, scree, deep rich soil, muddy slopes, stream banks, sandy beds, moist granite ledges, alpine pastures and dwarf scrub, *Kobresia* turf, under *Juniperus* trees

Elevation: 3600–5200 m.

Distribution: Bhutan, China (Qinghai, Xizang [Tibet]), India, Nepal.

13. *Eutrema integrifolium* (de Candolle) Bunge in Delile, Delect. Seminum Hort. Bot. Dorpat. 1839: 8. 1839; *Cochlearia integrifolia* de Candolle, Syst. Nat. 2: 369. 1821; *Smelowskia integrifolia* (de Candolle) C. A. Meyer in Ledebour, Fl. Altaic. 3: 168. 1831. TYPE: Russia. Siberian Altai, *Patrin s.n.* (holotype, G-DC).

Eutrema alpestre Ledebour, Fl. Ross. 1(1): 198. 1841. [nom. Illeg., cited the earlier published *Cochlearia integrifolia* in synonymy].

Eutrema alpestre Ledebour var. *hissaricum* Lipsky, Trudy Imp. S.-Peterburgst. Bot. Sada 23: 81. 1904; *E. integrifolium* var. *hissaricum* (Lipsky) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft86): 34. 1924. TYPE: xx.

Goldbachia laevigata de Candolle var. *adscendens* Franchet, Ann. Sci. Nat. Bot., ser. 6, 15: 234. 1883. TYPE: xx

Herbs, perennial, glabrous throughout; rhizomes short. Stems (30–)40–80(–90) cm tall, erect, simple at base, branched above. Basal leaves rosulate, somewhat fleshy; petiole (2.5–)3.5–9(–12) cm; leaf blade ovate, orbicular, or cordate, (1.5–)2–4(–6) × (1.5–)1.7–3.5(–5.5) cm, base cordate or rounded, margin entire, apex obtuse; middle cauline leaves lanceolate to oblong-lanceolate, 4–6.5(–8) × 1–2(–3) cm, pinnately veined, sessile, base cuneate, margin entire, apex subacute. Raceme ebracteate, lax, main branch 10–20 cm; fruiting pedicels divaricate, (4–)6–13(–18) mm. Sepals ovate, 2–2.5 × 1–1.5 mm, deciduous; petals white, spatulate, 4–5 × 2–3 mm; filaments white, 1.7–2.5 mm, slightly dilated at base; anthers oblong, 0.6–0.7 mm; ovules 4 per ovary. Fruit ellipsoid to oblong, 5–8(–10) × 1–2 mm, slightly 4-angled, not torulose; valves cuneate at both ends, with a prominent midvein; gynophore to 0.3 mm; septum complete or rarely perforate;

style 0.3–0.6 mm. Seeds oblong, plump, $2-3 \times 1-1.5$ mm.

Flowering: May–Jun.

Habitat: woods, subalpine areas, open slopes.

Elevation: 1200–2400 m.

Distribution: China (Xinjiang), Kazakhstan, Kyrgyzstan, Russia (Siberia), Tajikistan, Uzbekistan.

14. *Eutrema japonicum* (Miquel) Koidzumi, Fl. Symb. Or. Asiat.: 22. 1930. *Lunaria japonica* Miquel, Ann. Mus. Bot. Lugduno-Batavi 2: 74. 1866; *Wasabia japonica* (Miquel) Matsumura, Ind. Pl. Jap. 2: 161. 1912; TYPE: Japan, Siebold s.n. (holotype, U).

Cochlearia wasabi Siebold, Verh. Batav. Genootsch. Kunst. Wet. 12: 54. 1832, nom. nud; *Eutrema wasabi* (Siebold) Maximowicz, Bull. Acad. Imp. Sci. Saint-Pétersbourg 17: 283. 1873. *Alliaria wasabi* (Siebold) Prantl in Engler & Prantl, Natur. Pflanzenfam. 3(2): 168. 1890; *Wasabia wasabi* (Siebold) Makino, J. Jap. Bot. 8: 35. 1932.

Eutrema okinosimense Takenouchi in Fukouka (1935).

Wasabia pungens Matsumura, Bot. Mag. (Tokyo) 13: 71. 1899. nom. illeg. because the earlier published *Lunaria japonica* is listed as a synonym.

Wasabia koreana Nakai, J. Jap. Bot. 11: 150. 1935; *Eutrema koreana* (Nakai) K. Hammer, Kulturpflanze 34: 98. 1986.

Herbs, perennial, glabrous or sparsely pilose on upper parts, with a fleshy rhizome to 2 cm in diam. Stems 20–60(–75) cm tall, erect to decumbent, simple. Basal leaves rosulate; petiole (6–)10–20(–26) cm, dilated at base; leaf blade cordate to reniform, (2.5–)6–15(–20) $\times$ (3–)6–18(–22) cm, base cordate, margin dentate, denticulate, shallowly crenate, repand, or subentire, with distinct apiculate callosities terminating ultimate veins, apex rounded to obtuse; middle cauline leaves with petioles 1–5(–8) cm; leaf blade broadly ovate to ovate-cordate, 1.5–4(–6) $\times$ 2–4(–6) cm, palmately veined, base and margins as basal leaves, apex acute. Raceme bracteate throughout or only basally, lax, elongated in fruit; fruiting pedicels ascending to divaricate, slender, 1–3.5(–5) cm. Sepals oblong, 3–4 $\times$ 2–2.5 mm, deciduous; petals white, oblong-spatulate, 6–8(–9) $\times$ 2–3 mm; filaments white, 3.5–5 mm; anthers oblong, 0.6–0.8 mm; ovules 6–8 per ovary. Fruit linear, 1–2 cm $\times$ 1.5–2 mm, terete, torulose; valves with an obscure midvein; gynophore (1–)2–5 mm; septum usually complete; style 2–3 mm. Seeds oblong, plump, $2-3 \times 1-1.5$ mm.

Flowering: Mar–May.

Habitat: wet areas along streams in mountains.

Elevation: 0–2,500 m.

Distribution: Japan, Korea, Russia (Far East), naturalized in Taiwan.

15. *Eutrema lowndesii* (H. Hara) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 133. 2005; *Glabribraya lowndesii* H. Hara, J. Jap. Bot. 53: 136. 1978; *Taphrospermum lowndesii* (H. Hara) Al-Shehbaz, Harvard Pap. Bot. 5(1): 107. 2000. TYPE: Nepal, Khangsar, 28 Jul 1950, 16,500 m, *D. G. Lowndes 1287* (holotype, BM!).

Herbs, perennial, glabrous throughout or puberulent with papillae 0.05–0.2 mm; root slender, slightly fleshy, base with a whorl of oblong scalelike leaves ca. $2-5 \times 0.5-1$ mm. Stems 5–12 cm, erect, 1–3 from root, lowermost leafless part 2–9 cm. Leaves glabrous, fleshy, lowermost cauline ones verticillate, others alternate; petioles 2–5 mm, gradually shorter upward; leaf blade

spatulate, $3-15 \times 1-5$ mm, gradually reduced in size upward, base attenuate, margin entire, apex retuse or rounded. Racemes bracteate throughout, densely flowered, elongated considerably in fruit, bracts leafy, smaller than cauline leaves; rachis glabrous or papillate; fruiting pedicels glabrous, slender, straight or curved, 4–8 mm. Sepals oblong, $1.5-2.5 \times$ ca. 1 mm, persistent well after fruit dehiscence, membranous at distal margin and apex, not ciliolate, glabrous or papillate; petals white, narrowly obovate, $3-5 \times 1.5-2$ mm, attenuate to clawlike base to 1.5 mm, apex obtuse; filaments white, 1.5–2.5 mm; anthers broadly ovate, 0.2–0.3 mm; ovules 4–6 per ovary. Fruit oblong or narrowly so, strongly latiseptate, not torulose, $7-15 \times 3-5$ mm, obtuse to cuneate at base; valves membranous, glabrous, often distinctly veined, smooth; replum broadly and evenly expanded throughout; septum complete, membranous; style slender, (1–)2–3 mm. Seeds 3–8, brown, oblong, compressed, $1.9-2.1 \times 1.2-1.4$ mm, densely papillate with papillae 0.1–0.2 mm; cotyledons accumbent.

Flowering: Jul–Aug.

Habitat: Scree slopes

Elevation: 5000–5200 m.

Distribution: China (Xizang [Tibet]), Nepal.

16. *Eutrema parvulum* (Schrenk) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 133. 2005; *Diplotaxis? parvula* Schrenk in Fischer & C. A. Meyer, Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint Pétersbourg ser. 2, 2: 199. 1844; *Arabidopsis parvula* (Schrenk) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 269. 1924; *Sisymbrium parvulum* (Schrenk) Lipsky, Trudy Imp. S.-Peterburgsk. Bot. Sada 23: 25. 1904; *Stenophragma parvulum* (Schrenk) B. Fedtschenko, Rastit. Turkest. 457. 1915; *Thellungiella parvula* (Schrenk) Al-Shehbaz & O’Kane, Novon 5: 309. 1995. TYPE: Kazakhstan, “In desertis salsuginosus ad Ters-Akkan,” A. Schrenk s.n. (holotype, LE!).

Herbs, annual, glabrous throughout. Stems erect, 3–15 cm, slender, strongly flexuous, simple or branched. Basal leaves fleshy, ovate to spatulate, entire; cauline leaves linear, subsessile, not auriculate at base, entire. Racemes 8–30-flowered, elongated considerably in fruit; rachis flexuous; fruiting pedicels erect to ascending, 3–6 mm. Sepals narrowly oblong, erect, ca. 2 mm; petals absent; stamens 6, filaments 1.8–2 mm; ovules 28–34 per ovary. Fruits erect to ascending, linear, $6-15 \times 1-1.5$ mm, latiseptate, torulose; valves with a slender midvein and narrower anastomosing lateral veins; septum complete, hyaline, not veined. Seeds subbiseriate, oblong-ellipsoid, brown, ca. 0.5×0.3 mm; cotyledons incumbent.

Flowering Apr–May.

Distribution: Azerbaijan, Kazakhstan, Russia, Turkey, Turkmenistan, Uzbekistan.

17. *Eutrema platypetalum* (Schrenk) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 134. 2005; *Taphrospermum platypetalum* Schrenk in Fischer & C. A. Meyer, Enum. Pl. Nov. 2: 60. 1842. TYPE: Kazakhstan, Dzungai Alatau, Mt. Dzhabayk, 23 Jul 1839, Schrenk s.n. (holotype, LE!; isotypes, K!, LE!).

Herbs, perennial, glabrous throughout. Stems prostrate to erect, 6–12 cm, 1 to several from base. Leaves not rosulate, somewhat fleshy, petiolate; petioles of basal and lowermost leaves 0.5–2 cm, gradually shorter upward; leaf blade suborbiculate to broadly ovate or oblong, $3-12 \times 2-8$ mm, gradually reduced in size upward, base obtuse to subcordate, margin entire, apex obtuse or rounded. Racemes basally bracteate, densely flowered, elongated considerably in fruit; fruiting

pedicels slender, straight, ascending to divaricate-ascending, 4–8 mm. Sepals oblong, 1.5–2.2 × 1–1.2 mm, persistent, membranous at margin; petals white, broadly obovate, 3.5–4.5 × 2–2.5 mm, cuneate to a clawlike base to 1 mm, apex rounded; filaments white, 1.1–1.4 mm, dilated and to 0.3 mm wide at base; anthers ovate-oblong, 0.3–0.4 mm; ovules 2–4 per locule. Fruit cylindric, strongly torulose, 6–11 mm, widest at middle, ca. 1 mm wide, base cuneate, apex acuminate; valves thin papery, glabrous, somewhat veined; base of replum slightly expanded; style slender, 0.2–0.4 mm. Seeds 2–4 per locule, reddish brown, oblong, plump, ca. 1.2 × 0.6 mm; cotyledons incumbent.

Distribution: Kazakhstan.

18. *Eutrema pseudocordifolium* Popov in Komarov, Fl. URSS 8: 634. 1939. TYPE:

Kazakhstan, Tian Shan, Alatau Transilienses, Talgar, 25 May 1936, *M. Popov s.n.* (holotype, LE).

Herbs, perennial; rhizomes robust, short, covered with fibrous remnants of old petioles. Stems 50–80 cm, branched above. Basal leaves with petioles longer than blade; blade deeply cordate, to 10 × 10 cm, obscurely crenate at margin; lower caulines leaves 1–3, resembling basal ones, cordate, with petioles shorter than blade, uppermost 1 or 2 leaves much smaller, ovate, cuneate and not auriculate at base. Raceme corymbose, much elongated in fruit; fruiting pedicels divaricate, to 2 cm. Sepals oblong, ca. 3 mm; petals white, obovate, ca. 6 mm; ovules to 4 per ovary. Fruits erect, fusiform, glabrous; style cylindrical; stigma entire.

Flowering: May.

Distribution: Kazakhstan.

19. *Eutrema salsugineum* (Pallas) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 134.

2005; *Sisymbrium salsugineum* Pallas, Reise Russ. Reich 2: 466. 1773; *Arabidopsis salsuginea* (Pallas) N. Busch, Fl. Siberia Orient. 1: 136. 1913; *Hesperis salsuginea* (Pallas) Kuntze, Revis. Gen. Pl. 2: 935. 1891; *Stenophragma salsugineum* (Pallas) Prantl in Engler & Prantl, Pflanzenfam. III(92): 192. 1890; *Thellungiella salsugineum* (Pallas) O. E. Schulz, in Engler, Pflanzenreich IV. 105 (Heft 86): 252. 1924; *Thelypodium salsugineum* (Pallas) B. L. Robinson in A. Gray & S. Watson, Syn. Fl. N. Amer. 1(1): 175. 1895. SYNTYPE (according to German, 2002): “in descetis salsas Bargusinensiz, Jul 1772 (Herb. Trin. No. 423) MW,” not seen).

Sisymbrium glaucum Nuttall in Torrey & A. Gray, Fl. N. Amer. 1: 93. 1938; *Hesperis glauca* (Nuttall) Kuntze, Revis. Gen. Pl. 2: 934. 1891; *Pilosella glauca* (Nuttall) Rydberg, Torrey 7: 171. 1907. TYPE: United States, “prairies of the Oregon, towards the Rocky Mountains,” *T. Nuttall s.n.* (holotype, BM).

Herbs, glabrous throughout, often glaucous. Stems (6–)10–30(–40) cm, erect or ascending, simple or several branched at base. Basal leaves rosulate or not; petiole 5–10 mm; leaf blade obovate, spatulate, or oblong, 0.5–1.5(–2.5) cm × 2–5 mm, margin entire or rarely dentate or pinnatifid, apex obtuse; middle cauline leaves cordate, ovate, or oblong, sessile, 0.4–1.7(–2.5) cm × 1–7(–10) mm, base deeply sagittate-amplexicaul, margin entire or repand, apex acute or obtuse. Raceme elongated in fruit; rachis straight; fruiting pedicels slender, divaricate to divaricate-ascending, 3–10 mm. Sepals oblong, 1–1.5 × 0.5–0.6 mm; petals white, obovate, 2–3 × 1–1.7 mm; filaments 1–1.5 mm; anthers oblong, 0.2–0.4 mm, apiculate; ovules 55–96 per ovary. Fruit 0.7–1.6(–2) cm × (0.7–)0.8–1 mm, distinctly torulose, sessile; valves obscurely veined; style 0.1–0.3 mm. Seeds brown, oblong, biseriate, 0.4–0.5 × 0.2–0.3 mm. 2n=14.

Flowering: May–Jun.

Habitat: sandy alkaline ground, saline flats and fields, alkaline sloughs, river banks, salt meadows and plains, steppes.

Elevation: 600–2500 m.

Distribution: Canada (British Columbia, Northwest Territories, Saskatchewan, Yukon), China (Hebei, Henan, Jiangsu, Jilin, Nei Mongol, Shandong, Xinjiang), Kazakhstan, Kyrgyzstan, Mongolia, Russia (European part, Siberia), Turkmenistan, United States (Colorado, Montana), Uzbekistan.

20. *Eutrema schulzii* Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 134. 2005;

Platycraspedum tibeticum O. E. Schulz, Repert. Sp. Nov. Regni Veg. Beih. 12: 386. 1922, non *Eutrema thibeticum* Franch., Nouv. Arch. Mus. Hist. Nat. Paris, ser. 2, 8: 201. 1885 (1886). TYPE: China, Sichuan (as Tibet), Tatsienlu, zwischen den Steinen de Mani auf der Passhöhe Gila, 4400 m, 4 Oct 1914, W. Limpricht 1838 (lectotype, designated by Al-Shehbaz et al. (2000), WRSL; isolectotype, WU!).

Herbs, perennial, glabrous or sparsely pubescent with trichomes to 0.8 mm, with fusiform roots to 5 mm in diam. Stem (6–)10–20(–60) cm tall, several branched from single short base. Cauline leaves petiolate, glabrous or pubescent; petiole (0.1–)0.5–2(–3) cm; leaf blade suborbicular to cordate or broadly ovate, (4–)7–15 × (1–)5–12(–15) mm, reduced in size in inflorescence, base cordate, margin repand-dentate to repand or palmately 5-lobed, the teeth or lobes not mucronate, apex obtuse. Raceme bracteate throughout, elongated in fruit; fruiting pedicel slender, ascending to divaricate, straight to recurved, (3–)5–12(–20) mm. Sepals 1.5–2 × 0.8–1.5 mm, glabrous, margin membranous and to 0.2 mm wide; outer pair oblong, narrower than inner, not saccate at base; inner pair broadly ovate, saccate at base; petals white, narrowly obovate to subelliptic, 4–6 × 2–3 mm, base cuneate, apex rounded; filaments white, 1.1–2 mm; outer pair slender; inner pair strongly flattened basally and 0.4–0.6 mm wide, with ovate to oblong lateral tooth 0.2–0.4 × 0.1–0.2 mm; anthers oblong, 0.4–0.6 mm, apex obtuse; ovules 6–9 per ovary. Fruit narrowly oblong, 4-angled and longitudinally 4-winged, curved, not torulose, (6–)8–15 × 2.5–3 mm, base cuneate; valves glabrous, with a well-developed, winged midvein with wing to 0.5 mm wide; gynophore to 0.5 mm; replum longitudinally winged with a wing to 0.5 mm; style thick, 0.5–1.5 mm. Seeds ovate to broadly oblong, flattened, (2.8–)3–3.5 × 1.5–2 mm.

Flowering: Jun–Aug.

Habitat: alpine areas.

Elevation: 4100–4800 m.

Distribution: China (Sichuan, Xizang).

Distribution: China (Sichuan, Xizang [Tibet]).

21. *Eutrema sherriffii* Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 133. 2005; *Dipoma tibeticum* O. E. Schulz, Repert. Sp. Nov. Regni Veg. 38: 32. 1935, non *E. thibeticum* Franch., Nouv. Arch. Mus. Paris, ser. 2, 8: 201. 1886; *Taphrospermum tibeticum* (O. E. Schulz) Al-Shehbaz, Harvard Pap. Bot. 5(1): 107. 2000. TYPE: China, Tibet, 20 mi E of Tsona, 16,500 ft, 20 Jul 1934, F. Ludlow & G. Sherriff 695 (holotype, B!; isotype, BM!).

Herbs, perennial, densely hirsute with simple trichomes 0.5–1 mm. Root conical, slightly fleshy, base with a whorl of oblong scalelike leaves to 5 × 2 mm. Stems 4–12 cm, erect, 1–3 from fleshy root, lowermost leafless part 1–9 cm, glabrous underground. Leaves densely hirsute on

both surfaces and petiole, not fleshy, lowermost cauline ones verticillate to alternate, others opposite or alternate; petioles 3–5 mm, gradually shorter upward, densely hirsute; leaf blade oblong to spatulate, 4–7 × 1–3 mm, gradually reduced in size upward, base attenuate, margin entire or 2-toothed, apex retuse. Racemes bracteate throughout, densely flowered, elongated slightly in fruit, bracts leafy, smaller than cauline leaves, hirsute; rachis retrorsely to spreading hirsute; fruiting pedicels hirsute, slender, straight, 3–6 mm. Sepals oblong, 1.7–2.5 × 1–1.5 mm, membranous at distal margin and apex, ciliolate with trichomes to 0.1 mm, densely hirsute outside with trichomes ca. 0.5 mm; petals white, broadly obovate, 4.5–5 × 2.5–3 mm, attenuate to clawlike base to 1.5 mm, apex emarginate; filaments white, 2–2.5 mm, slightly dilated at base; anthers broadly ovate, ca. 0.5 mm; ovules 4–6 per ovary. Immature fruit ovate, apparently latiseptate; valves membranous, densely puberulent; replum broadly and evenly expanded throughout; septum absent; style subconical, 1–1.5 mm. Immature seeds oblong, ca. 1 mm, foveolate.

Flowering: Jun–Jul.

Habitat: stony slopes, earth slides, turf, shale along streamsides.

Elevation: 4200–5000 m.

Distribution: China (Xizang [Tibet]).

22. *Eutrema tenue* (Miquel) Makino, Bot. Mag. (Tokyo) 26: 177. 1912. *Nasturtium tenue* Miquel, Ann. Mus. Bot. Lugduno-Batavi 2: 71. 1866; *E. wasabi* (Siebold) Maximowicz var. *tenuis* (Miquel) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 37. 1924. TYPE: Japan, *Siebold s.n.* (holotype, U).

Cardamine bracteata Moore, J. Bot. 16: 130. 1878; *Eutrema bracteata* (Moore) Koidzumi, Fl. Symb. Or. Asiat. 24. 1930. TYPE: xx.

Eutrema hederacifolium Franchet & Savatier, Enumer. Pl. Jap. 2: 283. 1879; *Wasabia hederacifolia* (Franchet & Savatier) Matsumura, Bot. Mag. (Tokyo) 12: 72. 1899. TYPE: xx.

Eutrema thibeticum Franchet, Nouv. Arch. Mus. Paris, ser. 2, 8: 201. 1886. TYPE: China. Tibet, Moupin, Fl. March & April 1869, *Abbe David s.n.* (holotype, P!).

Neomartinella guizhouensis S. Z. He & Y. C. Lan, Acta Phytotax. Sin. 35: 73. 1997. TYPE: China. Guizhou, Jinsha, Datian, under forests valley, 1100 m, 13 April 1994, S. Z. He 94013 (holotype, HGCM; isotype, NAS!).

Herbs, perennial, glabrous or retrorsely pilose on upper parts; rhizomes not fleshy. Stems 12–35(–55) cm tall, decumbent, simple, often a few from base. Basal leaves rosulate; petiole 3–8(–10) cm; leaf blade cordate to reniform, 1–3(–5) × 1–3(–6) cm, base cordate, margin dentate, repand, or subentire, with distinct apiculate callosities terminating ultimate veins, apex rounded to obtuse; middle cauline leaves with petioles 0.7–2.5 cm; leaf blade broadly ovate to ovate-cordate, 0.7–2(–3.5) × 0.8–2 cm, palmately veined, base and margins as basal leaves, apex acute. Raceme bracteate throughout, lax, elongated in fruit; fruiting pedicels reflexed or spreading, slender, (0.5–)1–2(–2.5) cm. Sepals ovate, 1.5–2 × 1–1.2 mm, deciduous; petals white, oblong-spatulate, 4–5 × 1–1.5 mm; filaments white, 1.5–2 mm; anthers ovate, 0.3–0.5 mm; ovules 6–10 per ovary. Fruit linear, (0.8–)1–2 cm × 1.5–2 mm, terete, torulose; valves with an obscure midvein; gynophore absent or obsolete; septum complete; style 0.5–2 mm. Seeds oblong, plump, 2–3 × 1–1.5 mm.

Flowering: Mar–May.

Elevation: 0–4000 m.

Distribution: China (Guizhou, Sichuan, Xizang [Tibet], Yunnan), Japan.

23. *Eutrema verticillatum* (Jeffrey & W. W. Smith) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 134. 2005; *Cardamine verticillata* Jeffrey & W. W. Smith, Notes Roy. Bot. Gard. Edinburgh 8: 120. 1913; *Braya verticillata* (Jeffrey & W. W. Smith) W. W. Smith, Notes Roy. Bot. Gard. Edinburgh 11: 202. 1920; *Staitoniella verticillata* (Jeffrey & W. W. Smith) H. Hara, J. Jap. Bot 49: 198. 1974; *Taphrospermum verticillatum* (Jeffrey & W. W. Smith) Al-Shehbaz, Harvard Pap. Bot. 5(1): 106. 2000. TYPE: China, Yunnan, near Atuntsi, 15,000 ft, Jul 1911, *F. Kingdon-Ward 17* (lectotype designated by Al-Shehbaz (2000a), E!).

Herbs, perennial, sparsely to moderately pubescent, rarely glabrous; root narrowly fusiform-linear, fleshy, base with oblong to ovate scalelike leaves $3-7 \times 1-2.5$ mm. Stems (4-)6-15(-23) cm, erect, often solitary from fleshy root, lowermost leafless part (0.5-)4-10(-15) cm. Leaves glabrous, lowermost cauline leaves verticillate, others opposite or alternate; petioles (0.4-)0.6-2 cm, gradually shorter upward; leaf blade oblong, rarely oblanceolate, $0.5-1.5(-2.5)$ cm $\times$ $2-7(-9)$ mm, gradually reduced in size upward, base obtuse to rarely attenuate, margin entire, apex rounded. Racemes densely flowered, elongated considerably in fruit, bracteate throughout; bracts leafy, smaller than cauline leaves; rachis sparsely pubescent with retrorse trichomes $0.4-0.6$ mm; fruiting pedicels glabrous, slender, straight or curved, (4-)6-12(-18) mm. Sepals oblong, $2.5-3.5(-4) \times 1.5-2$ mm, caducous, membranous at margin, sparsely ciliolate near apex with trichome $0.05-0.1$ mm, glabrous or sparsely hairy distally with trichomes to 0.5 mm; petals white or rarely lavender, broadly obovate, $(7-)8-9(-10) \times (3.5-)4.5-6$ mm, cuneate to clawlike base to 4 mm, apex emarginate; filaments white to lavender, $(3-)3.5-4.5$ mm, dilated at base; anthers ovate, $0.6-0.8$ mm; ovules 4-8 per ovary. Fruit ovate to oblong, strongly latiseptate, not torulose, $7-13 \times 4-7$ mm, obtuse to cuneate at base; valves membranous, glabrous, often distinctly veined, smooth; replum broadly and evenly expanded throughout; septum absent; style slender, $(1-)2-3$ mm. Seeds 3-8, brown, oblong, foveolate, compressed, $1.8-2.2 \times 1.2-1.4$ mm; cotyledons accumbent.

Flowering: Jun-Jul.

Habitat: screes and ledges of cliffs, glaciers, open stony moorland, siliceous scree slopes

Elevation: 3800-5200 m.

Distribution: China (Xizang [Tibet], Yunnan).

24. *Eutrema violifolium* (H. Léveillé) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 134. 2005; *Martinella violifolia* H. Léveillé, Bull. Soc. Bot. France 51: 290. 1904; *Neomartinella violifolia* (H. Léveillé) Pilger in Engler & Prantl, Nat. Pflanzenfam. Nachtr. 3: 134. 1906; *Esquirolia violifolia* (H. Léveillé) H. Léveillé, Mondes Plantes, ser. 2, 18: 31. 1916. TYPE: China, Guizhou (as Kouy-Tchéo), environs de Gan-pin, Parois du Ta-long, Tsin-gay, Mont Kao-tchay, 11 Feb & 8 Mar 1898, *Martin & Bodinier 2069* (holotype, E!; isotype, P!).

Herbs, annual, scapose, glabrous throughout. Stems (4-)7-17(-20) cm tall, erect, simple, leafless, few to several from base. Basal leaves rosulate; petiole $(1.5-)3-10(-14)$ cm; leaf blade cordate to reniform or suborbicular, $(0.8-)1.5-4(-5) \times (0.6-)1-3.5(-4)$ cm, base cordate, margin crenate-repand or rarely subentire, with apiculate callosities to 1 mm, apex rounded to obtuse; cauline leaves absent. Raceme ebracteate, elongated in fruit; fruiting pedicels suberect to spreading, filiform, $(1-)1.5-4(-7)$ cm, a few solitary and originate from center of rosette. Sepals ovate, $1.5-2 \times 1-1.2$ mm; petals white, obcordate, $4-5.5 \times 2-3$ mm; filaments white, $1.5-2$ mm;

anthers ovate, 0.4–0.5 mm; ovules 10–20 per ovary. Fruit oblong-linear to oblong, 5–12 × 1–1.5 mm, slightly compressed, subtorulose; valves with an obscure midvein; style absent or rarely to 0.2 mm. Seeds suborbicular, slightly flattened, 0.6–0.9 mm diam.

Flowering: Feb–Apr.

Habitat: rocky areas.

Elevation: 800–1600 m.

Distribution: China (Guizhou, Hubei, Hunan, Sichuan, Yunnan).

25. *Eutrema wuchengyii* (Al-Shehbaz, T. Y. Cheo, L. L. Lu & G. Yang) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 135. 2005; *Platycraspedum wuchengyii* Al-Shehbaz, T. Y. Cheo, L. L. Lu & G. Yang, Novon 10: 3. 2000. TYPE: China, Xizang, Mangkang Xian, wet grounds by river, 4000 m, 27 Jun 1976, *Qinghai-Xizang Expedition 12038* (holotype, KUN!; isotypes, KUN!, PE!).

Herbs, perennial, glabrous or sparsely pubescent with trichomes to 1 mm; roots fusiform, fleshy, to 2 mm in diam. Stem 5–25 cm tall, single from fleshy root then few to several branched, branches slender, ascending to decumbent; cauline leaves petiolate, glabrous or very sparsely pubescent; petiole 0.5–2.5(–4) cm; leaf blade suborbicular to cordate or subreniform, 4–12 × 5–15 mm, reduced in size in inflorescence, base cordate, margin repand to shallowly and obtusely palmately 5-lobed, the lobes not mucronate, apex obtuse. Raceme bracteate throughout, elongated in fruit; fruiting pedicel slender, ascending to divaricate, straight, 5–15 mm. Sepals 1–1.5 × 0.6–1 mm, glabrous, margin membranous and to 0.1 mm wide; petals white, narrowly subelliptic to narrowly oblong, 3–4 × 1–1.5 mm, base cuneate, apex rounded; filaments white, 1.1–1.5 mm; outer pair slender; inner pair strongly flattened basally and 0.3–0.5 mm wide, with ovate to oblong lateral tooth to 0.2 × 0.1 mm; anthers oblong, 0.3–0.4 mm, apex obtuse; ovules 3–6 per ovary. Fruit linear, terete, wingless, torulose, 6–15 × ca. 1.5 mm, base cuneate; valves sparsely and minutely puberulent, obscurely veined, wingless; replum wingless; style thick, 0.5–1.5 mm; gynophore to 1 mm. Seeds oblong, flattened, 2–2.5 × ca. 1.5 mm.

Flowering: Jun–Aug.

Habitat: wet grounds by rivers, slope of ravines in *Juniperus* forests, woods

Elevation: 4000–4500 m.

Distribution: China (Sichuan, Xizang).

26. *Eutrema yungshunensis* (W. T. Wang) Al-Shehbaz & S. I. Warwick, Harvard Pap. Bot. 10: 135. 2005; *Cardamine yungshunensis* W. T. Wang, Keys Vascular Pl. Wuling Mts. 578. 1995; *Neomartinella yungshunensis* (W. T. Wang) Al-Shehbaz, Novon 10: 338. 2000. TYPE: China, Hunan, Yungshun, Xiaoxi, 480–520 m, 27 May 1988, *Expedition Wulingshan 271* (holotype, PE!; isotype, KUN!).

Herbs, annual, glabrous throughout. Stems 20–41 cm tall, erect, simple, leafy, few to several from base. Basal leaves rosulate; petiole 3–11 cm; leaf blade ovate or broadly so, 2–6 × 1–5 cm, base subcordate to truncate, margin repand, with apiculate callosities to 0.5 mm, apex rounded to obtuse; middle cauline leaves similar to basal but smaller, often subentire. Raceme ebracteate, lax, elongated in fruit; fruiting pedicels ascending, filiform, 1–2 cm. Sepals ovate, 1.5–2 × 1–1.2 mm; petals white, obcordate, 4–5 × 2–2.5 mm; filaments white, 1.5–2 mm; anthers ovate, 0.6–0.8 mm; ovules (20–)30–40 per ovary. Fruit linear, (0.8–)1.5–3.5 × 1–1.5 mm, terete,

torulose; valves with an obscure midvein; style 0.6–1 mm. Seeds oblong, slightly flattened, 0.8–1.1 × 0.6–0.7 mm.

Flowering: Apr.

Elevation: 500–600 m.

Distribution: China (Hunan).

27. *Eutrema yunnanense* Franchet, Pl. Delavay.: 61. 1889. TYPE: China, Yunnan, Yen-tze-hay (Lankong), 3,000 m, 9 May 1887, *J. M. Delavay s.n.* (holotype, P!); *Wasabia yunnanensis* (Franchet) Nakai, J. Jap. Bot. 11: 151. 1935. TYPE : China, Yunnan, San-tcha-ho, above Mo-so-yn, 3000 m, 17 Jun 1887, *Delavay s.n.* (lectotype, P!; isoelectotype, P!).

Eutrema potaninii Komarov, Repert. Sp. Nov. Regni Veg. 9: 393. 1911. LECTOTYPE (here designated): China, Sichuan, Omei Shan, 1 April 1893, *G. N. Potanin s.n.* (holoelectotype, LE!; isoelectotype, MO!).

Eutrema reflexa T. Y. Cheo, Bot. Bull. Acad. Sin. 2: 23. 1948. TYPE: China. Zhejiang, His-tien-mu Shan, 23 April 1936, H. Migo s.n. (holotype, NAS!).

Eutrema yunnanense var. *tenerum* O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 38. 1924. LECTOTYPE (here designated): China, [Hubei,] Changyang, E. H. Wilson 157 (holoelectotype, B!; isoelectotypes, E!, GH!, NY!, P!, W!).

Eutrema yunnanense var. *yexinicum* Z. X. An, Bull. Bot. Res., Harbin 1(1–2): 99. 1981. TYPE: China. Anhui, Yuexi Cian, ... (holotype, NAS).

Herbs, perennial, glabrous or retrorsely pilose on upper parts; rhizomes not fleshy. Stems (12–)20–60(–110) cm tall, erect, simple, often a few from base, rarely branched upward. Basal leaves rosulate; petiole 2–25(–35) cm, dilated at base; leaf blade cordate to reniform, (1–)3–10(–20) × (1.5–)3–10(–20) cm, base cordate, margin dentate, denticulate, repand, or subentire, with distinct apiculate callosities terminating ultimate veins, apex rounded to obtuse; middle cauline leaves with petioles (0.5–)1–3(–5) cm; leaf blade broadly ovate to ovate-cordate, (1–)2–5(–7) × (0.6–)1–4(–5) cm, palmately veined, base and margins as basal leaves, apex acute. Raceme ebracteate or rarely lowermost 1–3 flowers bracteate, lax, elongated in fruit; fruiting pedicels reflexed or spreading, slender, 0.6–1.5(–2.5) cm. Sepals ovate, 1.5–2 × 1–1.2 mm, deciduous; petals white, oblong-spatulate, 3.5–5(–6) × 1.5–2.5 mm; filaments white, 1.5–2 mm; anthers ovate, 0.4–0.5 mm; ovules 6–10 per ovary. Fruit linear or rarely oblong, (0.5–)0.8–1.5(–2.5) cm × 1.5–2 mm, terete, torulose; valves with an obscure midvein; gynophore absent or obsolete; septum usually complete; style 1–2 mm. Seeds oblong, plump, 2–3 × 1–1.5 mm.

Flowering: Mar–May.

Habitat: hillsides, forest undergrowth, shaded moist pasture, roadside, among *Rhododendron*.

Elevation: 400–3500 m.

Distribution: China (Anhui, Gansu, Hebei, Hubei, Hunan, Jiangsu, Jiangxi, Ningxia, Shaanxi, Sichuan, Xizang [Tibet], Yunnan, Zhejiaog).