

A SYNOPSIS OF *SMELOWSKIA* (BRASSICACEAE)

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Abstract. On the basis of extensive molecular data and comparative morphological studies, the genera *Ermania*, *Gorodkovia*, *Hedinia*, *Hediniopsis*, *Redowskia*, *Sinosophiopsis*, and *Sophiopsis*, which form a monophyletic group with *Smelowskia*, are herein united with *Smelowskia*, a recently conserved generic name. Seven new combinations are proposed in *Smelowskia*: *S. bartholomewii*, *S. czukotica*, *S. furcata*, *S. heishuiensis*, *S. jacutica*, *S. micrantha*, and *S. sopherifolia*. A key to the 25 species of *Smelowskia*, as well as a detailed description of the expanded genus, major synonymies, and distributions are given.

Keywords: Brassicaceae, *Ermania*, *Gorodkovia*, *Hedinia*, *Hediniopsis*, *Redowskia*, *Sinosophiopsis*, *Smelowskia*, *Sophiopsis*.

Generic delimitation is one of the most frequently encountered problems in the systematics of the Brassicaceae (Al-Shehbaz, 1984; Appel and Al-Shehbaz, 2003), and *Smelowskia* C. A. Mey. is no exception. The genus is distributed in central and northeastern Asia, western Canada, and neighboring United States, and the number of species assigned to it has ranged from 5 to 14 (Schulz, 1924, 1936; Drury and Rollins, 1952; Botschantzev, 1968; Velichkin, 1974, 1979; Rollins, 1993; Mulligan, 2001; Zhou et al., 2001).

Schulz (1936) and Appel and Al-Shehbaz (2003) considered *Smelowskia* to be closely related to the Asian genera *Ermania* Cham. ex Botsch. (1 sp.), *Gorodkovia* Botsch. & Karav. (1 sp.), *Hedinia* Ostenf. (3 spp.), *Hediniopsis* Botsch. & V. V. Petrovsky (1 sp.), *Redowskia* Cham. & Schldl. (1 sp.), *Sinosophiopsis* Al-Shehbaz (3 spp.), and *Sophiopsis* O. E. Schulz (4 spp.). Except for *Hediniopsis*, these genera were subjected to extensive molecular phylogenetic and morphological studies by Warwick et al. (2004).

Warwick et al. (2004) compared sequence data from the nuclear internal transcribed ribosomal DNA (ITS) and the chloroplast *trnL* intron to study the phylogeny of *Smelowskia* and the above genera. Data of both markers clearly show that *Smelowskia* is polyphyletic.

The ITS data indicate that *Smelowskia*, *Ermania*, *Gorodkovia*, *Hedinia*, *Redowskia*, *Sinosophiopsis*, and *Sophiopsis* form a polytomy supported by 90% bootstrap values. By contrast, the *trnL* sequence data place *Smelowskia*, *Ermania*, *Gorodkovia*, and *Redowskia* in a polytomous clade supported by 75% bootstrap values, whereas the genera *Hedinia*, *Sinosophiopsis*, and *Sophiopsis* were rather weakly separated (54% bootstrap) from that polytomy. All seven genera are weakly distinguished by character combinations, and the interested reader should consult Warwick et al. (2004) for details on comparative morphology and critical evaluation of individual genera. On the basis of morphological, molecular, and cytological data and because of the lack of adequate morphological grounds to separate genera in this complex, Warwick et al. (2004) concluded that the most practical taxonomic account is to reduce the seven genera to one.

Redowskia, the earliest published generic name in the complex (see below), is a poorly known genus, whereas *Smelowskia*, the second oldest, is well known to most Asian and North American botanists. In order to unite all seven genera of the complex, one was faced with either recognizing *Redowskia* or conserving *Smelowskia*. The latter course of action was taken in a proposal by Al-Shehbaz (2003), and

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the proposal was approved by the general committee during the nomenclatural sessions of the Vienna Botanical Congress, on the basis of the recommendation by the Committee for Spermatophyta (Brummitt, 2005).

As delimited by Drury and Rollins (1952), Botschantzev (1968), Velichkin (1974, 1979), Rollins (1993), and Mulligan (2001), the generic boundaries of *Smelowskia* can easily accommodate *Redowskia*. The only differences between the two are the presence in *Smelowskia* of entire stigmas and uniseriate seeds and in *Redowskia* of slightly lobed stigmas and biseriate seeds (see Warwick et al., 2004). These features are insufficient for the recognition of the two genera as distinct, and there are many other genera of Brassicaceae (e.g., *Draba* L., *Rorippa* Scop., *Tropidocarpum* Hook., *Vella* L.) that exhibit similar or even greater fruit diversity (Appel and Al-Shehbaz, 2003).

Warwick et al. (2004) recognized 12 species in *Smelowskia*, 6 of which (*S. americana*, *S. borealis*, *S. johnsonii*, *S. media*, *S. ovalis*, *S. pyriformis*) are North American, 5 (*S. alba*,

S. bifurcata, *S. calycina*, *S. inopinata*, *S. parryoides*) are central and eastern Asian, and 1 (*S. porsildii*) grows in both continents. Their data also showed that the North American varieties of *S. calycina* sensu Drury and Rollins (1952) and Rollins (1993) represent distinct species. The generic names *Acroschizocarpus* Gombócz, *Chrysanthemopsis* Rech. f., and *Melanidion* Greene are kept as synonyms of *Smelowskia*, following Drury and Rollins (1952) and Hedge (1968). In Warwick et al. (2004), *S. holmgrenii* Rollins fell with *Polyctenium* Greene in a well-supported clade separate from *Smelowskia*, and the authors concur with its recent transfer to a new genus *Nevada* N. H. Holmgren (Holmgren, 2004).

The present paper deals with nomenclatural adjustments based on the conclusions above, and it provides an enumeration of all species, main homotypic synonymies, distributions, a key to species, and a description of the expanded *Smelowskia*. For additional synonymies, the reader should consult Botschantzev (1968), Velichkin (1974, 1979), Rollins (1993), and Mulligan (2001).

TAXONOMY

Smelowskia C. A. Mey. in Ledeb., Icon. Pl. 2: 17. 1830, nom. cons. TYPE: *S. cinerea* C. A. Mey., nom. illeg. (= *S. alba* (Pall.) Regel; based on *Sisymbrium album* Pall.).

Synonyms: *Acroschizocarpus* Gombócz, Bot. Közlem. 37: 1. 1940. TYPE: *A. kolianus* Gombócz.

Chrysanthemopsis Rech. f., Phytion (Horn) 3: 51. 1951. TYPE: *C. koelzii* Rech. f.

Ermania Cham. ex Botsch., Bot. Zhurn. (Moscow & Leningrad) 41: 730. 1956. TYPE: *E. parryoides* (Cham.) Botsch. (based on *Draba parryoides* Cham.). For a discussion on the validation of *Ermania* by Botschantzev (1956), see Al-Shehbaz (2001).

Gorodkovia Botsch. & Karav., Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 19: 109. 1959. TYPE: *G. jacutica* Botsch. & Karav.

Hedinia Ostenf. in Hedin, S. Tibet 6(3), Bot.: 76. 1922. TYPE: *H. tibetica* (Thomson) Ostenf. (based on *Hutchinsia tibetica* Thomson).

Hediniopsis Botsch. & V. V. Petrovsky, Bot. Zhurn. (Moscow & Leningrad) 71: 1548. 1986. TYPE: *H. czukotica* Botsch. & V. V. Petrovsky.

Melanidion Greene, Ottawa Naturalist 25: 146. 1912. TYPE: *M. boreale* Greene.

Redowskia Cham. & Schltldl., Linnaea 1: 32. 1826. TYPE: *R. sophiifolia* Cham. & Schltldl.

Sinosophiopsis Al-Shehbaz, Novon 10: 340. 2000. TYPE: *S. bartholomewii* Al-Shehbaz.

Sophiopsis O. E. Schulz in A. Engler, Pflanzenreich IV. 105(Heft 86): 346. 1924. LECTOTYPE (here designated): *S. sisymbrioides* (Regel & Herder) O. E. Schulz.

Annual or perennial herbs, sometimes pulvinate and with well-developed, often branched caudex covered with persistent petioles of previous years. Trichomes dendritic, sometimes mixed with fine, long, simple and forked stalked ones. Stems erect, ascending, or decumbent, single to many from caudex, simple or branched apically. Basal leaves herbaceous, petiolate,

rosulate, 1- or 2-pinnatisect, sometimes flabellate, rarely entire, often densely pubescent. Cauline leaves short petiolate or sessile, not auriculate, entire to pinnatisect, rarely absent. Racemes many flowered, dense or lax, ebracteate or bracteate, often elongated considerably in fruit; rachis straight; fruiting pedicels slender, suberect, ascending, divaricate, to recurved. Sepals ovate to oblong, free, deciduous or persistent, ascending to spreading, equal, base of inner pair not saccate, margin membranous. Petals white, creamy white, pink, purple, or rarely yellow, erect at base with flaring blade, longer than sepals; blade suborbicular, obovate, to spatulate, apex rounded; claw distinct, subequaling or longer than sepals, glabrous. Stamens 6, exerted, erect, tetradynamous; filaments wingless, unappendaged, glabrous, free, dilated at base; anthers ovate to oblong, not apiculate at

apex. Nectar glands confluent and subtending bases of all stamens; median nectaries present or rarely absent. Ovules 4–30 per ovary. Fruit dehiscent silique or silicle, linear, lanceolate, oblong, ovoid, obovoid, ellipsoid, fusiform, or suborbicular, terete, slightly 4-angled, or strongly flattened and latiseptate (flattened parallel to the septum) or angustiseptate (flattened at a right angle to the septum), not inflated, sessile or rarely short stipitate; valves papery, with an obscure or prominent midvein, often glabrous, keeled or not, smooth, wingless, unappendaged; replum rounded; septum complete or perforated, membranous; style obsolete or distinct; stigma capitate, entire or rarely slightly 2-lobed. Seeds uniseriate or rarely biseriata, wingless, oblong, plump; seed coat minutely reticulate, not mucilaginous when wetted; cotyledons incumbent or rarely incumbent.

KEY TO THE SPECIES OF *SMELOWSKIA*

- 1a. Basal and often cauline leaves simple, subapically 3-toothed, or palmately 3- or 5-lobed 2
 1b. Basal and at least some cauline leaves 1- or 2-pinnatisect or pinnatifid 5
 2a. Fruits 4-angled to terete, fusiform to linear-fusiform, less than 2 mm wide; leaves pinnately veined, entire or subapically 3-toothed 21. *S. porsildii*
 2b. Fruits strongly latiseptate or angustiseptate, oblong, elliptic, linear or linear lanceolate, more than 2 mm wide; leaves palmately veined, at least some 3- or 5-lobed 3
 3a. Fruits latiseptate; cotyledons accumbent; petals white; caudex often with many slender branches; plants of the Russian Far East 20. *S. parryoides*
 3b. Fruits angustiseptate; cotyledons incumbent; petals lavender to purple; caudex mostly simple, stout; Northwest Territories, Yukon, Alaska 4
 4a. Cauline leaves entire or shallowly toothed; calyx caducous; style obsolete or to 0.4 mm long; fruits 2–3 times longer than broad. 15. *S. johnsonii*
 4b. Cauline leaves 3- to 5-lobed; calyx often persistent until fruit maturity; style (0.2–)0.5–1.2 mm long; fruit often more than 3 times longer than broad. 7. *S. borealis*
 5a. Racemes bracteate throughout or at least along proximal third. 6
 5b. Raceme ebracteate, rarely lowermost few flowers bracteate. 8
 6a. Fruits strongly angustiseptate, 3–5 mm wide 25. *S. tibetica*
 6b. Fruits terete, 0.8–1.8 mm wide. 7
 7a. Fruits linear, 15–25 mm long, (20–)26- to 36-seeded; petals white; stems single. 5. *S. bartholomewii*
 7b. Fruits ellipsoid to linear-ellipsoid, 5–10 mm long; 10- to 16-seeded; petals yellow; stems few to many from base. 4. *S. annua*
 8a. Fruits strongly latiseptate; seeds biseriata; cotyledons accumbent; trichomes a mixture of simple and fewer forked ones 14. *S. jacutica*
 8b. Fruits angustiseptate, terete, or 4-angled; seeds uniseriate (biseriata in *S. sophiifolia* and *S. micrantha*); cotyledons incumbent; at least some trichomes dendritic (malpighiaceus or forked in *S. furcata*) 9
 9a. Fruits angustiseptate. 10
 9b. Fruits terete or 4-angled 13
 10a. Fruits 6- to 9-seeded, broadly fusiform; seeds biseriata; stigma slightly 2-lobed; style distinct. 24. *S. sophiifolia*
 10b. Fruits 18- to 46-seeded, oblong, elliptic, or obovate; seeds uniseriate; stigma entire; style obsolete 11
 11a. Annuals; stems solitary from base; Russian Far East 9. *S. czukotica*
 11b. Perennials; stems several to many from base; Russian Altai and neighboring Mongolia 12
 12a. Leaves 1-pinnatisect; style obsolete; petals 2.0–2.5 mm long; Russian Altai 2. *S. altaica*
 12b. Leaves 2-pinnatisect; style 0.7–1.0 mm; petals 3.5–4.0 mm long; Mongolia 18. *S. mongolica*
 13a. Annuals or biennials, with slender roots; basal rosettes often withered by anthesis. 14
 13b. Perennials, with well-developed caudex covered with leaf remains of previous years; basal leaves persistent through fruiting 18

KEY TO THE SPECIES OF *SMELOWSKIA* CONT.

- 14a. Flowers white; fruits siliques, linear, 20- to 40-seeded 15
 14b. Flowers yellow or pale yellow; fruits silicles, oblong, obovoid, ellipsoid, or rarely linear,
 4- to 12-seeded 16
 15a. Trichomes sessile; cauline leaves with 5-7 lateral lobes on each side; sepals 3-4 mm long; anthers oblong,
 ca. 1.5 mm long 11. *S. furcata*
 15b. At least some trichomes stalked; cauline leaves with 2-4 lateral lobes on each side; sepals 1.5-2.5 mm long;
 anthers ovate, 0.4-0.5 mm long 12. *S. heishuiensis*
 16a. Seeds biseriate, ca. 0.5 mm long; petals 1.0-1.5 mm long 17. *S. micrantha*
 16b. Seeds uniseriate, 1.0-1.5 mm long; petals 2-4 mm long 17
 17a. Fruits linear; petals bright yellow, abruptly narrowed to claw; cauline leaves 1-pinnatisect 10. *S. flavissima*
 17b. Fruits ellipsoid or obovoid; pale yellow, gradually narrowed to a claw-like base; cauline leaves
 2-pinnatisect 23. *S. sisymbrioides*
 18a. Sepals persistent well after anthesis or fruit maturity 19
 18b. Sepals caducous 20
 19a. Fruit ovoid, base truncate or rounded; British Columbia, Washington, Oregon, California 19. *S. ovalis*
 19b. Fruits ellipsoid to linear-ellipsoid, base cuneate; Siberia, W China, central Asia 8. *S. calycina*
 20a. Fruits pyriform; caudex often simple; central Alaska 22. *S. pyriformis*
 20b. Fruits ellipsoid, fusiform, or linear; caudex often branched; elsewhere 21
 21a. Fruits appressed or subappressed to rachis; fruiting pedicels erect or ascending, usually forming less than 40°
 angle with rachis; continental United States and adjacent Canada 3. *S. americana*
 21b. Fruits not appressed to rachis; fruiting pedicels divaricate-ascending to horizontal, forming more than 45°
 angle with rachis; Alaska, Russia, China, Mongolia, Central Asia 22
 22a. Fruits linear, 8-18 mm long; fruiting pedicels horizontal to divaricate 23
 22b. Fruits ellipsoid or fusiform; fruiting pedicels ascending to divaricate-ascending 24
 23a. Fruits 12- to 24-seeded; seeds 1.0-1.5 mm long; stems with several leaves 1. *S. alba*
 23b. Fruits 6- to 10-seeded; seeds 2-3 mm long; stems leafless or to 2-leaved 13. *S. inopinata*
 24a. Stems leafless or 1(-3)-leaved; plants tomentose; Alaska 16. *S. media*
 24b. Stems several leaved; plants woolly; Kazakhstan and Siberia 6. *S. bifurcata*

1. *Smelowskia alba* (Pall.) Regel, Bull. Soc. Imp. Naturalistes Moscou 34: 208. 1861.

Basionym: *Sisymbrium album* Pall., Reise Russ. Reich. 3: 739. 1776. TYPE: RUSSIA. Baykal, *P. Pallas s.n.* (Holotype: LE).

Distribution: China (Heilongjiang), Mongolia, Russia (Far East, Siberia).

2. *Smelowskia altaica* (Pobed.) Botsch., Novosti Sist. Vyssh. Rast. 5: 142. 1968.

Basionym: *Hedinia altaica* Pobed., Novosti Sist. Vyssh. Rast. 1966: 117. 1966. TYPE: RUSSIA. Altai: Oirotia, above Akkol, 5 August 1931, *B. Schischkin, L. Szilikina & G. Sumnevics s.n.* (Holotype: LE).

Distribution: Russia (Altai).

A close relative of *Smelowskia tibetica*, from which it is readily distinguished by the perennial habit and ebracteate racemes (Pobedimova, 1966).

3. *Smelowskia americana* (Regel & Herder) Rydb., Bull. Torrey Bot. Club 29: 239. 1902.

Basionym: *Hutchinsia calycina* (Stephan) Desv. var. *americana* Regel & Herder, Bull. Soc. Imp. Naturlistes Moscou 39(2): 101. 1866. SYNTYPES: Rocky

Mts., 1858, Bourgeau s.n. (GH, LE, NY), Hooker s.n. (K, LE); Oregon, 1861, Lyall s.n. (LE). (Lectotype, here designated and agreeing with an annotation by V. Botschantzev, Palliser's Brit. N. Am. Expl. Expedition. Rocky mountains, 1858, *E. Bourgeau s.n.*: LE; isolectotypes, GH, NY).

Synonym: *S. calycina* (Stephan) C. A. Mey. var. *americana* (Regel & Herder) W. H. Drury & Rollins, Rhodora 54: 99. 1952.

Distribution: Canada (Alberta, British Columbia), U.S.A. (Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming).

Of the three sheets of this species at LE (*Bourgeau s.n.*, *Lyall s.n.*, *Hooker s.n.*) that were cited by Regel and Herder (1866), only Bourgeau's was annotated by Regel as "*Hutchinsia calycina* β *Americana*." This sheet was also annotated by V. Botschantzev as the lectotype, but no such lectotypification was previously published. Rydberg (1902) cited only Hooker's collection, but in our opinion this does not constitute the correct lectotypification of the taxon, because Hooker's sheet at LE was not annotated by Regel.

Drury and Rollins (1952) and Rollins (1993) treated *Smelowskia americana* ($2n = 22$) as a variety of *S. calycina* ($2n = 12$). However, these taxa are quite different morphologically and disjunct geographically. *Smelowskia americana* also differs by having caducous (vs. persistent) sepals, linear to linear-fusiform (vs. ellipsoid) fruits, and erect to ascending (vs. divaricate) fruiting pedicels and/or fruits appressed to rachis.

4. *Smelowskia annua* Rupr., Mém. Acad. Imp. Sci. Saint Pétersbourg, Sér. 7, 14: 39. 1869. TYPE: KAZAKHSTAN. Tian Shan, Tschatyr-kul, 26 July 1867, *F. Osten-Sacken s.n.* (Holotype: LE). Basionym: *Sophiopsis annua* (Rupr.) O.E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 347. 1924.

Distribution: China (Xinjiang, Xizang), Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan.

5. *Smelowskia bartholomewii* (Al-Shehbaz) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Sinosophiopsis bartholomewii* Al-Shehbaz, Novon 10: 341. 2000. TYPE: CHINA. Qinghai: Nangqên Xian, Larong Gou on E side of the Zi Qu, N of Jiangxi Forest Station and SE of Mozhong, 3450 m, 32°9' N, 97°3' E, 29 August 1996, *T. N. Ho, B. Bartholomew, M. Watson & M. G. Gilbert 2621* (Holotype: MO; Isotypes: BM, CAS, E, GH, HNWP [not seen]).

Distribution: China (Qinghai, Xizang).

6. *Smelowskia bifurcata* (Ledeb.) Botsch., Novosti Sist. Vyssh. Rast. 5: 140. 1968.

Basionym: *Hutchinsia bifurcata* Ledeb., Fl. Ross. 1(1): 201. 1841. TYPE: RUSSIA. Baikal: Nuchu-Daban, *N. S. Turczaninow 174* (Holotype: LE).

Distribution: Kazakhstan, Russia (Siberia).

7. *Smelowskia borealis* (Greene) W. H. Drury & Rollins, Rhodora 54: 111. 1952.

Basionym: *Melanidion boreale* Greene, Ottawa Naturalist 25: 146. 1912. TYPE: CANADA. Yukon: Runt Creek, 66°18' N, 141° W, 2300 ft [ca. 700 m], 7 July 1911, *D. D. Cairnes 81249* (Holotype: CAN).

Distribution: Canada (Northwest Territories, Yukon), U.S.A. (Alaska).

Smelowskia borealis is a highly variable species divided by Drury and Rollins (1952) and Rollins (1993) into four varieties, some of

which (e.g., var. *villosa* W. H. Drury & Rollins) probably deserve to be recognized, but in the absence of a detailed study of the species, we refrain from dividing it at this stage. It is unclear why Velichkin (1979) failed to recognize *Smelowskia borealis* or *S. pyriformis* as good members of the genus.

8. *Smelowskia calycina* (Stephan) C. A. Mey. in Ledeb., Fl. Altaica 3: 170. 1831.

Basionym: *Lepidium calycinum* Stephan in Willd., Sp. Pl. 3(1): 433. 1800. TYPE: RUSSIA. Altai Mts., *C. F. Stephan s.n.* (Holotype: LE; Isotypes: B-W [not seen], LE).

Distribution: Afghanistan, China (Xinjiang), India, Kashmir, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Russia (Far East, Siberia), Tajikistan.

9. *Smelowskia czukotica* (Botsch. & V. V. Petrovsky) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Hediniopsis czukotica* Botsch. & V. V. Petrovsky, Bot. Zhurn. (Moscow & Leningrad) 71: 1549. 1986. TYPE: RUSSIA. Western Czukotka: "planities elata Anjuj, in fluxu superiore fl. Pogyniden, in rupibus remanentibus prope ostium rivi Loznikovy, 16 July 1985, *V. V. Petrovsky & T. V. Plieva 85-77* (Holotype: LE; Isotypes: LE [2 specimens]).

Synonym: *Hedinia czukotica* (Botsch. & V. V. Petrovsky) Jurtsev, Korobkov & Balandin, Bot. Zhurn. (Moscow & Leningrad) 72: 1035. 1987.

Distribution: Russia (Far East).

The species was described originally in the monotypic *Hediniopsis* (Botschantzev and Petrovsky, 1986), a genus said to differ from *Hedinia* by having single (vs. several) main stems, acute (vs. rounded) fruit apex, and broader septum (as replum). Yurtsev et al. (1987) clearly pointed out the artificiality of such differences and transferred the species to *Hedinia*. However, when the latter genus is critically compared with *Smelowskia*, none of its distinguishing characters holds (Warwick et al., 2004).

10. *Smelowskia flavissima* (Kar. & Kir.) Kar. & Kir., Bull. Soc. Imp. Naturalistes Moscou 15: 156. 1842.

Basionym: *Sisymbrium flavissimum* Kar. & Kir., Bull. Soc. Imp. Naturalistes Moscou 14:

382. 1841. TYPE: KAZAKHSTAN. Tarbagatay, banks of Dschanybeck and Terekty, May 1840, *G. Karelin & J. Kirilov* 95 (Lectotype, here designated: LE).

Synonym: *Sophiopsis flavissima* (Kar. & Kir.) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 348. 1924.

Distribution: Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan.

All seven sheets of the type collection at LE have the exact locality information above and carry the collection number 95 instead of 91, the number cited in the protologue, which must have been an error in print. The complete sheet annotated "Relig Ledebour" is designated herein as the type.

11. *Smelowskia furcata* (Al-Shehbaz) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Sinosophiopsis furcata* Al-Shehbaz, Novon 12: 313. 2002. TYPE: CHINA. Sichuan: Kanding Xian, Sha De Qu Ma Ti, sunny dry areas near stream, 2700 m, 29 May 1961, *Jian Shu 5031* (Holotype: KUN).

Distribution: China (Sichuan).

12. *Smelowskia heishuiensis* (W. T. Wang) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Cardamine heishuiensis* W. T. Wang, Acta Bot. Yunnan. 9: 15. 1987. TYPE: CHINA. Sichuan: Heishui, Luhwa, 2400 m, 16 July 1957, *Li Xin 73629* (Holotype: PE; Isotype: IBSC).

Synonym: *Sinosophiopsis heishuiensis* (W. T. Wang) Al-Shehbaz, Novon 10: 341. 2000.

Distribution: China (Sichuan).

13. *Smelowskia inopinata* (Kom.) Kom. in Komarov & Klobukova-Alissova, Key Pl. Far East. Reg. USSR 1: 589. 1931.

Basionym: *Hutchinsia inopinata* Kom., Bot. Mater. Gerb. Glavn. Bot. Sada SSR 6: 8. 1926. TYPE: RUSSIA. Khabarovsk, Mt. Sikhote-Alin, valley of Botscha, upper timberline, 1800 m, 18 August 1924, *I. K. Schisckin 579* (Holotype: LE; Isotype: LE).

Distribution: Russia (Far East).

Of the two sheets at LE carrying the exact type data, the one annotated by Komarov as "*Hutchinsia inopinata* sp. nov." should be considered as the holotype.

14. *Smelowskia jacutica* (Botsch. & Karav.) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Gorodkovia jacutica* Botsch. & Karav., Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 19: 109. 1959. TYPE: RUSSIA. "Jacutia, fl. Lena pars inferior, dist. Bulunskij, montes Charaulach, planites elata calcarea ad fonts fluminis Chotogu-Uchta in tundra schistose-lichenosa," 21 August 1938, *M. Karavaev s.n.* (Holotype: LE).

Distribution: Russia (Siberia, Far East).

It is interesting to note that the holotype of *Smelowskia jacutica* was initially annotated by Karavaev, its collector and one of its authors, as *Smelowskia gorodkovii*, a name that was never published. The resemblance of this species in almost every morphological aspect (except trichomes) to what has been called *Ermania parryoides* (see Botschantzev and Karavaev, 1959) are remarkable and clearly provide further support to the placement of these two species in one genus. Yurtsev and Zhukova (1972) also emphasized their close relationship and indicated that both species are diploids with $2n = 12$ (*E. parryoides* is also tetraploid). For a cytological summary of *Smelowskia*, see Warwick et al. (2004).

15. *Smelowskia johnsonii* G. A. Mulligan, Canad. Field-Naturalist 115: 341. 2001. TYPE: U.S.A. Alaska: hills adjacent to Kukpuk River, 68°17'N, 165°32'W, 300–1400 ft [ca. 91–427 m], steep slopes and ridges of Flint Mountain and surrounding hills, talus slopes, 15–16 August 1959, *A. W. Johnson, L. Viereck & H. Melchior 688* (Holotype: DAO; Isotype: ALA). Synonym: *Smelowskia borealis* (Greene) W. H.

Drury & Rollins var. *jordalii* W. H. Drury & Rollins, Rhodora 54: 116. 1952. *Syn. nov.* TYPE: U.S.A. Alaska: Richardson Mountains, Lake Peters, Romanzoff Mountains, sunny mountain shale slope, west-facing, 69°20'N, 145°00'W, 4500 ft [ca. 1372 m], 11 July 1948, *L. A. Spetzman 597* (Holotype: MIN; Isotype: S).

Distribution: U.S.A. (Alaska).

Although Mulligan (2001) did not suggest any possible relationship of *Smelowskia johnsonii* to its nearest relatives, an examination of the type material of this species clearly indicates that it is the same as *S. borealis* var. *jordalii*.

16. *Smelowskia media* (W. H. Drury & Rollins) Velichkin, Bot. Zhurn. (Moscow & Leningrad) 64: 167. 1979.

Basionym: *Smelowskia calycina* (Stephan) C. A. Mey. var. *media* W. H. Drury & Rollins, Rhodora 54: 100. 1952. TYPE: U.S.A. Alaska: Arctic north slope, Lake Schrader, sunny sandstone slope, 69°25'N, 145°00'W, 4000 ft [ca. 1219 m], 10 July 1948, L. A. Spetzman 653 (Holotype: MIN [not seen]; Isotype: S).

Distribution: Canada (Northwest Territories, Yukon), U.S.A. (Alaska).

This taxon was first recognized at the specific rank by Velichkin (1979), and therefore Mulligan's (2001) same "new" combination is illegitimate.

17. *Smelowskia micrantha* (Botsch. & Vved.) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Sophiopsis micrantha* Botsch. & Vved., Not. Syst. Herb. Inst. Bot. Acad. Sci. Uzbekistan 13: 9. 1952. TYPE: UZBEKISTAN. Fergania: Kara-Tepe, Solonjak, 18 April 1948, Schafeev s.n. (Holotype: "Herb. Univ. As. Med.," not seen). The holotype was not examined, but a paratype at LE was seen.

Distribution: Tajikistan, Uzbekistan.

18. *Smelowskia mongolica* Kom., Repert. Sp. Nov. Regni Veg. 9: 393. 1911. TYPE: MONGOLIA. Sagiastai, 26 July 1895, E. Klementz 125b (Holotype: LE; Isotype: LE).

Basionym: *Sophiopsis mongolica* (Kom.) N. Busch, in Komarov, Fl. URSS 8: 87. 1939.

Distribution: Mongolia.

19. *Smelowskia ovalis* M. E. Jones, Proc. Calif. Acad. Sci. 5: 624. 1895. TYPE: U.S.A. Washington: Mt. Adams, 12 August 1882, Howell 3846 (Holotype: US; Isotypes: MIN, NY).

Distribution: Canada (British Columbia), U.S.A. (California, Oregon, Washington).

20. *Smelowskia parryoides* (Cham.) Polunin, Circumpolar Arctic Fl. 243. 1959.

Basionym: *Draba parryoides* Cham., Linnaea 6: 533. 1831. TYPE: RUSSIA. Kamchatka, "in rupestribus montis ignivomi Schiwelutsch, 4000 m," A. Erman s.n. (Holotype: LE).

Synonym: *Ermania parryoides* (Cham.) Botsch., Bot. Zhurn. (Moscow & Leningrad) 41: 730. 1956.

Distribution: Russian Far East (Magadan).

21. *Smelowskia porsildii* (W. H. Drury & Rollins) Jurtsev, Novosti Sist. Vyssh. Rast. 6: 309. 1970.

Basionym: *Smelowskia calycina* (Stephan) C. A. Mey. var. *porsildii* W. H. Drury & Rollins, Rhodora 54: 105. 1952. TYPE: U.S.A. Alaska: Kokrines Mountains, north side of divide toward Melozitna River, 65°20'N, 154°30'W, dry gravelly slope, 2500 ft [ca. 762 m], 23 June–5 July 1926, A. E. & R. T. Porsild 741 (Holotype: GH; Isotype: CAN).

Distribution: Russia (Far East, especially the northeastern part of Magadan; see Berkutenko, 1988), U.S.A. (Alaska).

Velichkin (1974, 1979) recognized three species of *Smelowskia* with simple leaves. These, *S. jurtzevii* Velichkin, *S. porsildii*, and *S. spathulatifolia* Velichkin, most likely represent one species highly variable in leaf shape, size and shape of petals, and fruit shape. Czerepanov (1995) had correctly listed *S. jurtzevii* in the synonymy of *S. porsildii* but erroneously suggested that *S. integrifolia* Seeman has priority. The latter was originally published as a variety (not as a species) but was renamed as a species (*S. spathulifolia*) by Velichkin (1974) to avoid creating a later homonym of *S. integrifolia* C. A. Mey., a species that belongs to *Eutrema* R. Br. (see Warwick et al., 2004). Further studies are needed on *S. porsildii* to determine whether it includes *S. calycina* var. *integrifolia* (Seeman) Rollins or whether the latter is an independent taxon.

22. *Smelowskia pyriformis* W. H. Drury & Rollins, Rhodora 54: 108. 1952. TYPE: U.S.A. Alaska: Kushokwim River Drainage Basin, Farewell Mountain, open limestone slide-rock, north slope near the top, 8 August 1949, W. H. Drury, Jr. 2783 (Holotype: GH).

Distribution: U.S.A. (Alaska).

23. *Smelowskia sisymbrioides* (Regel & Herder) Lipsky ex Paulsen, Kjoeb. Vidensk. Meddel. 137. 1903.

Basionym: *Hutchinsia sisymbrioides* Regel & Herder, Bull. Soc. Imp. Naturalistes

Moscou 39(2): 99. 1866. TYPE: KAZAKHSTAN. Trans-Ili Alatau, Merke River, A. C. Semenov *s.n.* (Holotype: LE; Isotype: LE).

Synonym: *Sophiopsis sisymbrioides* (Regel & Herder) O. E. Schulz in Engler, Pflanzenreich IV. 105(Heft 86): 346. 1924.

Distribution: China (Xinjiang), Kazakhstan, Tajikistan, Uzbekistan.

24. *Smelowskia sophiifolia* (Cham. & Schltld.) Al-Shehbaz & S. I. Warwick, *comb. nov.*

Basionym: *Redowskia sophiifolia* Cham. & Schltld., *Linnaea* 1: 33, tab. 2. 1826. TYPE: RUSSIA. Yakutia: Ust Mai, *I. Redowski s.n.* (Holotype: LE).

Distribution: Russia (central and eastern Siberia).

Of the three sheets at LE that were collected by Redowski, the one carrying Chamisso's

hand-written species name, the crossed out *Myagrurn achillaefolium* and "Herb. Cham.," should be considered as the holotype.

25. *Smelowskia tibetica* (Thomson) Lipsky, Trudy Imp. S.-Peterburgsk. Bot. Sada 23: 76. 1904.

Basionym: *Hutchinsia tibetica* Thomson, Icon. Pl. 9: t. 900. 1852. TYPE: WESTERN TIBET. Lanak Pass, 18–19,000 ft [ca. 5480–5790 m], *Thomas Thomson s.n.* (Holotype: K).

Synonym: *Hedinia tibetica* (Thomson) Ostenf. in Hedin, S. Tibet 6(3), Bot. 76. 1922.

Distribution: Bhutan, China (Gansu, Qinghai, Sichuan, Xinjiang, Xizang), India, Nepal, Tajikistan.

Smelowskia tibetica is highly variable in fruit shape and has been divided (as *Hedinia*) into several species and infraspecific taxa (Zhou and An, 1990).

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