

DIMITRY GERMAN

Erysimum mongolicum*, a new species from Mongolia, and notes on *E. vassilczenkoi* and *E. kotuchovii* (Brassicaceae)*Abstract**

German, D.: *Erysimum mongolicum*, a new species from Mongolia, and notes on *E. vassilczenkoi* and *E. kotuchovii* (Brassicaceae). – Willdenowia 35: 305-313. – ISSN 0511-9618; © 2005 BGBM Berlin-Dahlem.

doi:10.3372/wi.35.35212 (available via <http://dx.doi.org/>)

Taxonomy and distribution of the poorly known *Erysimum vassilczenkoi* (\equiv *Syrenia macrocarpa*) (Brassicaceae) is revised on the basis of herbarium material and field studies. The presence of the species in the flora of Mongolia is not confirmed; instead, a new species, *E. mongolicum*, is described from the Mongolian Altai, and *E. kotuchovii* is reported for Mongolia for the first time. The distinguishing characters and relationships of the three species are discussed. A map of their distribution and a key to their identification also including the closely related *E. siliculosum* are given. Some comments on the status of *Syrenia* are added.

Introduction

The present paper deals with the problematic and poorly known N and Central Asian species group around *Erysimum vassilczenkoi* Polatschek, a species originally described as *Syrenia macrocarpa* Vassilcz. (Vassilczenko 1939: 640). *Syrenia* Andr. ex Besser is treated by many authors as congeneric with *Erysimum* L. (e.g. Polatschek 1994, Appel & Al-Shehbaz 2002, Zhou & al. 2001), for which reason the species was transferred to *Erysimum* by Polatschek (1994: 201), who gave it the new name *E. vassilczenkoi* to avoid creating a later homonym of *E. macrocarpum* (Rupr.) Stev. ex Trautv. (1883).

The distribution area of *Erysimum vassilczenkoi* has been a matter of controversy since its publication in 1939. Vassilczenko based his taxon on a collection from the Blandy-Kul-Kum sands, situated in the border region of Kazakhstan and China (NE part of Zaissan depression), and only two more collections (*Sedelnikov s.n.* of 11.7.1908, and *Fedtschenko 2323* of 6.8.1908, both LE), also from the NE part of Zaissan depression, from the Akkum sands along the river Alkabek, were available to him, when preparing the treatment of *Syrenia* for the Flora SSSR (Vassilczenko 1939). Nevertheless, he reported the species not only for the Balkhash region in Middle Asia, to which the Zaissan depression belongs according to the floristic divisions used in the Flora SSSR, but also for “W Siberia (Altai)” (Vassilczenko 1939: 130). The reason for this

puzzling range extension we find on the label of the type specimen: the label template contains the printed locality information “Semipalatinskaya oblast’ [Semipalatinsk region], Ust’-Kamenogorsky uезд [Ust’-Kamenogorsk district], Altai mts.”, to which the collector added the handwritten locality: “Blandy-Kul-Kum sands near the mountains” but did not cross out the (partly) contradicting and misleading template text.

This first erroneous range extension was subsequently strongly widened once more by Vassil’eva (1961), who reported the species for several floristic units of E Kazakhstan, i.e. Zaissan and Balkhash-Alakol depressions (in contrast to Flora SSSR the latter is treated as a separate floristic district in Flora Kazakhstana), Altai and Dzungarian Alatau Mts. Neither Adylov (1974) nor Goloskokov (1984) confirmed the occurrence of *Syrenia macrocarpa* in the Dzungarian Alatau, and the first author also emphasized the lack of any material from the Balkhash-Alakol depression (Adylov 1974: 80). A further range extension was made by An (1983) and Kuan (1987), who reported *S. macrocarpa* for Xinjiang. However, later An (1995) did not include the species into Flora Xinjiangensis nor gave any comments on the previous reports of the species for Xinjiang and China. Zhou & al. (2001) did not include the species into Flora of China and regarded its former Chinese records as erroneous: “The record of *Erysimum vassilczenkoi* Polatschek in FRPS (as *Syrenia macrocarpa* Vassilczenko [...]) is very likely based on misidentified plants of *E. siliculosum*” (Zhou & al. 2001: 169). Grubov (1976, 1982) reported the species also for the Dzungarian Gobi in W Mongolia, and Gubanov & al. (1990) added its report for the Mongolian Altai (near the border with China).

The present author assumed recently (German 2002) that the main part of the distribution area of the species is situated probably in NW China, and pointed out the lack of any material from Altai Mts in the herbaria AA, LE, MW and TK (German 2003a, herbarium abbreviations following Holmgren & Holmgren 1998-). Field studies and additional revision of herbarium material in ALTB, LE, MW and TK revealed that the case is even more complex and that actually three different species are involved as is shown in the present contribution.

Morphological and geographical characterization of the taxa recognized

Erysimum vassilczenkoi Polatschek in Phytion (Horn) 34: 201. 1994 ≡ *Syrenia macrocarpa* Vassilcz. in Komarov, Fl. SSSR 8: 640. 1939 [non *Erysimum macrocarpum* (Rupr.) Stev. ex Trautv. in Acta Horti Petrop. 8: 105. 1883]. – Holotype: [printed text:] “Semipalatinskaya oblast’ [Semipalatinsk region], Ust’-Kamenogorsky uезд [Ust’-Kamenogorsk district], Altai Mts” [handwriting, translated:] “Blandy-Kul-Kum sands near the place of their lean on serpentine mountains. 5.1911, V. Reznitschenko 18” (LE!; isotype: TK!).

Other specimens seen. – “Plants of Semipalatinskaya oblast’. Zaisansk. uезд [Zaissan district], sands Akkum along the bank of Alkabek near Nizhn. Terekty”, 11.7.1908, A. N. Sedelnikov (LE); “Iter Turkestanicum – 1908. Chinese Dzungaria, Alkabek, sands”, 6.8.1908, B. A. Fedtschenko, 2323 (LE).

Distribution. – China (NW Xinjiang), ? NE Kazakhstan.

Morphology. – According to the original description, *Erysimum vassilczenkoi* is most closely related to *E. siliculosum* (M. Bieb.) DC. (≡ *Syrenia siliculosa* (M. Bieb.) Andr. ex Besser), from which it was stated to differ by longer and broader fruits (15-20 × 3-5 mm, not 5-14 × 1.5-3 mm) and broader (up to 8-10, not 2-5 mm wide), broadly oblong (not linear to lanceolate) leaves (Vassilczenko 1939: 130, 640, as *Syrenia macrocarpa*). However, investigation of the available material of *E. vassilczenkoi*, also including an isotype recently traced in the Krylov Herbarium (TK) during the author’s visit to Tomsk in December 2004, led to a revised description of several characters. The leaf blades are mostly narrowly obovate with rounded apex (acute to subacute in *E. siliculosum*) and reach a width in lower leaves of 12-15 mm. The length of the fruits without style (“valvate part of fruit”, following Dorofeyev 2004) is 14-16.5 mm, but not up to 20 mm. The width of the fruits varies from 3.5 to 5.5 mm (up to 6 mm at base), but because they are

slightly compressed in the plane of the septum (i.e. angustiseptate, see Appel & Al-Shehbaz 2002: 80), the width of the septum is only 2.5-3.2 mm. Their form is thus oblong, and as it is nearly 3-4 times longer than broad, it is a “silique” (or “silicle”). The style length is (7-)8-9(-10) mm, and the ratio of the length of valvate part of the fruit to the style length is c. 1.7-2.1; the total fruit length (valvate part + style) is 23-26 mm.

Distribution. – Only the above cited three of the collections referred in the literature to *Erysimum vassilczenkoi* (or *Syrenia macrocarpa*, respectively) actually represent this species. All three were made within the localised area comprising the Blandy-Kul-Kum and Akkum sands in the Chinese-Kazakhstanian border region in the NE part of the Zaissan depression. Although the protologue and the label of *Sedelnikov* give the Semipalatinsk region (territory of present day Kazakhstan), it is unlikely that the specimens were collected in Khasakhstan. First, the mentioned sands are entirely confined to the territory of China. Second, only in the territory of China the sands in the NE part of the Zaissan depression touch the mountains (“lean on mountains”, according to the type label). Fedtschenko’s label giving “Chinese Dzungaria” even directly points out that his specimen was collected in China. Hence the three known collections of *E. vassilczenkoi* strongly indicate its occurrence in China, whereas its presence in Kazakhstan needs verification. Exactly the same situation has been reported recently for *Alyssum fedtschenkoanum* N. Busch, which also turned out to be a local endemic to the these sands notwithstanding the information on its wide distribution in NE Kazakhstan and its absence in China (for details see German 2003b).

***Erysimum mongolicum* D. German, sp. nov.**

Holotype: Mongolia, Khobdo (Hovd) aimak, Mongolian Altai, valley of Bodonchijn-gol, 30-35 km NE [settlement] Altai, 46°05'N, 92°31'E, 1650-1700 m, sandy bottom of dried stream between rocks, 17.7.2003, D. A. German (ALTB; isotypes: B, LE) – Fig. 1.

Ab *Erysimo siliculoso* et *E. vassilczenkoi* siliquis longioribus ((15-)20-28 non 5-16.5 mm) et area geographica et a *E. kotuchovii* indumento siliquorum differt.

Biennial plant, covered throughout with appressed, predominantly malpighiaceus trichomes. *Stems* erect, few-branched, up to 60 cm tall. *Leaves* up to 80 × 8 mm; blades linear-lanceolate, margin entire, basal (rosulate) and lowermost cauline leaves with a petiole 2-3.5 cm long, middle and upper cauline leaves short-petiolate to sessile, smaller and narrower, all moderately covered with malpighiaceus trichomes mixed with few 3-rayed ones. *Sepals* pale yellow, 8-9 mm long, pairwise connected in the middle part; the lateral sepals 3 mm wide, oblong-ovate, at the base strongly saccate; the median sepals 1.8 mm wide, oblanceolate, at base and apex saccate, narrowly pale-margined, pubescent with 2- and 3-rayed trichomes. *Petals* yellow, glabrous, 14-15 mm long, claw 8.5-9 mm long, blade 5.5-6.5 mm wide, almost round. *Stamens* slightly tetradynamous: the lateral ones 9-9.5 mm, the median ones 10.5-11 mm; filaments of median stamens expanded to 1 mm width; anthers linear, sagittate, 2.5-4 mm long. *Pedicels* 2-4 mm long, in fruits somewhat thickened and 4.5-14 mm long. *Siliques* linear, (15-)20-28 × 1.8-2.2 mm, occasionally shorter, base slightly (up to 2.5-2.8 mm) widened, very gradually narrowed towards apex, strongly 4-angled, almost erect, densely covered with transversely oriented malpighiaceus trichomes intermixed with few 3-rayed ones; valves with prominent, green, slightly keeled midvein; septum narrowly veined. *Style* (4-)6-7(-8) mm long, with few 2- and 3-rayed trichomes, stigma with divergent lobes c. 0.8 mm long. *Seeds* 1.6-2.2 × 0.8-1.1 mm, ovate, elliptic or oblong-elliptic, mostly asymmetric, brown, biseriata, c. 30 per locule.

Other specimens seen. – MONGOLIA: Dzungarian Gobi, foothills of Argalante in 4 km from Ubchu-Bulak, sandy valleys, c. 1700 m, 2.7.1973, *Golubkova & Cogt 161* (LE); Khobdo distr., Mongolian Altai, middle reaches of Bayan-gol, valley of its right tributary Ulyastyjn-Sala, Arshantyn-Nuruu range, Mt Mogojn-Ulan-Ula, 46°23'N, 91°14'E, N macroslope, c. 2000 m, gravel slopes & sandy sairs, 21.6.2004. S. A. *Dyachenko & P. A. Kossaczew* (ALTB).



Fig. 1. *Erysimum mongolicum* – holotype specimen.

Distribution. – Mongolia (Dzungarian Gobi, adjacent parts of Mongolian Altai). Probably also in neighbouring China (N Xinjiang: westernmost Chinese Altai).

Note. – The specimen that served as the basis for the first report of *Erysimum vassilczenkoi* for Mongolia (Dzungarian Gobi, Golubkova & Cogt 161, LE), differs from *E. vassilczenkoi* in having much narrower (up to 6 mm wide), mostly linear-oblongate leaves, and is supplied with a critical note by Vassilzenko: “A typo foliis angustioribus paulo differt”. The plant has no mature fruits, but even immature ones have a length typical for *E. vassilczenkoi* (valvate part up to 15-17 mm). In 2003 the present author had the opportunity to work in W Mongolia not far from the place of the first finding of “*Syrenia macrocarpa*” and succeeded to collect several samples of this plant. Mature fruits had the following dimensions: length of valvate part: (15-)20-28 mm; style length: (4-)6-7(-8) mm; average ratio valvate part to style: (3-)3.5-4; total fruit length (valvate part + style): (20-)28-35 mm; fruit width: 1.8-2.2 mm (up to 2.8 mm at base), width of septum: 1.9-2.3 mm. Their form is linear, they are in general 8-10 and more times longer than broad, and are thus “siliques”. The leaves are mostly linear-lanceolate and up to 8 mm wide. These characters distinguish the W Mongolian plants clearly from both *E. vassilczenkoi* and *E. siliculosum*, and justify their recognition as a separate species, *E. mongolicum*.

Erysimum kotuchovii D. German in Turczaninowia 7(2): 14. 2004

Holotype: Kazakhstan, Vostochno-Kazakhstanskaya oblast' (East-Kazakhstanian province), Sarym-Sakty range, NW foothills, vicinities of Chingistai, valley of Bukhtarma, sandy and gravelly deposits, 16.7.1984. Yu. A. Kotukhov (ALTB; isotype: Herbarium of Altai Botanical Garden, Ridder, Kazakhstan).

Biennial or short-lived perennial plant, covered throughout with appressed trichomes. *Stems* erect, single or several (3-5) at base, to 52 cm tall. *Basal leaves* rosulate, petiolate; blade linear-oblongate to linear or narrowly linear, 30-70 × 2-4 mm, long-attenuate towards base, margin entire, longitudinally folded; *cauline leaves* similar to the basal ones, the middle and upper leaves smaller, short-petiolate to sessile, all rather densely covered with malpighiaceus trichomes and an inconsiderable admixture of 3-rayed ones. *Sepals* pale yellow, 6-11 × 1.8-3.2 mm, strongly saccate, narrowly pale-margined, pubescent with malpighiaceus and 3-rayed trichomes. *Petals* yellow, glabrous, 12-19 × 4-7 mm, claw 8-12 mm, blade almost round. *Stamens* slightly tetradynamous, the lateral 8-13 mm, the median 9.5-15.5 mm long; filaments of the median stamens expanded to 1 mm width; anthers linear, sagittate, 2-4.5 mm long. *Pedicels* (1-)2-5 mm long, in fruit (2.5-)5-7 mm long. *Siliques* linear, (14-)24-39 × 1.5-2 mm, at base slightly (to 2.2 mm) widened, 4-angled, erect, moderately covered with a mixture of 3-rayed and malpighiaceus trichomes oriented transversely, or parallel, or obliquely to the length of the silique (malpighiaceus trichomes of different orientation either mixed on one fruit, along the whole length or in certain parts, or only one type present), sometimes with few 4-rayed trichomes; valves with prominent, green, slightly keeled midvein; septum narrowly veined. *Style* slender, (3-)4-6 mm long, with few 2- and 3-rayed trichomes, stigma with divergent lobes 0.6-1 mm long. *Seeds* 0.6-1.2 × 0.7 mm, ovate or elliptic, often asymmetric, brown, biseriate, 30-40 per locule.

Other specimens seen. – KAZAKHSTAN: Bukhtarma area, [vicinities of] Chernovaya, steppe, 10.8.1921. V. V. Sapozhnikov (TK). — MONGOLIA: Mongolian Altai, basin of Sanginin-gol (upper reaches of Kara-Irtysh) near the border with China, 25 km SE the border post Dayan-Nuur of Bayan-Ulgij aimak, 16.-17.7.1988, I. A. Gubanov, R. V. Kamelin & al. 61514 (LE, MW).

Note. – The second report of “*Syrenia macrocarpa*” for Mongolia, by Gubanov & al. (1990), is based on the single collection from the vicinity of the Dayan-Nuur lake in NW Mongolia (Gubanov, Kamelin & al. 61514, LE, MW). These plants also cannot be attributed to *Erysimum vassilczenkoi*, because they have even longer and narrower fruits (total length up to 38-43 mm, valvate part 33-39 mm, style 4-6 mm, 1.8-2 mm wide (up to 2.2 mm at base), septum 1.5-1.8 mm wide). One might be tempted to assign these specimens to *E. mongolicum*, but the fruit valves in



Fig. 2. Distribution of *Erysimum mongolicum* (●), *E. vassilczenkoi* (■) and *E. kotuchovii* (▲).

E. mongolicum are covered with tight, almost exclusively transversely oriented, sessile, medifixed 2-rayed (malpighiaceus) trichomes with an inconsiderable admixture of sessile 3-rayed trichomes along the septum margin and on the midrib, occasionally on the valve surface. The indumentum is so dense that the valve surface is completely covered and silvery. In contrast, the fruit valves of the specimens from Dayan-Nuur are covered with moderately dense malpighiaceus trichomes mixed with rather numerous 3-rayed ones common all over the valve surface. Most unusual is the orientation of the malpighiaceus trichomes: these are oriented transversely, or parallel, or obliquely to the length of the silique, and often trichomes of different orientation are mixed on a single fruit. For these peculiarities, the collection can only be attributed to the recently described *E. kotuchovii* D. German from the Kazakhstani Altai (German 2004).

As *Erysimum kotuchovii* was known only from the type collection from Kazakhstan (two rather poorly developed specimens), the Mongolian material allowed to emend its description. In particular, it is evident that the species may well have transversely oriented trichomes (which are absent on the type) on the fruits, and that plants may have fruits predominantly covered with trichomes oriented either transversely or parallel to its length. However, no geographical correlation of these character states exists (e.g. in a specimen at LE consisting of two plants each represents one of the above mentioned variants of trichome orientation on fruits).

The author previously assumed (German 2004) that this unusual indumentum type, unknown in closely related species, could be due to recent hybridization with a species of *Erysimum* s.str. The considerable variability of this character in addition to the long, linear fruits with comparatively short styles supports this hypothesis.

Conclusion

The material of all three species discussed here is very scarce, and though it is evident that each species is rather narrowly distributed, additional field work in the southern Altai, especially in the Chinese Altai, is needed to shed more light on the distribution, morphology, ecology and relationship of these taxa.

All three taxa recognized differ in their ecology. *Erysimum vassilczenkoi* inhabits moving sandy dunes at an altitude of 300-600 m. *E. mongolicum* occurs on dry sandy beds of temporary spring streams (“sairs”) in the middle mountainous zone at an altitude of 1600-2000 m. Data on the ecology of *E. kotuchovii* are largely absent, but the species is apparently distributed in mountainous habitats and grows on sandy and gravely deposits along rivers and “in steppes” at an altitude of c. 1200-2100 m.

All three species are very closely related to *Erysimum siliculosum*, which appears to be an ancestral species for the whole group, representing the eastern branch of evolution of the *Syrenia* branch of *Erysimum*. Obviously, this evolutionary line has undergone intensive recent speciation in the southern Altai and neighbouring Dzungaria, resulting in the formation of three endemic species. *E. siliculosum* and the three endemic species can be keyed out as follows.

Key to *Erysimum siliculosum*, *E. vassilczenkoi*, *E. kotuchovii* and *E. mongolicum*

1. Fruits (without styles) 5-16.5 mm long, shorter, or as long as, or up to 2 times longer than styles 2
 - Fruits (without styles) (14-)20-39 mm long (rarely single fruits on a plant shorter), (2.5-)3-7 times longer than styles 3
2. Fruits (without styles) 5-12(-14) × 2-3.5(-4) mm; leaves linear to narrowly oblanceolate, (1-)2-5(-8) mm wide, apex mostly acute *E. siliculosum*
 - Fruits (without styles) 15-16.5 × 3.5-5.5(-6) mm; leaves narrowly obovate to oblanceolate, up to 15 mm wide, apex rounded *E. vassilczenkoi*
3. Fruit valve surface silvery, completely covered with very dense, exclusively transversally oriented 2-partit (or occasionally few intermixed 3-partit) trichomes *E. mongolicum*
 - Fruit valve surface greenish grey, not completely covered with a mixture of 2-partit trichomes of different orientation, 3- and rarely 4-partit trichomes *E. kotuchovii*

Finally, some comments on the status of *Syrenia* seem appropriate. There is a set of characters that supports the generic rank of this group in the view of several authors: (1) absence of median nectaries in *Syrenia* versus presence in *Erysimum*, (2) transverse orientation of the malpighiaceus trichomes on fruits in *Syrenia* versus not transversely oriented in *Erysimum*, and (3) biseriate seeds in *Syrenia* versus uni- or rarely biseriate seeds in *Erysimum* (Ball 1993). Obviously, non of these characters is actually reliable to set *Syrenia* apart, since there are some exceptions for each of them. With respect to the seed arrangement and presence/absence of median nectaries such exceptions are given by Ball (1993); with respect to the orientation of the trichomes on the fruits, a perfect exception provides *E. kotuchovii* (see above). Moreover, both Busch (1931) and Vassilczenko (1939) reported the presence of median nectaries in certain species of *Syrenia*.

Only recently Veselova (2002) defended the separation of *Syrenia* and gave additional arguments in support of its generic status, viz. the exclusive presence of malpighiaceus trichomes in *Syrenia* (versus 2-6-partit trichomes in *Erysimum*) and the preference of sandy habitats on plains (versus mostly rocky habitats in mountainous areas in *Erysimum*). However, both characters also do not work. All species of *Syrenia* have 3-fid trichomes at least on the sepals, and there is a number of species of *Erysimum* covered with exclusively malpighiaceus trichomes. Some species of *Syrenia* (e.g. *E. mongolicum*) occur exclusively in mountainous areas, whereas some species of *Erysimum* s.str. are obligatory psammophytes growing only on plains (e.g. *E. czernjajevii* N. Busch). Therefore, neither morphology nor ecology provide any argument to justify a separation of *Syrenia* from *Erysimum*.

Acknowledgements

The author is most grateful to A. I. Shmakov and R. V. Yakovlev (Barnaul) for the organization of the field trip in W Mongolia in 2003, and to the curators and personnel of LE (R. V. Kamelin, O. V. Cherneva & A. E. Borodina-Grabovskaya), MW (I. A. Guvanov, S. A. Balandin & T. P. Balandina), TK (I. I. Gureeva, N. V. Kurbatskaya & A. L. Ebel), ALTB (N. A. Usik, S. V. Smirnov) for providing the opportunity of work with the herbarium material. I also thank E. von Raab-Straube and N. Kilian (Berlin), Chen W.-L. (Beijing), N. V. Friesen (Osnabrueck), E. A. Davydov and E. L. German (Barnaul) for different kind of help during the preparing and publication of the present paper. Special thanks for his reviews are due to I. Al-Shehbaz, who's fruitful comments and suggestions helped to improve the manuscript considerably.

References

- Adylov, T. A. 1974: *Syrenia*. – Pp. 79-80 in: Pahomova, M. G. (ed.), *Conspectus Florae Asiae Mediae* **4**. – Tashkent.
- An, Z.-H. 1983: *Claves plantarum xinjiangensium*. – Urumqi.
- 1995: *Cruciferae*. – Pp. 38-229 in: Mao, Z.-M. (ed.), *Flora xinjiangensis* **2(2)**. – Urumqi.
- Appel, O. & Al-Shehbaz, I. A. 2002 [2003]: *Cruciferae*. – Pp. 75-174 in: Kubitzki, K. (ed.), *The families and genera of vascular plants* **5**. – Berlin & Heidelberg.
- Ball, P. W. 1993: *Erysimum* L., *Syrenia* Andrz. – Pp. 325-336 in: Tutin, T. G., Burges, N. A., Chater, A. O., Edmondson, J. R., Heywood V. H., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. (ed.), *Flora europaea*, ed. 2, **1**. – Cambridge, etc.
- Busch, N. A. 1931: *Flora Sibiri i Dal'nego Vostoka* [Flora of Siberia and the Far East] **6**. – Leningrad.
- Dorofeyev V. I. 2004: Plody krestotsvetnyh: raznoobrazie, stroenie, klassifikatsiya, proiskhozhdenie [Fruits of *Cruciferae*: diversity, structure, classification, origin]. – *Turczaninowia* **7(3)**: 76-87.
- German, D. A. 2002: K voprosu sohraneniya vidovogo raznoobraziya krestotsvetnyh Altaiskoj Gornoj Strany [To the problem of Altai Mountain Country *Cruciferae* species diversity conservation]. – Pp. 245-252 in: *Problems of Botany of South Siberia and Mongolia. Proceedings of the 1st International Scientific-Practical Conference (Barnaul, 26.-28.11.2002)*. – Barnaul.
- 2003a: Zametki po vidovomu sostavu i rasprostraneniyu krestotsvetnyh Vostochnogo Kazakhstana [Notes on species composition and distribution of East Kazakhstan *Cruciferae*]. – Pp. 30-36 in: *Plant world of Kazakhstan investigation and protection / Proceedings of the 2nd International Botanical Conference of young scientists, devoted to the memory of M. S. Baytenov (Almaty, 2003, April, 8-10)*. – Almaty.
- 2003b: Zametki po rodu *Alyssum* L. (*Cruciferae*) Kazakhstana [Notes on the genus *Alyssum* (*Cruciferae*) in Kazakhstan]. – *Turczaninowia* **6(1)**: 45-57.
- 2004: Novye taksony roda *Erysimum* L. (*Cruciferae*) iz Kazakhstanskogo Altaia [New taxa of the genus *Erysimum* L. (*Cruciferae*) from the Kazakhstaniai Altai]. – *Turczaninowia* **7(2)**: 14-18.
- Goloskokov, V. P. 1984: *Flora Dzungarskogo Alatau* [Flora of the Dzungarian Alatau]. – Alma-Ata.
- Grubov, V. I. 1976: Shestoye dopolnenie k spisku flory Mongol'skoj Narodnoj Respubliki [Sixth addition to the check-list of flora of Mongolian People Republic]. – *Bot. Zhurn.* **61**: 1751-1753.
- 1982: *Opredelitel' sosudistyxh rastenij Mongolii (s atlasom)* [Key to the vascular plants of Mongolia (with an atlas)]. – Leningrad.
- Gubanov, I. A., Kamelin, R. V., Budantsev, A. L., Ganbold, E. & Darijmaa, Sh. 1990: Novye vidy i rody rastenij dlya flory Mongolii i otdelnykh ee raionov [New species and genera of plants for the flora of Mongolia and its districts]. – *Bull. Soc. Naturalistes Moscou, Sect. Biol.* **95(1)**: 117-123.
- Holmgren, P. K. & Holmgren, N. H. 1998- (continuously updated): *Index herbariorum*. – <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>

- Kuan, K.-C. 1987: *Syrenia*. – Pp. 391-392 in: Cheo, T.-Y. (ed.), *Flora Republicae Popularis Sinicae* **33**. – Beijing.
- Polatschek, A. 1994: Nomenklatorischer Beitrag zur Gattung *Erysimum* (*Brassicaceae*). – *Phyton* (Horn) **34**: 189-202.
- Vassilczenko, I. T. 1939: *Syrenia*. – Pp. 128-130, 640 in: Komarov, V. L. (ed.), *Flora SSSR* **8**. – Moscow & Leningrad.
- Vassil'eva, A. N. 1961: *Cruciferae*. – Pp. 171-339 in: Pavlov, N. V. (ed.), *Flora Kazakhstana* **4**. – Alma-Ata.
- Veselova, P. V. 2002: K voprosu o sistematicheskoi blizosti rodov *Erysimum* L. i *Syrenia* Andrz. [To the problem of the taxonomic closeness of *Erysimum* L. and *Syrenia* Andrz.]. – Pp. 34 in: *Problems of Botany of South Siberia and Mongolia / Proceedings of the 1st International Scientific-Practical Conference* (Barnaul, November 26-28, 2002). – Barnaul.
- Zhou, T. Y., Lu, L. L., Yang, G. & Al-Shehbaz, I. A. 2001: *Brassicaceae* (*Cruciferae*) – Pp. 1-193 in: Wu, Zh. G. & Raven, P. H. (ed.), *Flora of China* **8**. – Beijing & St Louis.

Address of the author:

Dr Dmitry German, Herbarium, South-Siberian Botanical Garden, Altai State University, Lenina str. 61, 656049 Barnaul, Russia; e-mail: d_german@inbox.ru