



A reconsideration of *Pseudofortuynia* and *Tchihatchewia* as synonyms of *Sisymbrium* and *Hesperis*, respectively (Brassicaceae)

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Pseudofortuynia leucoclada (Boiss.) Khosravi was initially described and was long treated as a member of *Hesperis* L. whereas *Tchihatchewia isatidea* Boiss. has never hitherto been assigned to this genus. Currently these species represent monospecific genera, *Pseudofortuynia* Hedge and *Tchihatchewia* Boiss., endemic to restricted areas in Iran and Turkey, respectively. Based on a re-evaluation of morphological characters in light of available molecular data, the merger of *Pseudofortuynia* with *Sisymbrium* L. and *Tchihatchewia* with *Hesperis* is proposed. Relevant combinations are validated.

Keywords: Cruciferae, Iran, South-West Asia, Turkey

Introduction

Ongoing studies on the Brassicaceae for various projects such as the World Flora Online, BrassiBase (Kiefer *et al.* 2014), and Boissier's Cruciferae typification (Al-Shehbaz, submitted) resulted in the need of reconsideration of the status of two monospecific SW Asian genera. Neither of them was ever synonymized before but morphological and available phylogenetic information provide sound grounds for reducing them to synonymy of larger related genera with minimal changes to their morphological characteristics.

1. *Pseudofortuynia* Hedge

The generic placement of the single species of *Pseudofortuynia* Hedge (1968: 56) has been controversial. Despite being quite distinct and uniform morphologically, it was described in three different genera of three tribes: first as *Hesperis leucoclada* Boissier (1842: 69) of Hesperideae Prantl, then as *Sisymbrium hesperidiflorum* Boissier & Buhse (1860: 22) of Sisymbrieae DC., and eventually as *Pseudofortuynia esfandiarii* Hedge (1968: 57) of Brassiceae DC. While the first two were synonymized shortly after the description of *S. hesperidiflorum* (Boissier 1867: 233, Fournier 1868: 354), conspecificity of *P. esfandiarii* with *H. leucoclada* was established only recently (Khosravi 2003). It was repeatedly emphasized that the species possesses an unusual combination of characters which made its generic assignment quite difficult (Boissier 1867, Dvořák 1968a, Hedge 1968) and led to completely different taxonomic decisions that were often based on quite arbitrary reliance on a particular feature of which the presence of gynophore is most illustrative. For example, Dvořák (1968a) who correctly argued for exclusion of *H. leucoclada* from *Hesperis*, assigned it to *Gynophorea* Gilli (1955: 226), now generally treated as a synonym of *Erysimum* Linnaeus (1753: 660) [Erysimeae Dumort.] (conf. Polatschek 2010, Al-Shehbaz 2012), almost solely on having stipitate vs. sessile fruit despite “there are no any other important characters which correlate *H. leucoclada* and *Gynophorea*” (Khosravi 2003: 16). Much earlier, the same feature became the reason for Fournier (1865: 109) to synonymize *Sisymbrium hesperidiflorum* with the unrelated *S. cartilagineum* Pall. ex Candolle (1821b: 471), a dubious taxon for over 180 years and the identity of which [*Diploaxis tenuifolia* (Linnaeus 1755: 18) Candolle (1821b: 632); Brassiceae] was clarified only five years ago (German 2012: 41). The presence of a gynophore was also used by Hedge (1968), though not as a single character, to propose affinity of *P. esfandiarii* to the tribe Brassiceae. Other features were implied by Boissier (1867: 233) who after some doubts between *Sisymbrium* Linnaeus (1753: 657) and *Hesperis* Linnaeus (1753: 663) made a choice in favour of the latter genus based on the structure of stigma (“capitato-subbilobo”) which he found to be “more *Hesperis*- rather *Sisymbrium*-like” (initially in Latin). Although the species is quite anomalous in *Hesperis* because it does not have the decurrent stigmas, branched trichomes, and uniseriate-multicellular glands characteristic of the majority of species in

the genus, initial generic placement of Boissier (1842: 69) was followed most often and till rather recent time (e.g., Dvořák 1968b, Zohary *et al.* 1980).

On the other hand, as demonstrated by Khosravi (2003) based on of a thorough morphological study combined with molecular analysis of chloroplast DNA, and by our closer examination of the type collections of *H. leucoclada* and *P. esfandiarii*, the species reveals unambiguous affinity to *Sisymbrium*. In fact, the above-mentioned difficulty of many authors to properly assign the species finds its explanation in the unique combination of large, purple flowers, which superficially resemble those of many species of *Hesperis* or members of some Brassiceae genera such as *Fortuynia* Shuttlew. ex Boissier (1841: 379) and *Moricandia* Candolle (1821a: 243), with the rest of characters (runcinate leaves, 3-veined fruit valves, 2-lobed and non-decurrent stigmas, etc.; surveyd by Khosravi l.c.) typical for *Sisymbrium* but not for any of the above-mentioned genera. Presence of the gynophore also contributes to this “strange” character combination. However, the taxonomic value of the gynophore is not always high; as exemplified by *Gynophorea*, it may not stand even at the species level, and it is also not always developed in specimens of *P. leucoclada*. As for the petal colour, despite most representatives of *Sisymbrium* are yellow- or, less often, white-flowered, pinkish to lilac petals are known in two SW Asian species, *S. aculeolatum* Boissier (1842: 75) and *S. afghanicum* Gilli (1955: 228) (Warwick *et al.* 2006). Hence, there are no morphological features supporting *Pseudofortuynia* as a genus distinct from *Sisymbrium*. A subsequently published ITS-based phylogeny (Warwick *et al.* 2010) further confirms this approach. Noteworthy, except for the flower colour, the discussed species is especially resembles the Turanian *Sisymbrium subspinescens* Bunge (1847: 151), a fact noticed by Boissier & Buhse (l.c.) and by V.P. Botschantzev who annotated in 1970 a fruiting specimen (LE-01037337) collected in *locus classicus* of *P. esfandiarii* as “whether distinct from *Sisymbrium subspinescens*?” (originally in Russian). One more interesting detail is that Fournier (1868) who agreed with Boissier (1867) on conspecificity of *Hesperis leucoclada* and *Sisymbrium hesperidiflorum*, accepted, in contrast to Boissier, the species in *Sisymbrium*, but he used the later name *S. hesperidiflorum* and failed to publish the necessary combination *S. leucocladum*. This is done here along with formal merger of *Pseudofortuynia* with *Sisymbrium*.

Sisymbrium leucocladum* (Boiss.) D.A. German & Al-Shehbaz, *comb. nov.

≡ *Hesperis leucoclada* Boissier (1842: 69) ≡ *Gynophorea leucoclada* (Boiss.) Dvořák (1968a: 111) ≡ *Pseudofortuynia leucoclada* (Boiss.) Khosravi (2003: 20). Described from: “[Aucher-Eloy] N. 4123, Ispahan.” Lectotype (designated by Dvořák (1968a: 105; 1968b: 269): IRAN. Ispahan [Isfahan]. *Aucher-Eloy* 4123. W-0050812!; isolectotypes: BM-000522181!, BM-000522182!, G-BOIS-00332220!, G-00446088!, G-00446989!, G-BOIS-00332220!, K-000693872!, KW!, LE-00013085!, P-02272565!, P-02272566!, P-02272567!).

= *Sisymbrium hesperidiflorum* Boissier & Buhse (1860: 22). Described from: “Im Gebirge von Jesd [Yazd], Thal Derrehgoum, 23 April 1849 (florens et fructiferum). [*Buhse*] No 1296.” Type: ?

Note. No material of *S. hesperidiflorum* was found in G and LE and neither JSTOR nor other databases provide any relevant information.

The name is treated as conspecific with *S. leucocladum* based on the synonymy proposed by Boissier (1867), the author of both *S. hesperidiflorum* and *H. leucoclada*, and by an analysis of their protologues which fully match each other.

= *Pseudofortuynia esfandiarii* Hedge (1968: 57). Described from: “Inter Abadeh et Dowlatabad, 1500–2000 m, 26. 4. 1956, *Schmid* 5335, Holotypus W!, Isotypus G.” Type: W-19590022415!; isotypes E-00135544!, G-00371875!

2. *Tchihatchewia* Boiss.

Family-wide molecular phylogenetic study by Warwick *et al.* (2010) provided strong support for the monophyly of the tribe Hesperideae which included *Hesperis matronalis* Linnaeus (1753: 663), *H. sibirica* Linnaeus (1753: 663), and *Tchihatchewia isatidea* Boiss. (Tchichatscheff 1860: 292). Their results clearly show that the monospecific *Tchihatchewia* is nested within the larger and earlier-published *Hesperis* and, therefore, the two genera ought to be united as done herein, and the species below transferred to the latter genus. The main problem for the failure to do such a transfer in the past was the bizarre fruit morphology of *T. isatidea*. The species has broadly winged, 1- or 2-seeded, latispetate, indehiscent silicles and flattened seeds with accumbent cotyledons (Tchihatcheff 1860, Appel & Al-Shehbaz 2003), whereas species of *Hesperis* are characterized by wingless, predominantly many-seeded, terete to subquadrangular, dehiscent siliques, and plump seeds with incumbent cotyledons (Busch 1939, Tan & Suda 2002). However, fruit morphology in *Hesperis* is quite diverse (Dvořák 1968b, 1972, 1973) and, with a single exception of a fruit being a silicle, all features of *Tchihatchewia* can be found separately or in various combinations in some SW Asian representatives of *Hesperis*. In particular, according to Dvořák’s (1973) classification, indehiscent siliques occur in two out of five subgenera including all five species of *H.* subgen. *Diaplectos* (Dvořák 1968b: 271) Dvořák (1973: 267). Clearly latisetate fruit characterize *H. breviscapa* Boissier (1842: 67), *H. kotschyi* Boissier (1856: 21), and *H. thyrsoidea* Boissier (1867: 234), representing another two subgenera of Dvořák (1973). A tendency of reduction of

the number of seeds is also revealed in *H. breviscapa* and especially in *H. thyrsoides* having just 3 or 4 seeds per fruit (Boissier 1867) which are visibly compressed. Besides, the latter species is peculiar for its silique being remarkably expanded (as if narrowly winged) around the seeds and twisted at maturity; this is the only representative of *Hesperis* for which accumbent cotyledons are reported (Dvořák 1973). In this and in a number of other species of *Hesperis*, siliques also strongly reflexed just as in *Tchihatchewia*.

Every other morphological aspect of *Tchihatchewia isatidea*, including important diagnostic features such as the indumentum of a mixture of long simple setose and smaller stalked branched trichomes, large fragrant flowers with closed bisaccate calyx and long-unguiculate petals, flattened filaments of inner stamens, deeply bilobed stigmas, non-margined seeds (Schulz 1936, Cullen 1965, Appel & Al-Shehbaz 2003), etc., fits the description of *Hesperis*. Hence, a merger of *Tchihatchewia* with *Hesperis* does not drastically (in fact, only slightly) change the characteristics of the latter genus as it might initially seem. Evolutionary plasticity of the fruit of Brassicaceae is a well-known phenomenon and silicles of *Tchihatchewia* most likely represent recent apomorphy within *Hesperis*, as can be assumed from their structure. Indeed, the wing disregarded, “the fruit [of *T. isatidea*] itself is elongated-elliptic” (Schulz 1936: 482, originally in German), and when mostly developed, 2-seeded, it is even lanceolate-linear and quite reminding somewhat shortened, also gradually tapered upward silique of *H. breviscapa* or *H. kotschyi* with subglobose stigma similar to that of *Tchihatchewia*. Summing up, it is obvious that the single difference between *T. isatidea* and species of *Hesperis* is insignificant to warrant the recognition of the former as independent monospecific genus that evolved within *Hesperis*.

***Hesperis isatidea* (Boiss.) D.A. German & Al-Shehbaz, comb. nov.**

≡ *Tchihatchewia isatidea* Boiss. (Tchichatscheff 1860: 292). Described from: “Armenia: montibus ad septentr. Euphrates vallem circumdantibus, inter pagos Kalaratch et Almalu (ad Orient. Urbis Erzindjan), alt. 1700–2000 m. *T[chihatcheff s.n.]*. Lectotype designated here by Al-Shehbaz: [TURKEY, Erzincan], Armenia ad orientum Urbis Erzindjan. Aia minor, OEst. 1858. *M. de Tchihatchef s.n.* (G-BOIS-00332474!; isolectotypes: K-000484469!, P-00835139!).

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References

- Al-Shehbaz, I.A. (2012) A generic and tribal synopsis of the Brassicaceae (Cruciferae). *Taxon* 61 (5): 931–954. Available from: <https://www.jstor.org/stable/41679341> (accessed 1 January 2018)
- Appel, O. & Al-Shehbaz, I.A. (2003) Cruciferae. In: Kubitzki, K. & Bayer, C. (Eds.) *Families and Genera of Vascular Plants. Vol. 5*. Springer-Verlag, Berlin & Heidelberg, pp. 75–174.
https://doi.org/10.1007/978-3-662-07255-4_17
- Boissier, E. (1841) Novarum generum cruciferarum diagnosis, ex plantarum aucherianarum enumeratione excerpta. *Annales des Sciences Naturelles. Botanique. Sér. 2* 16: 378–382.
- Boissier, E. (1842) Plantae aucherianae orientales enumeratae, cum novarum specierum descriptione. *Annales des Sciences Naturelles. Botanique, Sér. 2* 17: 45–90, 150–205, 381–390.
- Boissier, E. (1856) *Diagnoses plantarum Orientalium novarum. Ser. 2, 3* (5). B. Herrmann, Lipsiae [Leipzig] (Typis Ramboz et Schuchardt, Genève), 118 pp.
- Boissier, E. (1867) *Flora Orientalis. Vol. I*. H. Georg, Basel & Genève, XXXIV + 1017 pp.
- Boissier, E. & Buhse, F. (1860) Aufzaehlung der auf einer Reise durch Transkaukasien und Persien gesammelten Pflanzen. *Nouveaux mémoires de la Société impériale des naturalistes de Moscou* 12: I–LIVII + 1–246.
- Bunge, A.A. (1847) Alexandri Lehmanni Reliquiae botanicae, sive Enumeratio plantarum in itinere per deserta Asiae mediae ab A. Lehmann annis 1839 ad 1842 collectarum. *Arbeiten der Naturforschenden Vereins zu Riga* 1 (2): 115–256.
- Busch, N.A. (1939) *Hesperis* L. Juss. In: Komarov, V.L. (Ed.) *Flora SSSR [Flora of USSR]. Vol. 8*. Izdatel’stvo Akademii Nauk SSSR [Publishers of Academy of Sciences of USSR], Moscow & Leningrad, pp. 242–251. [In Russian]

- Candolle, A.P. de (1821a) Mémoire sur la famille des Crucifères. *Mémoires du Muséum d'Histoire Naturelle* 7: 169–252.
- Candolle, A.P. de (1821b) *Regni vegetabilis systema naturale. Vol. 2.* Socii Treuttel et Würtz, Parisii [Paris], [II] + 745 pp.
- Cullen, J. (1965) *Tchihatchewia* Boiss. In: Davis, P.H. (Ed.) *Flora of Turkey and the East Aegen Islands*. University Press, Edinburgh, p. 352.
- Dvořák, F. (1968a) Problems of the taxon *Hesperis leucoclada* Boiss. *Feddes Repertorium* 77 (2): 105–112.
<https://doi.org/10.1002/fedr.19680770202>
- Dvořák, F. (1968b) *Hesperis*. In: Rechinger, K.H. (Ed.) *Flora Iranica. Vol. 57.* Akademische Druck- u. Verlagsanstalt, Graz, pp. 266–274.
- Dvořák, F. (1972 [‘1971’]) *Hesperis* L. subg. *Mediterranea* Borb. *Scripta Facultatis Scientiarum Naturalium Universitatis Purkynianae Brunensis, Biologia* 4, 1 (10): 237–250.
- Dvořák, F. (1973) Infrageneric classification of *Hesperis* L. *Feddes Repertorium* 84 (4): 259–272.
<https://doi.org/10.1002/fedr.19730840402>
- Fournier, E. (1865) *Recherches anatomiques et taxonomiques sur la famille des Crucifères, et sur le genre Sisymbrium en particulier.* J. Rothschild, Paris, 154 pp.
<https://doi.org/10.5962/bhl.title.15428>
- Fournier, E. (1868 ‘1866’) Monographie du genre *Hesperis*. *Bulletin de la Société botanique de France* 13: 326–362.
- German, D.A. (2012) Taxonomical confusions in the Cruciferae of North and Central Asia. II. *Sisymbrium lineare* and *Arabis crassifolia*. *Turczaninowia* 15, 2: 37–43. [In Russian] Available from: http://old.ssbg.asu.ru/turcz/turcz_15_2_37-43.pdf (accessed 1 January 2018)
- Gilli, A. (1955) Neue Cruciferen aus Afghanistan und Iran. *Feddes Repertorium* 57 (3): 218–231.
- Hedge, I.C. (1968) Brassiceae. In: Rechinger, K.H. (Ed.) *Flora Iranica. Vol. 57.* Akademische Druck- u. Verlagsanstalt, Graz, pp. 33–61.
- Khosravi, A.R. (2003) A reconsideration of *Hesperis leucoclada* Boiss. (Cruciferae). *Iranian Journal of Botany* 10 (1): 15–23.
- Kiefer, M., Schmickl, R., German, D.A., Mandáková, T., Lysak, M.A., Al-Shehbaz, I.A., Franzke, A., Mummenhoff, K., Stamatakis, A. & Koch, M.A. (2014) BrassiBase: introduction to a novel knowledge database on Brassicaceae evolution. *Plant and Cell Physiology* 55 (1): e3.
<https://doi.org/10.1093/pcp/pct158>
- Linnaeus, C. (1753) *Species plantarum.* L. Salvius, Holmiae [Stockholm], 1200 pp.
<https://doi.org/10.5962/bhl.title.669>
- Polatschek, A. (2010) Revision der Gattung *Erysimum* (Cruciferae): Teil 1: Russland, die Nachfolgestaaten der USSR (excl. Georgien, Armenien, Azerbaidzan), China, Indien, Pakistan, Japan und Korea. *Annalen des Naturhistorischen Museums in Wien, B* 111: 181–275. Available from: <http://www.jstor.org/stable/41767461> (accessed 1 January 2018)
- Schulz, O.E. (1936) Cruciferae. In: Engler, A. & Harms, H. (Eds.) *Die natürlichen Pflanzenfamilien. Vol. 17B.* Verlag von Wilhelm Englemann, Leipzig, pp. 227–658.
- Tan, K. & Suda, J. (2002) *Hesperis* L. In: Tan, K. & Strid, A. (Eds.) *Flora Hellenica. Vol. 2.* A. R. G. Gantner Verlag K. G., Ruggell, pp. 152–155.
- Tchichatscheff, P.A. (1860) *Asie Mineure: description physique, statistique et archéologique de cette contrée. Troisième partie: Botanique. Vol. I.* Gide, Paris, LVI + 484 pp.
<https://doi.org/10.5962/bhl.title.12040>
- Warwick, S.I., Sauder, C.A., Al-Shehbaz, I.A. (2006) Molecular phylogeny, morphology and cytological diversity of *Sisymbrium* (Brassicaceae). In: Sharma, A.K. & Sharma, A. (Eds.) *Plant Genome: Biodiversity and Evolution. Phanerogams (Angiosperm – Dicotyledons).* Vol. 1. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi with Science Publishers, USA, pp. 219–250.
- Warwick, S.I., Mummenhoff, K., Sauder, C.A., Koch, M.A. & Al-Shehbaz, I.A. (2010) Closing the gaps: Phylogenetic relationships in the Brassicaceae based on DNA sequence data of nuclear ribosomal ITS. *Plant Systematics and Evolution* 285 (3–4): 209–232.
<https://doi.org/10.1007/s00606-010-0271-8>
- Zohary, M., Heyn, C.C. & Heller, D. (1980) *Conspectus florum orientalis. An annotated catalogue of the flora of the Middle East. Vol. 1.* The Israel Academy of Sciences and Humanities, Jerusalem, 107 pp.