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Notes on taxonomy and nomenclature of *Chenopodium acerifolium* and *C. betaceum* (*C. strictum* auct.) (Chenopodiaceae)

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Abstract

Andrzejowski described in 1862 three species of *Chenopodium* from Ukraine. The standing lectotype (LE) of *C. acerifolium* was designated by Sukhorukov in 2014; it is represented by a single plant with a few cauline leaves, but without fruits. As a consequence, it is not properly diagnostic of and representative for the species according to its current concept in *Chenopodium*. An epitype is proposed here (Art. 9.8 of *ICN*), which is a specimen from the Besser collection at KW annotated by Andrzejowski, with a handwritten original description on the label. The first effective lectotypification of *C. acerifolium* has been done by Dvořák in 1987, based on a specimen from KW at that time sent on loan to BRNU. Unfortunately, this specimen is probably lost (not traced in KW and BRNU) but, if found, should be considered the non-supersedable lectotype. Lectotypes are designated also for *C. betaceum* and *C. divaricatum*. The name *C. betaceum* should be applied to most of European and western Asian plants currently called *C. strictum sensu auct*. The true *C. strictum* Roth belongs to a group of insufficiently known taxa from India and adjacent areas, and is not closely related to *C. betaceum*. The identity of *C. divaricatum* remains obscure. This name is definitely not a synonym of *C. ficifolium* (as it was suggested by Iljin) but might be an earlier name for *C. suecicum*.

Key words: Chenopodiaceae, *Chenopodium*, nomenclature, taxonomy, typification

Introduction

Antoni Andrzejowski (1785–1868) described three species of *Chenopodium* Linnaeus (1753: 218), i.e. *C. acerifolium* Andrz., *C. betaceum* Andrz., and *C. divaricatum* Andrz. (Andrzejowski 1862: 132), all reported from Ukraine (however, a few specimens were probably also collected in the territory of the present-day Republic of Moldova). His species were rarely recognized from the 19th century and to the first half of the 20th century, being mentioned in just a few publications of that period (e.g., Trautvetter 1884: 124–125, Gürke 1897: 137), mostly as taxa of uncertain identity and obscure affinity, or as possible synonyms of *C. album* Linnaeus (1753: 219). However, at least two out of the three taxa of Andrzejowski's *Chenopodium* are in fact good and distinct species and their names have priority over other names often applied to these entities. Iljin (1952) was the first author who correctly established the identities of *C. acerifolium* and *C. betaceum*, and he accepted these long-forgotten species names, although only his conclusion on the true identity and taxonomic status of *C. acerifolium* was widely accepted in later publications. The proper identification and typification of these two names are especially important because these species occasionally form natural hybrids, as we demonstrated (Feodorova *et al*. 2017) using morphological, cytogenetic, and molecular evidence. The presence of such hybrids was noted by Mosyakin already in the 1990s (Mosyakin 1996, 2012; see also discussion in Uotila & Lomonosova 2016) and the provisional name "*C.* × *kioviense*" was applied to these plants in Mosyakin's collections at KW (*in schedae*) and by Feodorova *et al*. (2017), who reported our preliminary results (the formal validation of the name of that hybrid is under preparation). These results challenge the conclusion on extreme rarity (at least at present) of natural hybrids in *Chenopodium* (Mandák *et al.* 2012, Krak *et al*. 2016). However, almost unlimited hybridization patterns suggested and accepted for the *C. album* aggregate by some authors (especially Dvořák 1984a, 1984c, 1986a, 1986b, 1987, 1989, 1993, 1994 etc.) is also an exaggeration, and thus the truth lies somewhere between these extremities.

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In view of the continued efforts aimed at untangling the complex phylogenetic relationships and current processes of microevolution in *Chenopodium sensu stricto*, and especially in crop species and the group of taxa often referred to as the aggregate of *C. album sensu latissimo* (see, e.g., Fuentes-Bazan *et al*. 2012a, 2012b, Mandák *et al*. 2012, Kolano *et al*. 2015, 2016, Krak *et al*. 2016, Feodorova *et al*. 2015, 2017, Walsh *et al*. 2015, Jarvis *et al*. 2017 etc.), proper and precise identification of the plants involved in such studies becomes important. However, there are indications that at least some voucher specimens were either identified in a wide sense or sometimes misidentified. The proper application of names in botanical nomenclature is achieved by means of nomenclatural types (see McNeill *et al.* 2012), and thus proper typification of taxa of *Chenopodium* is crucial not only for achieving reliable taxonomy of the group but also for ongoing molecular phylogenetic and evolutionary studies, which should be complemented by morphological, ecological, biogeographical and other evidence.

Material and methods

Plant material was studied mainly in KW, G, K, LE, MO, US, and in some other herbaria (here and below, herbarium acronyms are given according to *Index Herbariorum*, Thiers 2017–onward). High-resolution digital images of selected specimens were consulted using available online resources (mainly JSTOR Global Plants database: https://plants.jstor.org/). Standard methods of herbarium taxonomy and plant morphology were used, as well as field observations in Ukraine and some other countries. Abbreviations of names of authors follow IPNI (2017–onward).

Results and discussion

Chenopodium acerifolium*: remaining problems with taxonomy and distribution*

Chenopodium acerifolium is a psammophytic species that occurs mainly in sandy alluvial habitats along large rivers of Eastern Europe and adjacent parts of Asia (Iljin 1952, Mosyakin 1996, 2012, Uotila & Lomonosova 2016 etc.), while it is less common in sandy ruderal habitats. However, Uotila & Lomonosova (2016) treated *C. acerifolium* in a rather wide sense. My opinion is that in central and northeastern parts of Europe and in Siberia *C. acerifolium sensu stricto* is probably replaced, at least partly, by other similar and related species or subspecies. In particular, the plants from the Baltic Sea area [*C. klinggraeffii* Aellen (1929b: 159) *sensu stricto*] seem to differ from the typical Ukrainian plants of *C. acerifolium* in having fruits slightly different in size, as well as in some other characters (Mosyakin 1996), but the taxonomic value of these minor morphological differences remains obscure at present. Uotila & Lomonosova (2016) also included in *C. acerifolium* the northern Siberian plants that were sometimes accepted (at least in part) by earlier authors under the name *C. jenissejense* Aellen & Iljin (in Iljin & Aellen 1936: 873). However, Uotila & Lomonosova (2016) lectotypified the latter name with a specimen of *C. karoi* (Murr 1923: 97) Aellen (1929b: 149), thus making *C. jenissejense* its synonym (Arts. 7.2 and 7.10 of *ICN*, McNeill *et al*. 2012). Consequently, if the Siberian plants evidently related to *C. acerifolium sensu stricto* are recognized as an infraspecific entity of *C. acerifolium* or as a separate species, there is no name currently available for them.

The records of *C. acerifolium* from North America (Weber 1966, Weber & Wittmann 1992; see also discussion in Clemants & Mosyakin 2003) and Saudi Arabia (Al-Turki & Ghafoor 1996) are clear misidentifications. The description and drawings by Al-Turki & Ghafoor (1996: 201–203, Fig. 5 A–E) leave no doubt that the plant reported from Saudi Arabia does not belong to *C. acerifolium*. On the basis of the acute-serrate margins of triangular leaves in the depicted plant and the keeled seeds mentioned in the description, it might be some form of *Chenopodiastrum murale* (Linnaeus 1753: 219) S. Fuentes, Uotila & Borsch (in Fuentes-Bazan *et al*. 2012b: 14). The description in Weber (1966: 6), who reported for his plants from Colorado the presence of "strongly pitted seed-coat", rather indicates *C. berlandieri* Moquin-Tandon (1840: 23). Indeed, some forms of *C. berlandieri* can be superficially similar to *C. acerifolium* in their leaf shape and general appearance. A field photograph (made by Matt Lavin, Montana State University, Bozeman, Montana, USA) of one of such North American forms was even used to illustrate "*C. album*" in Wikipedia (https://en.wikipedia.org/wiki/Chenopodium#/media/File:Chenopodium_album_(4032134406).jpg). Additional images made by Lavin in the same locality (available from Flickr: https://www.flickr.com/photos/plant_diversity/4032135322/; https://www.flickr.com/photos/plant_diversity/4032134406/; https://www.flickr.com/photos/plant_diversity/4032133918/ etc.) also suggest that these plants are probably to be identified as *C. berlandieri*. However, a few specimens of plants

similar to the Siberian "*C. acerifolium*" (*C. jenissejense auct*.) are known from Alaska (Clemants & Mosyakin 2003: 298), but their real identity cannot be positively confirmed from the available scarce material.

Dvořák (1987: 562) concluded that *C. acerifolium* is "a taxon of hybrid origin". He further stated that "[a]ccording to the morphological characters and to the frequency polygon of the p. g. [pollen grains—S.M.] …there participate in the development of this species: *Chenopodium album* L., *C. diversifolium* (Aellen) Dvořák, *C. pedunculare* Bertol., *C. striatiforme* J. Murr, *C. suecicum* J. Murr. A crossing of a fairly frequent in nature *Chenopodium suecicum* × *subhastatum* with *Chenopodium striatiforme* J. Murr (or rather with *Chenopodium* × *striatialbum* Dvořák) probably takes place". These assumptions contradict our present knowledge of *C. acerifolium* (see Feodorova *et al*. 2015, 2017). This species was reported as a tetraploid with 2n = 36 (see Dvořák 1987, Uotila & Lomonosova 2016 and references therein). However, there are preliminary indications that other chromosome races might be also present within the species group of *C. acerifolium* (see Feodorova *et al*. 2015, 2017). Thus, an ancient hybridization event (or events?) probably indeed contributed to the formation of the tetraploid *C. acerifolium sensu stricto*, but now it represents a lineage phylogenetically rather distinct from the typical *C. album* and other taxa mentioned by Dvořák (1987). Moreover, judging from the available images (Dvořák 1987) and a few duplicate specimens at KW, most probably some specimens reported by Dvořák (l.c.) as *C. acerifolium* from ruderal non-sandy habitats in former Czechoslovakia in fact represent only superficially similar forms of *C. album sensu latissimo*. The ruderal habitats reported by Dvořák (l.c.) for *C. acerifolium* in Brno, the Czech Republic ("on the margin of roads and by the fences in plant communities of *Polygonion avicularis* Br. Bl. 1931": Dvořák 1987: 571), definitely do not correspond to typical habitats of *C. acerifolium sensu stricto* in Ukraine and the European part of Russia.

Recently the species group of *C. acerifolium* and related taxa attracted much attention of taxonomists because of still remaining nomenclatural and taxonomic problems (see e.g., Uotila & Lomonosova 2016) and also because of recent hybridization events observed in nature with participation of this species (Mosyakin 1996, 2012, Feodorova *et al*. 2017).

Chenopodium acerifolium*: problems with earlier lectotypifications, and designation of the epitype*

Chenopodium acerifolium was recently lectotypified by Sukhorukov (2014: 227) based on a specimen from LE: "Lectotypus (Sukhorukov, designated here): [Украина] In ins. Borystheni Kioviae, ex herb. Besser (LE!)". This specimen is a single plant with a few cauline leaves and without fruits. Unfortunately, Sukhorukov (2014) seems to have not considered and discussed other original and representative specimens of *C. acerifolium* which at the time of his lectotypification were still preserved and available at KW, those kept on loan at H (see Uotila & Lomonosova 2016), as well as some other specimens from LE (at least two other specimens annotated at LE by Mosyakin in 1990 as possible iso(lecto)types).

The lectotype designation made by Sukhorukov (2014) was accepted by Uotila & Lomonosova (2016). However, all these authors failed to notice or recognize the effective lectotypification of the species already done by Dvořák (1987). His lectotypification was based on a specimen from KW at that time sent on loan to BRNU. This specimen was cited (as "Type: '*Chenopodium acerifolium* Andrz. … Ins. Borysthenicis, Kiev A. 38.' KW": Dvořák 1987: 562) and illustrated in Dvořák's article. He used the word "type" both in the text and on the photograph of the herbarium specimen (Dvořák 1987: 562, 563, Fig. 1). According to Art. 7.10 of *ICN* (McNeill *et al*. 2012), this evidently constitutes a valid lectotypification of the species name. Unfortunately, the specimen selected by Dvořák as the lectotype of *C. acerifolium* is probably now lost and I have not traced it in KW and BRNU. I sent a request for information to Jiří Danihelka (Curator of BRNU), who informed me that he was able to find in BRNU only a small envelope with a few loose seeds from the lectotype and "…this suggests to me that the specimen had been sent back to Kyiv, indeed. Still, I cannot guarantee this because it may be filed by mistake anywhere in one of more than 100 boxes with *Chenopodium* specimens [of Dvořák's collection—S.M.]. Apart from these fragments, there are no specimens from abroad labeled as *C. acerifolium* here at BRNU" (J. Danihelka, pers. comm. dated 13 September 2016). There are records at KW indicating that some specimens sent by Dvořák from BRNU have been received once. Checking of this information demonstrated that those were duplicates of specimens collected and identified by Dvořák. No positive information about the return of the loan has been traced. Probably the loan of KW specimens of *C. acerifolium* was sent back to KW from BRNU, but either has been lost in mail or arrived to Kiev and was misplaced in the vast collections of KW. If found (in KW or BRNU), the specimen selected by Dvořák should be considered the non-supersedable lectotype of *C. acerifolium*.

It is not evident from the label of the lectotype selected by Sukhorukov (2014) if the plant was actually collected or identified by Andrzejowski. The specimen has only a curatorial label (definitely not by hand of Andrzejowski or Besser) with the following text: "Herb. Fischer. *Chenopodium acerifolium* Andrz. In ins. Borystheni Kiioviae. Herb. W.

Besser". No collection date (year) and collector name are provided. Thus, there is no reliable proof that the specimen selected as the lectotype (Sukhorukov 2014) belongs to original material. However, the present wording of Art. 9.3 and Art. 9.19 of *ICN* (McNeill *et al*. 2012) provides no solid justification for the rejection of this lectotypification. It means that until the specimen selected as the lectotype by Dvořák (1987) is found, the selection of a lectotype by Sukhorukov, unfortunately, should stand.

As indicated above, this specimen from LE lacks fruits and "is only flowering" (Uotila & Lomonosova 2016: 235). However, morphological characters of fruits are crucial for taxonomy of *Chenopodium*, as it was emphasized by many authors (see e.g., Iljin & Aelen 1936, Aellen 1960–1961, Sukhorukov & Zhang 2013, Sukhorukov 2014). Considering the possible presence of several taxa (segregate species and probably also infraspecific entities) and possible hybrids in the group containing *C. acerifolium*, well-developed fruits are important for precise identification of the plants, especially those considered as type specimens. Thus, in my opinion, the plant selected as a lectotype by Sukhorukov (2014) is not properly diagnostic of and representative for the species. Consequently, the epitype is proposed here following Art. 9.8 of *ICN* (McNeill *et al*. 2012), a specimen from the Besser memorial collection at KW collected and annotated by Andrzejowski, with a handwritten original description on the label.

Chenopodium acerifolium Andrzejowski (1862: 132).

Lectotype[1] (designated by Sukhorukov 2014: 227):—UKRAINE: City of Kyiv (Kiev), islands of the Dnipro (Dnieper) River [probably Trukhaniv Island—S.M.], "Herb. Fischer. *Chenopodium acerifolium* Andrz. In ins. Borystheni Kiioviae. Herb. W. Besser" (LE!, s.n.).

Epitype (designated here): KW-001002780! (Fig. 1; image of the epitype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.kw001002780); **isolectotype:** KW-0010027781! (image of the isolectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.kw001002781).

Protologue:—"ad Hyp. Savrań, in insulis Borysthenicis Kief" [now Savran' (Саврань in Ukrainian) on the Southern Buh River (Hypanis in Latin, a name of Greek origin; Південний Буг in Ukrainian) in Savran' District, Odesa (Odessa) Region; and the City of Kyiv (Київ in Ukrainian)].

= *Chenopodium album* L. var. *hastatum* Klinggraeff (1866: 130) ≡ *C. hastatum* (C. Klinggr.) Murr (1902: 360), *nom. illeg.* (later homonym: Art. 53.1 of *ICN*) non *C. hastatum* Philippi (1860: 47) ≡ *C. album* L. subsp. *hastastum* (C. Klinggr.) Murr (1904: 291) ≡ *C. album* L. var. *klinggraeffii* Abromeit (in Abromeit *et al*. 1917: 712), *nom. illeg*. (Arts. 52.1 and 52.2 of *ICN*) ≡ *C. klinggraeffii* Aellen (1929b: 159).

Lectotype [designated by Uotila & Lomonosova 2016: 233: "Westpreussen, Montauer Spitze, Sept. 1850, *C.J. v. Klinggraeff* (G!, Herbarium Aellen, fragment, provided by Aellen with a note "*Typus*")"]:—POLAND: [Województwo Pomorskie, near Gdańsk] Cypel Mątowski (also Narożnik Mątowski, formerly Montauer Spitze) (G!).

Protologue:—"häufig an den Weichselufern!" (translation: "often on the banks of the Vistula!").

Notes:—For comparison, I provide here the published original description of *C. acerifolium* and descriptions on the labels of the epitype and isolectotype.

Published description (Andrzejowski 1862: 132): "Caete [a typo—should be "Laete", meaning "light [green]"—S.M.] virens, caule simplici, foliis rhombeis trilobis, acutis sinuato-dentatis summis, lanceolatis, subintegerrimis [misplaced comma—should be "*acutis sinuato-dentatis, summis lanceolatis, subintegerrimis*"—S.M.], racemis aphyllis, glomerulis densis, aphyllis, seminibus exiguis laevibus opacis; ad Hyp. Savrań, in insulis Borysthenicis Kief. Panicula stricta".

Labels, KW-001002780 (epitype): (Label 1, with description by Andrzejowski) "*Chenopodium acerifolium* Andrz. foliis rhombeis acutis trilobis dentatis, superioribus lanceolatis, spicis subaphyllis sinuato dentatis acutis, summis subintegerrimis lanceolatis, racemis laxis aphyllis erectis, seminibus laevibus ~~nitidis~~ opacis ["*nitidis*" crossed out in darker ink, "*opacis*" added—S.M.]. In insulis Kief 35 [1835—S.M.]". (Label 2, curatorial, not by Andrzejowski) "*Chenopodium acerifolium* Andrz. *C. albi* L. var.? Herb. univers. №6642. Circa Kioviam leg. Andrzejowsky, in insulis".

Label, KW-001002781 (isolectotype): "*Chenopodium acerifolium* Nob. laete virens, fol. rhombeis trilobis, sinuato dentatis acutis, summis subintegerrimis lanceolatis, racemis laxis aphyllis erectis, seminibus exiguis opacis laevibus. In insulis Kief 35 [1835—S.M.]".

[1] Apparently lost lectotype: "*Chenopodium acerifolium* Andrz. Ins. Borysthenicis, Kiev A. 38." (formerly in KW) (Dvořák 1987: 562).

FIGURE 1. Epitype of *Chenopodium acerifolium* Andrz. (KW-001002780!).

Chenopodium betaceum *and the problem of* C. strictum

It was commonly assumed by most authors (except Beaugé 1974, Gervais 1979, and a few others) that the name *Chenopodium strictum* was validly published in 1821 by Roth (1821: 180). However, this name was first validated in the volume no. 6 (published August–December 1920: see IPNI 2017–onward) of *Caroli a Linné... Systema Vegetabilium*… (ed. 15 bis, volumes 1–4 by Roemer & Schultes) (Schultes 1920: 264). Schultes ascribed the name to Roth, provided the Latin description, the provenance and collector ("*H.* [Habitat] *in India orientali*. B. *Heyne*"), highlighting that the description was provided in Roth's manuscript ("*Roth nov. pl. Spec. MSS*"). Finally he compared the new species with *C. lanceolatum* Muehlenberg ex Willdenow (1809: 291) by characters of leaf shape and with *C. album* by the inflorescence structure ("Quoad foliorum figuram proxime accedit ad *Ch. lanceolatum* Mühlenb.; quoad inflorescentiam vero ad *Ch. album*"). Roth (1821) provided an updated and expanded description of the species. It seems that the earlier date and place of valid publication of the name *C. strictum* (1820, not 1821) was first emphasized, at least in the 20th century, by Beaugé (1974) in his thorough historical overview of *C. album* and related taxa.

The name *Chenopodium strictum* Roth (in Schultes 1820: 264) is usually applied now to a tetraploid species (or, in a wide sense, to a group of species and/or infraspecific taxa) of the *C. album* (*sensu latissimo*) aggregate (Aellen & Just 1943, Aellen 1960–1961, Uotila & Suominen 1976, Uotila 1977, 1997, 2001a, 2001b, Skripnik 1987, Lomonosova 1992, Mosyakin 1996, 2003, 2012, Mosyakin & Fedoronchuk 1999, Clemants & Mosyakin 2003, Zhu *et al*. 2003, Iamonico 2010, Feodorova 2014, Sukhorukov 2014 etc.). Before 1929, if and when this species was accepted, it was usually mentioned in European publications under the name *C. striatum* (Krašan 1894: 255) Murr (1896: 32). However, Aellen (1929a) suggested that *C. striatum* is conspecific with *C. strictum*. He provided a few arguments in favor of his decision, but cited the opinion of Murr (1904), who commented that one of the species names listed by Moquin-Tandon (1849), for example, *C. strictum* or a doubtful species *C. virgatum*[2] Thunberg (1815: 143), might be "an older synonym" of his taxon (recognized by Murr in 1904 as a subspecies of *C. album*): "Es wird sich übrigens noch darum handeln festzustellen, ob *Ch. striatum* (Kraš.) nicht noch in einer der von Moquin-Tandon aufgeführten Arten, z. B. in sp. 6 *Ch. strictum* Roth oder in der zweifelharten sp. 62 *Ch. virgatum* Thunb. ein älteres Synonym besitzt" (Murr 1904: 223). However, on the same page (in a footnote) Murr also compared his *C. album* subsp. *striatum* to a North American taxon now usually accepted as a variety of *C. berlandieri* (Clemants & Mosyakin 2003): "Von den nordamerikanischen Formen kommt dem *Ch. striatum* das *Ch. Boscianum* Moq. mit länglich eiförmigen, grünen Blattern, stark rotstreifigen Stengeln und sehr glänzenden Samen nahe, teilt aber die Neigung zur Mikrophyllie mit der folgenden ssp." [the next subspecies was "ssp. *glomerulosum* Rchb." *sensu* Murr]; translation: "Of the North American forms, *Ch. striatum* is approached by *Ch. Boscianum* Moq. with oblong-ovate green leaves, strongly red-striped stems and very shining seeds, but [the latter] shares the tendency to microphylly with the following ssp." ["ssp. *glomerulosum* Rchb." *sensu* Murr—S.M.]).

Aellen's decision to synonymize *C. striatum* with *C. strictum* was soon accepted in many standard European floras and other publications (see e.g., Iljin & Aellen 1936: 64–65, Mansfeld 1939: 102), and the name *C. strictum* is now widely applied (in a wide or strict sense) to the Eurasian tetraploids related to the hexaploid *C. album* (see references above).

Several segregate tetraploid species are also sometimes recognized in this group, such as *C. striatiforme* Murr (1901: 51) [≡ *C. strictum* Roth subsp. *striatiforme* (Murr) Uotila (1977: 199)], *C. glaucophyllum* Aellen (1929b: 155) [≡ *C. strictum* subsp. *glaucophyllum* (Aellen) Aellen in Aellen & Just (1943: 67) ≡ *C. strictum* var. *glaucophyllum* (Aellen) Wahl (1954: 38)], and *C. novopokrovskyanum* (Aellen) Uotila (1993: 192) [≡ *C. album* subsp. *novopokrovskyanum* Aellen (1938: 3)]. Dvořák (1984a, 1984b, 1989, 1993 etc.) recognized in Europe several other segregate species and supposed hybrids, but his extreme "splitter's" approach was followed by only a few botanists.

However, the application of the name *C. strictum* to a rather widespread Eurasian species (and probably to its relatives in North America, if they are indeed native there) was soon considered at least questionable. Iljin & Aellen (1936: 65) already noted that the plants of *C. strictum* occurring in the former USSR differ from typical Indian plants in having terminal spicate partial inflorescences arranged in a pyramidal general inflorescence. Because of that they proposed the new combination *C. strictum* subsp. *striatum* (Krašan) Aellen & Iljin (in Iljin & Aellen 1936: 65) [see also Brenan (1964: 94), who accepted this taxon as *C. album* subsp. *striatum* (Krašan) Murr (1904: 222)].

[2] The taxonomic identity of *C. virgatum* Thunb. (described from Japan) still remains insufficiently understood. Judging from the digital images (including close-ups of the inflorescence provided by Mats Hjertson) of the holotype (UPS, Herb. Thunberg 6444), the plant is definitely not a member of *Chenopodium* sect. *Acuminata* Ignatov (1988: 18) and is not conspecific with *C. vachellii* Hooker & Arnott (1838: 269) because it lacks the characteristic multicellular tubular hairs on inflorescence branches (see also discussion in Mosyakin & Iamonico 2017). Instead, it belongs to the *Chenopodium album* aggregate, as it was suggested by Aellen (1960–1961), but is morphologically different from the species accepted here as *C. betaceum*. In recent publications (e.g., Uotila 2001b, Sukhorukov 2014) *C. virgatum* is recognized as a separate species distinct from both *C. album* and "*C. strictum*".

Mosyakin (1996: 41–42), judging from the available type fragment and the protologue, emphasized that the name *C. strictum* may in fact belong to one of the taxa or hybrids of the *C. album* aggregate and because of that it is quite possible that the correct name for the East and Central European species is *C. betaceum*, which is definitely applicable to the European plants. Sukhorukov (2014) noted that the morphological diversity of Indian taxa belonging to the *C. album* aggregate is very different from the patterns observed in Europe and also concluded that it is quite possible that "for European populations the priority name might be *C. betaceum*" [in Russian: "Не исключено, что для европейских популяций приоритетным названием может быть *C. betaceum*" (Sukhorukov 2014: 229)]. Dvořák (1989, 1993), who preferred to treat *C. strictum*, *C. striatum*, *C. striatiforme* and several other taxa as separate species and interspecific hybrids, assumed that *C. strictum* "is a hybridogenous species in whose genotype there participate *C. album* L. <…>, *C. diversifolium* (Aellen) Dvořák, *C. eustriatum* Dvořák and *C. striatiforme* J. Murr" (Dvořák 1989: 198). Dvořák (1986) added a note on the herbarium specimen GZU-000273164 (see below): "*Chenopodium striatum* (Krašan) J. Murr ist nicht identisch mit *Chenopodium strictum* Roth" (see JSTOR Global Plants 2017–onward).

The type of *Chenopodium strictum* (the standing lectotype, designated by Dvořák 1989: 201; a fragment of a specimen that was originally in B but was destroyed in 1943 during World War II) has a much-branched cymose-paniculate inflorescence superficially similar to inflorescences of *C. pedunculare* Bertoloni (1837: 32; see also Dvořák 1984c, Walter 1995, Paśnik 1999) or *C. lanceolatum*, which are hexaploid taxa ("microspecies", or infraspecific entities, or just morphotypes?) of the *C. album* aggregate. A very similar much-branched cymose inflorescence is also peculiar to the original Linnaean specimen (LINN 313.9) of *C. viride* Linnaeus (1753: 219); this Linnaean name is also considered to be applicable to a form of the *C. album* aggregate (see Uotila 1978) but in the past it was often misapplied to the diploid species now known as *C. suecicum* Murr (1902: 341). In contrast, type specimens of *C. betaceum* and *C. striatum*, as well as most of other European and western Asian specimens usually identified as "*C. strictum*", have linear ("spicate") inflorescences, normally with moniliform arrangement of glomerules.

Inflorescences similar to those of the type of *C. strictum* also occur in some other Indian plants, e.g. in *C. purpurascens* Jacquin [1776–1777: 43, tab. 80; lectotype designated by Dvořák 1994: 127 (Fig. 10), 128]. It is worth noticing that Murr (1904: 223) cited the name "*C. purpurascens* β [var.] *lanceolatum* Moq.-Tand." (Moquin-Tandon 1849: 67) in synomymy of his *C. album* subsp. *striatum*. In turn, *Chenopodium purpurascens* was sometimes considered (most probably erroneously) as conspecific with *C. giganteum* D. Don (Don 1825: 75). However, Sukhorukov & Kushunina (2014: 10, 18) claimed that "*C. bengalense* seems to be an older name for the taxa known as *C. giganteum* or *C. album* subsp. *amaranticolor*". The lectotype of *C. bengalense* (designated by Sukhorukov & Kushunina 2014: 18; Fig. 5 on page 19) also has upper leaves very similar in shape to those of the type of *C. strictum*. The standing lectotype of *C. strictum* in its inflorescence branching habit is also more similar to the lectotype of *C. giganteum* (designated by Sukhorukov & Kushunina 2014: 18) than to European plants. At least two additional species described from India (Pandeya *et al*. 1998, Pandeya & Pandeya 2003) may be also related to *C. strictum*, but their real identity remains obscure because their published descriptions and illustrations are insufficient for positive identification.

Sukhorukov & Kushunina (2014: 18) cited the combination *C. bengalense* as validated in 1821. However, in 1821 the name "Chenopodium bengalense. *Spielm*." (Steudel 1821: 92) was cited only in synonymy of the accepted name *Atriplex bengalensis*: the name in *Chenopodium* was thus not validly published (Art. 36.1 of *ICN*, McNeill *et al*. 2012). Steudel (1840) accepted the name *C. bengalense* (as "*benghalense*") in the 2nd edition of his *Nomenclator*, so the name should be cited as *C. bengalense* (Lam.) Spielm. ex Steudel (1840: 348) [*Atriplex bengalensis* Lamarck (1783: 276)]. Despite several relevant publications (e.g., Aellen 1929c, Beaugé 1974, Dvořák 1992, 1994, Sukhorukov & Kushunina 2014), the taxonomy and identity of the mentioned presumably native Indian and/or Southeast Asian taxa of *Chenopodium* remain highly problematic, and further studies are necessary. The real identity of *C. strictum* (which at present remains *nomen dubium*) also remains obscure and will be probably clarified after in-depth studies of *Chenopodium* from India and adjacent regions.

Thus, the inflorescence branching pattern and leaf shape observed in the type of *Chenopodium strictum* are not typical for *C. betaceum* or most other plants of Eurasian "*C. strictum*". It should be also emphasized that most of Eurasian plants of *C. betaceum* (incl. *C. striatum*) have striate stems and branches, with stripes of deep beet-red color (in old herbarium specimens the stripes often become dark olive green). This prominent feature, which is reflected in the epithets "*betaceum*" (similar to *Beta* in its color) and "*striatum*" (striped), is not well manifested in the plant fragments of the standing lectotype of *C. strictum*. The absence of mature fruits in that lectotype also hampers its precise identification. In contrast, the original specimen (lectotype) of *C. betaceum* reported below leaves no doubt that it is conspecific with *C. striatum* and not conspecific with *C. strictum*, as it has been already concluded by Iljin.

In his treatment of *Chenopodium* for the *Flora of the Ukrainian SSR*, Iljin (1952: 306–308) accepted *C. betaceum* and placed *C. striatum* in its synonymy. He commented that *C. betaceum* is a "good southern species of goosefoot"

[in Ukrainian: "Добрий південний вид лободи…" (Iljin 1952: 308)] that was only recently recognized in Western Europe under the name *C. striatum*; he further commented that "now, however, as demonstrated by the study of Andrzejowski's herbarium kept in Kiev, the priority in establishing and recognizing this species should be credited to that author, who described it under the name *C. betaceum* Andrz. already in 1862" [In Ukrainian: "…тепер, як показало вивчення гербарію Андржієвського, що зберігається в Києві, пріоритет на встановлення і виділення цього виду треба залишити за цим автором, який описав його під назвою *C. betaceum* Andrz. ще в 1862 р." (Iljin 1952: 308)]. He also mentioned that European plants differ from Indian *C. strictum* mainly in inflorescence characters. Iljin further suggested that *C. betaceum* is probably not a native European plant and hypothesized that it may have originated in the eastern parts of the "Ancient Mediterranean region". In Soviet historical biogeography that term, as outlined by Popov (1963, reprinted in 1983) (*Область Древнего Средиземья* in Russian, which can be also translated as the "Ancient Middle-Earth" because the term *Средиземье* but not *Средиземноморье* was used), covers not only the Mediterranean area but also the Irano-Turanian region, the zone that can be also called the Tethyan area (of the ancient Tethys and Paratethys oceans). It means that Iljin (l.c.) placed the hypothetical native (or ancestral?) range of *C. betaceum* somewhere in a wide zone stretching from the Eastern Mediterranean to Central Asia.

Historical and geographical considerations also indicate that the Indian plant originally described by Roth as *C. strictum* is not identical with the European and western and Central Asian plants since the time of publication of Aellen's article (Aellen 1929a) and until recently commonly called "*C. strictum*". Benjamin Heyne (1770–1819) worked and collected plants mainly in the southern regions of India (Heyne 1814, Burkill 1953, Stewart 1982, Kochhar 2013). He arrived to Tranquebar (Tharangambadi, Tamil Nadu state) in 1793 and then visited and/or stayed in Madras (Chennai, Tamil Nadu), Bangalore (Bengaluru, Karnataka state), Mysore (Mysuru, Karnataka) and some other places (Kochhar 2013: 2), traveled "from Cuddapa [Kadapa (formerly known as Cuddapah), Andhra Pradesh state] to Hydrabad [Hyderabad, Andhra Pradesh]" and "from Bengalore [Bangalore or Bengaluru, Karnataka] to Trichinopoly [Tiruchirappalli, Tamil Nadu]" (see Heyne 1814: 461–462), and died in Madras in 1819. It is documented that in 1813 Heyne "passed on a considerable number of plant specimens to the German botanist Albrecht William [Wilhelm —S.M.] Roth (1757–1834), who published an account of 200 of them in *Novae plantarum species praesertium Indiae Orientalis*" (Kochhar 2013: 12). For almost all new taxa described by Roth (1821), no geographical information has been provided except "India Orientalis" (meaning India in the sense of the [British] East India Company, as opposed to the West Indies of the New World, and not to be interpreted as "eastern parts" of India): "there is scarcely a single precise record of locality from back to back of the book" (Burkill 1953: 859). We anyway can thus safely assume that the specimens of *Chenopodium* provided by Heyne to Roth were collected somewhere in southern India. However, I am not aware of any reliable records or herbarium specimens from southern India that are referable to Eurasian plants now usually called "*C. strictum*" (following Aellen 1929a). If such plants ("*C. strictum*" *sensu* Aellen and many other authors who followed him) indeed occur in India, they are most probably restricted to the northern regions of the country, closer to the border with Pakistan (see Uotila 2001a). It is worth noticing that *C. strictum* (in either sense) is not reported in recent treatments of Chenopodiaceae of Nepal (Sukhorukov & Kushunina 2014) and India (Paul 2012); however, in the latter publication it is definitely one of several glaring omissions. Thus, historical and geographical data also testify (although indirectly) that the type of *C. strictum* (in the strict sense) collected by Heyne and provided by him to Roth most probably represents some local southern Indian taxon of the *C. album* aggregate, but not the plant called "*C. strictum*" in recent literature.

In my opinion, the best solution would be to stop the misapplication of the name *C. strictum* to European and some Asian tetraploid plants and to restore the name *C. betaceum*, as it was proposed by Iljin (1952; see above), similar to what happened with the restored (also by Iljin) and now almost universally accepted name *C. acerifolium*. Alternatively, one might argue that *C. strictum* was a name used widely since 1929 and until recently, and because of that its recent usage might deserve to be preserved, e.g. through its conservation with a conserved neotype. However, cases of similar abandonment of previously widely accepted names happened in *Chenopodium* many times. For example, the Linnaean names *C. viride* and *C. serotinum* Linnaeus (1756: 12) were commonly misapplied before for the taxa now properly known as *C. suecicum* Murr and *C. ficifolium* Smith (1800: 276), respectively. Thus, the name *C. strictum* should again join a long list of obscure names of uncertain taxonomic identity that were proposed in *Chenopodium* in the 18th and 19th centuries and which are now not in current use, such as *C. paganum* Reichenbach (1832: 579), *C. patulum* Roth (1821: 181), and many others (for more examples and a historical overview of some of those names, see Beaugé 1974).

Chenopodium betaceum Andrzejowski (1862: 132), as "*betaccum*" [typographical error correctable under Art. 60.1 of *ICN*: McNeill *et al*. 2012; Andrzejowski (see below) evidently compared his new species to *Beta* Linnaeus (1753: 222)].

Lectotype (designated here):—UKRAINE: Nizhyn (Ніжин in Ukrainian), Nizhyn District, Chernihiv (also Chernigov; Чернігів in Ukrainian) Region (KW-001002779!, Fig. 2, image of the lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.kw001002779).

Protologue:—"In arenosis humidis Savrań, Krasnenkie, in insulis Borysthenicis" [now Savran' (Саврань in Ukrainian) in Savran' District, Odesa (Odessa) Region; and Krasnen'ke (Красненьке in Ukrainian), see below; on the Dnipro (Dnieper) islands (probably in the former Kiev or Chernigov Governorate)].

= *Chenopodium album* L. var. *striatum* Krašan (1894: 255) ≡ *C. striatum* (Krašan) Murr (1896: 32) ≡ *Chenopodium album* L. subsp. *striatum* (Krašan) Murr (1904: 222) ≡ *C. strictum* Roth subsp. *striatum* (Krašan) Aellen & Iljin (in Iljin & Aellen 1936: 35).

Lectotype (designated by Dvořák 1989: 198, 199, Fig. 1):—AUSTRIA: Steiermark (Styria), Graz. (GZU-000273164, image of the lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.gzu000273164).

Protologue:—"…von allen ist *striatum* in und bei Graz die häufigste" (translation: "…of all [varieties—S.M.], *striatum* is most frequent in and near Graz").

Misapplied name:

Chenopodium strictum Roth (in Schultes 1920: 264; updated and expanded description: Roth 1821: 180).

Lectotype (designated by Dvořák 1989: 198, 201, Fig. 3):—INDIA: "Herbarium Paul Aellen. *Chenopodium strictum* Roth (Orig.). India orientalis. 1814. Benj. Heyne" (G!).

Protologue:—"*H. in India orientali*. B. *Heyne*".

Note:—Judging from available information, there were several original specimens of *Chenopodium betaceum* in KW. At least, Iljin (1952: 308) mentioned the specimens from KW collected by Andrzejowski in the present-day Kiev or Cherkasy (Cherkassy) Region (on the Ros' River) and in Odessa Region (Savran' and Krasnen'ke). Probably some of these specimens were lost (sent on loan?). At present we were able to locate in KW only the specimen cited above, which was part of the loan recently returned from H (see Uotila & Lomonosova 2016). On the basis of the label data, this specimen was collected in Nizhyn, and this locality is not mentioned in the protologue. However, the article by Andrzejowski was mainly about the plants of the Podolian Governorate (Province) (*Подольская губерния* in Russian) of the former Russian Empire and some parts of adjacent governorates/provinces (mainly those of Kiev and Odessa), and thus specific localities were mainly cited for these areas. The Podolian Governorate covered the territory which now mainly belongs to Khmel'nytsky, Vinnytsya (Vinnitsa), and parts of Odessa and Mykolayiv administrative regions (*oblasts*) of Ukraine, plus eastern parts of the present-day Moldova. Nizhyn in those times was within Chernigov Governorate (*Черниговская губерния* in Russian), on the left bank of the Dnieper, bordering Kiev Governorate in the west. Probably Andrzejowski did not mention the locality in Nizhyn because it was far outside the area covered by his *Enumeratio* (Andrzejowski 1862).

There are three towns and villages with the name Krasnen'ke within the former Podolian Governorate and adjacent areas: (1) on the Vyazovytsya River in Illintsi District, Vinnytsya Region of Ukraine, (2) in Kryve Ozero District of Mykolayiv Region of Ukraine, and (3) in Rybnitsa (Rîbnița in Moldovan/Romanian) District of Moldova. It was uncertain which one has been mentioned by Andrzejowski in the protologue. Iljin (1952) assumed that it was the village in Kryve Ozero District and reported it as located in Odessa Region. However, judging from its proximity to Yagorlyk (Iagorlîc) and Savran', which are mentioned several times by Andrzejowski (1862), it was Krasnen'ke (Crasnencoe in Moldovan/Romanian) of Rîbnița District in Moldova. Moreover, Andrzejowski collected much in the area between the Southern Buh and the Dniester rivers and provided information on selected visited localities (Andrzejowski 1823, 1830), which also points to the place in Moldova, near the present-day border with Ukraine.

All things stated, despite the fact that Nizhyn has not been mentioned in the protologue, the specimen selected here as the lectotype is definitely part of original material. According to Art. 9.3 of *ICN* (McNeill *et al*. 2012), original material comprises, among other elements, "(a) those specimens and illustrations (both unpublished and published either prior to or together with the protologue) upon which it can be shown that the description or diagnosis validating the name was based".

The lectotype designated here (KW-001002779) was collected in Nizhyn in 1839, well before the date of the protologue (publication date: 1862). The label of this specimen contains the description that is almost identical to the protologue. Certainly, that handwritten description was used by Andrzejowski when he was preparing his validating description. For comparison, I provide here both these texts.

FIGURE 2. Lectotype of *Chenopodium betaceum* Andrz. (KW-001002779!).

Published description (Andrzejowski 1862: 132):—"rubens, caule simplici erecto, foliis oblongo-hastatis, obtusis, dentatis, summis oblongis integerrimis, paniculae strictae oligoductae glomerulis densis sessilibus aphyllis, seminibus laevibus nitidis. Habitus Betae vulgaris; in arenosis humidis Savrań, Krasnenkie, in insulis Borysthenicis".

Label (KW-001002779):—"Nieżyn 1839. *Chenopodium betaceum* Nob. fol. hastato-oblongis subdentatis, summis oblongis integerrimis, glomerulis densis sessilibus, spicis aphyllis paniculatis, sem. nitidis laevibus. Habitus Betae maritimae, at robustior!".

Chenopodium divaricatum*: still in the mist*

The invalid name "*Chenopodium divaricatum*" (*nomen nudum*, Art. 38.1 of *ICN*, McNeill *et al*. 2012) was mentioned by Fischer already in 1808 and 1812, in both cases without any description or diagnosis (Fischer 1808: 23; Fischer 1812: 15). Thus, the name *C. divaricatum* proposed by Andrzejowski is valid and legitimate.

The name *Chenopodium divaricatum* was rarely mentioned in botanical publications, except for some nomenclatural lists (e.g., Trautvetter 1984). No opinion on its identity was expressed by other authors except Iljin (1952), who listed that name in synonymy of his "*C. serotinum* L.", which was in fact *C. ficifolium* Smith. However, the original plants of Andrzejowski are definitely not conspecific with *C. ficifolium*; they evidently belong to the *C. album* aggregate.

The two currently available specimens have a few remaining cauline leaves and fruits mostly fallen out, which hampers their morphology-based identification. Morphologically the plants resemble some forms of the *C. album* aggregate; the specimens such as those were reported earlier as *C. laciniatum* Murr [1903: 9, *nom. illeg*., *non* Thunb. *nec* Roxb. (Art. 53.1 of *ICN*, McNeill *et al*. 2012); see Dvořák 1990], for which the replacement name *C. dvorakianum* Mosyakin (1995: 459) was proposed. However, it is also possible that the specimen KW-001002777 is related to or even conspecific with *C. suecicum*. The plant on the sheet KW-001002778 is morphologically similar to *C. betaceum* (but the diagnostic cauline leaves are absent). Further comparative micromorphological and probably also molecular studies are needed to clarify the identity of the third species of *Chenopodium* described by Andrzejowski. The lectotype of this species is designated below.

Chenopodium divaricatum Andrzejowski (1862: 132).

Lectotype (designated here):—UKRAINE: Kherson (Херсон in Ukrainian), Kherson Region (KW-001002777!, image of the lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.kw001002777).

Protologue:—"ad sepis Jaorlik, Balta, Cherson" [now the Yagorlyk (Ягорлик in Ukrainian) River, a tributary of the Southern Buh, in Odesa (Odessa) Region of Ukraine and in Moldova; the settlement of Yagorlyk (Iagorlîc in Moldovan/Romanian) is located on that river in Iagorlîc District of Moldova; Balta (Балта in Ukrainian) in Balta District, Odesa Region; and Kherson].

Published description (Andrzejowski 1862: 132):—"caule altissimo ramosissimo, ramis divaricatis, foliis subuniformibus, oblongo-rhombeo-hastatis, subdentatis, summis subintegerrimis, paniculae patentissimae, cymis subaphyllis, glomerulis minimis sessilibus, seminibus nitidis foveolatis; 4–5 pedale, sordide-virens".

Labels (KW-001002777):—(Label 1) "*Chenopodium divaricatum* mihi. Cherson 1823". (Label 2) "*Ch. divaricatum* Nob. caulibus ramosiss. patentiss. foliis oblongo-hastatis [the word *rhombeo-* added above *oblongo-hastatis*] dentatis, summis subintegerrimis linearis, glomer. sessilibus, racemis paucifoliis paniculatis, sem. nitidis subfoveolatis. Chers. 1823. Hbr. Andrz."

Another specimen (KW-001002778!, image available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.kw001002778) has the following label: "*Ch. divaricatum* Nob.! sem. nitida excavato punct. Cherson ad vias in ipsae urbe descendendo ad portum 1823".

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