A nomenclatural survey of the genus Amaranthus (Amaranthaceae) 7: names published by Willdenow

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Source: Willdenowia, 50(1) : 147-155

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: https://doi.org/10.3372/wi.50.50114

Willdenowia
Annals of the Botanic Garden and Botanical Museum Berlin

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A nomenclatural survey of the genus *Amaranthus* (*Amaranthaceae*) 7: names published by Willdenow

Version of record first published online on 31 March 2020 ahead of inclusion in April 2020 issue.

Abstract: A nomenclatural study of 12 names and designations published by C. L. Willdenow was carried out. Two designations, "*Amaranthus incomptus*" (nomen nudum) and "*A. japonicus*" (pro synonymo), are not validly published. The ten validly published names are not yet typified except for *A. chlorostachys* Willd. Eight of the nine untypified names (*A. angustifolius* M. Bieb. ex Willd., *A. bicolor* Nocca ex Willd., *A. campestris* Willd., *A. inamoenus* Willd., *A. lateus* Willd., *A. polystachyus* Willd., *A. strictus* Willd. and *A. tenuifolius* Willd.) are lectotypified here on specimens preserved in the Willdenow Herbarium in Berlin (B), while the other name (*A. hecticus* Willd.) is lectotypified here on an illustration in Willdenow's *Historia Amaranthorum*. All the names in *Amaranthus* published by Willdenow are considered here to be heterotypic synonyms of currently accepted species names. The results obtained highlight how many *Amaranthus* species, especially in the past, were described on the basis of characters that have low or no taxonomic value, whereas morphological characters of the flowers have a high taxonomic value.

Key words: *Amaranthaceae*, *Amaranthus*, herbarium, nomenclature, synonymy, taxonomy, typification, valid publication, Willdenow

Article history: Received 14 October 2019; peer-review completed 4 February 2020; received in revised form 6 February 2020; accepted for publication 17 February 2020.

Citation: Iamonico D. 2020: A nomenclatural survey of the genus *Amaranthus* (*Amaranthaceae*) 7: names published by Willdenow. – Willdenowia 50: 147–155. doi: https://doi.org/10.3372/wi.50.50114

Introduction

Carl Ludwig Willdenow (Berlin, 22 August 1765 – 10 July 1812) was a German pharmacist and botanist. His interest in botany was kindled during his teenage years by his uncle, J. G. Gleditsch, when he started to accumulate his important herbarium. Willdenow was a member of the Berlin Academy of Sciences (since 1794) and Director of the Royal Botanic Garden at Schöneberg near Berlin (from 1801 until his death). Most of his collection has remained deposited at that institution (Stafleu & Cowan 1988: 298), now the Botanic Garden and Botanical Museum Berlin located in Berlin-Dahlem, herbarium code B (Thiers 2020+), or more specifically B-W for the Willdenow Herbarium. Willdenow's contribution to the knowledge of the family *Amaranthaceae* (sensu stricto) and the genus *Amaranthus* L. is important, especially concerning the treatments in his *Historia Amaranthorum* (Willdenow 1790) and his edition of *Species plantarum* (Willdenow 1805).

As part of ongoing nomenclatural investigations on all published names of *Amaranthus*, I present here my seventh contribution: concerning the names proposed by Willdenow. The six previous papers were on the Linnaean names (Iamonico 2014a, 2014b), the names linked to the Italian flora (Iamonico 2016a), *A. gracilis* Desf. and related names (Iamonico 2016b), names published by Moquin-Tandon (Iamonico 2016c) and names linked to the Australian flora (Iamonico & Palmer 2019).

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Material and methods

This research is based on analysis of the relevant Willdenow literature (Stafleu & Cowan 1988) and the examination of specimens deposited in the herbaria B-W, FI, G, LE and LINN (abbreviations according to Thiers 2020+). The names are listed alphabetically. In each case a currently accepted name is given, indicated in boldface. Specimens designated as lectotypes of *Amaranthus* names published by Willdenow in his *Species plantarum* are considered as part of the original material partly on the basis of the "Praefatio editoris" in the first volume of that work (Willdenow 1797: VII), where the author stated "Plantas Herbarii proprii, quas vel vivas (v.v.) vel siccas (v.s.) … vidi, adhibitis heic indicatis signis notavi, ut quisque viderit, quaenam vegetabilia ex aliorum descriptionibus descripta assumserim". However, this is only a guide, indicating that Willdenow saw at least one specimen, but not necessarily any particular specimen extant in B-W. More importantly, the labels on the folders containing the various lectotypes selected here are in the handwriting of Willdenow (H. W. Lack, pers. comm.), and therefore there is no reason to doubt that these specimens are original material for the corresponding names. When a choice is possible between a specimen and an illustration as the lectotype, and both agree with the current application of the name, the specimen is preferred because it potentially provides a larger number of characters (micromorphological, chemical, molecular, etc.; see Jarvis 2007: 21–22).

Results and Discussion

Three of Willdenow's works include new species of *Amaranthus*: *Historia Amaranthorum* (Willdenow 1790); volume 4 part 1 of Willdenow's edition (ed. 4) of *Species plantarum* (Willdenow 1805); and the *Supplementum* of *Enumeratio plantarum horti regii berolinensis* (Willdenow 1813).

Twelve new species names were published by Willdenow, of which two, "*Amaranthus incomptus*" (Willdenow 1813: 64) and "*A. japonicus*" (Willdenow 1805: 306) are not validly published; the former is a nomen nudum (Turland & al. 2018: Art. 38.1(a)), while the latter was merely cited as a synonym of *A. inamoenus* Willd. (Art. 36.1(b)).

Most of the online databases of plant names (The Plant List 2013a; GBIF Secretariat 2017a; POWO 2019a; Tropicos 2019) also list "*Amaranthus tristis* Willd." as published in *Historia Amaranthorum*. IPNI (2015+) does not report "*A. tristis* Willd." but does list the apparent new combination "*Amaranthus tricolor* var. *tristis* (Willd.) Mehrotra, Aswal & B.S.Bisht". Actually, Willdenow never published a new name "*A. tristis*" because he always referred to the Linnaean name, *A. tristis* L. (Linnaeus 1753: 989), as indicated under *A. tristis* in *Historia Amaranthorum* (Willdenow 1790: 21) by the synonym "*Amaranthus tristis* glomerulis triandris, rotundatis, subspicatis, foliis ovato-cordatis, emarginatis, petiolo brevioribus. Linn. Syst. ed. R. 4. p. 144" (the number "144" is probably a typographical error for "1404", which corresponds to the page on which *A. tristis* occurs in the second edition of Linnaeus's *Species plantarum* (Linnaeus 1763: 1404).

Nine of the ten *Amaranthus* names validly published by Willdenow are still not typified. Only *A. chlorostachys* Willd. was recently lectotypified by Iamonico (2016a: 521) on a specimen deposited at B-W (B -W 17521 -00 0) and synonymized with *A. hybridus* (see also Remarks under *A. strictus* below).

The results obtained highlight how many *Amaranthus* species, especially in the past, were described on the basis of morphological characters that have low or no taxonomic value, namely: habit; plant height; stem colour; leaf size, shape and colour; and synflorescence structure. While some of these characters (leaf shape; synflorescence structure) could be used to identify *Amaranthus* taxa, the characters of the flowers have a high taxonomic value and must therefore be properly considered.

Amaranthus angustifolius M. Bieb. ex Willd., Sp. Pl. 4: 381. 1805, nom. illeg. [non *Amaranthus angustifolius* Lam., Encycl. 1: 115. 1783]. – **Lectotype (designated here):** Herb. Willdenow (B -W 17492 -02 0!).

= ***Amaranthus graecizans*** L., Sp. Pl. 2: 990. 1753 subsp. ***graecizans*** [currently accepted name]. – Lectotype (designated by Fernald 1945: 139): *Clayton 442* (BM 000051563!).

Remarks — Willdenow (1805: 381–382) published *Amaranthus angustifolius* with a diagnostic phrase name "A. glomerulis axillaribus triandris, foliis lineari-lanceolatis acutis mucronatis, caule ramoso erecto" and an additional diagnosis. A synonym was cited, "A. graecus sylvestris angustifolius" (Tournefort 1703: 17), followed by "*Amaranthus angustifolius*. Marschall ab Bieberstein", the provenance "Habitat ad mare Caspium" and "v.s." (vidi siccas) indicating that Willdenow had seen least one herbarium specimen. Note that, although Willdenow ascribed the name *A. angustifolius* to Bieberstein, the latter never validly published such a binomial.

One specimen was traced in B-W (B -W 17492 -02 0). It bears a part of a plant with leaves and synflorescences, and the morphology matches the protologue. The specimen has also been annotated as "*Amaranthus angustifolius*" by Willdenow on the sheet itself. It is part of the original material used to describe *A. angustifolius* and is designated here as the lectotype of the name.

This specimen shows leaves lanceolate, floral bracts shorter than the perianth, and flowers with 3 tepals. On the basis of the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2017), the lectotype of *A. angustifolius* corresponds to *A. graecizans* subsp. *graecizans*, and these two names are considered here to be heterotypic synonyms.

Willdenow (1805) proposed *Amaranthus angustifolius* giving a diagnosis similar to that published by Linnaeus (1753: 990) for *A. graecizans*. In fact, the only different character, as reported in both the diagnoses, is the shape and apex of leaves: "foliis lineari-lanceolatis acutis mucronatis" in *A. angustifolius* and "foliis lanceolatis obtusis" in *A. graecizans*. However, this morphological character does not have a high taxonomic value in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2015b), with the result that names of many described taxa, especially the early ones, are actually later synonyms of Linnaean names (Iamonico 2014, 2016a, 2016b, 2016c).

Amaranthus bicolor Nocca ex Willd., Sp. Pl. 4: 384. 1805. – **Lectotype (designated here):** Herb. Willdenow (B -W 17498 -01 0!).

= ***Amaranthus tricolor*** L., Sp. Pl. 2: 989. 1753 [currently accepted name]. – Lectotype (designated by Townsend 1974: 14): Herb. Linn. No. 1117.7 (LINN!).

Remarks — *Amaranthus bicolor* was published by Willdenow (1805: 384) with a diagnostic phrase name "A. glomerulis triandris sessilibus capitatis, foliis ovatis acuminatis obtusis coloratis" followed by "*Amaranthus bicolor*. Nocca", the provenance "Habitat in China?" and "v.v." (vidi vivas) indicating that Willdenow had seen living material. A morphological comparison with *A. tricolor* was also given: "Accedit valde ad *A. tricolorem* sed abunde diversus, foliis ovatis acuminatis acumine obtuso mucronato", followed by a short description. Note that, although Willdenow ascribed the name *A. bicolor* to Nocca, the latter never validly published such a binomial.

One specimen was found in B-W (B -W 17498 -01 0). The plant pinned on this sheet displays petiolate leaves and developed synflorescences, which appear to be arranged in axillary glomerules. The morphology of the specimen matches Willdenow's diagnosis and description. The specimen is part of the original material of *Amaranthus bicolor* and it is designated here as the lectotype of the name.

The flowers on the specimen show the following morphological characters: floral bracts longer than perianth, awned, membranous margins narrowing toward apex; tepals 3, lanceolate, apex acute; fruit shorter than perianth. On the basis of the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2017), the lectotype of *A. bicolor* is identifiable as *A. tricolor*, and the two names are here synonymized.

On the basis of the diagnostic phrase names given by Willdenow (1805) for *Amaranthus bicolor* and by Linnaeus (1753: 989) for *A. tricolor*, the two taxa would differ from each other by the shape and apex of the leaves: "foliis ovatis acuminatis obtusis" and "foliis lanceolatis acuminatis", respectively. These morphological characters have a low taxonomic value in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2015b). Actually, *A. tricolor* is a variable species from the morphological point of view, especially concerning the shape and colour of the leaves and structure of the synflorescences (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b). Already Linnaeus (1753, 1755, 1759) proposed different species: *A. gangeticus* L., *A. mangostanus* L., *A. melancholicus* L., *A. polygamus* L. and *A. tristis* L., which were subsequently recognized at infraspecific rank by various authors [*A. tricolor* var. *gangeticus* (L.) Fiori, *A. tricolor* var. *mangostanus* (L.) Aellen, *A. tricolor* var. *melancholicus* (L.) Lam., *A. tricolor* var. *polygamus* (L.) Aellen and *A. tricolor* var. *tristis* (L.) Thell.]. However, four out of these five Linnaean names are currently considered to be heterotypic synonyms of *A. tricolor* (Iamonico 2014a), whereas *A. gangeticus* should be considered as ambiguous and was indicated as a species incertae sedis by Iamonico (2014b).

Amaranthus campestris Willd., Sp. Pl. 4: 382. 1805. – **Lectotype (designated here):** Herb. Willdenow (B -W 17495 -02 0!).

= ***Amaranthus albus*** L., Syst. Nat., ed. 10, 2: 1268. 1759 [currently accepted name]. – Lectotype (designated by Raus 1997: 143): Herb. Linn. No. 1117.1 (LINN!).

Remarks — Willdenow (1805: 382–383) published *Amaranthus campestris* with a diagnostic phrase name "A. glomerulis triandris axillaribus sessilibus, foliis ovatis emarginatis, caule ramoso erecto" and a description. The provenance was also provided: "Habitat in India orientali" and "v.s." (vidi siccas) indicated that Willdenow had seen at least one herbarium specimen.

There are two specimens in B-W (B -W 17495 -01 0 and B -W 17495 -02 0), the first one with five complete plants, the second one with a terminal part of a single plant. The morphology of both these specimens matches Willdenow's protologue, and they are part of the original material of *Amaranthus campestris*. Because the specimen B -W 17495 -02 0 includes better-preserved and complete plants, I designate it here as the lectotype of the name.

On the basis of the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2017), both specimens in B-W can be identified as *A. albus* because they display the following characters: tepals 3; floral bracts awned (spinescent) and longer than perianth; fruit dehiscent. *Amaranthus campestris* is therefore treated here as a heterotypic synonym of *A. albus*.

On the basis of the diagnosis given by Willdenow (1805; see above) and its comparison with that of *A. albus*, "A. glomerulis triandris axillaribus bipartitis, bracteis mucronatis, foliis ovatis retusis" (Linnaeus 1759: 1268), it is not clear how Willdenow distinguished his new species. In fact, the two diagnoses are very similar. Note, however, that Willdenow (1805: 382) also listed

A. albus and described that species citing the Linnaean diagnosis and adding a character concerning the stem, i.e. "caule tetragono simplici". Thus Willdenow (1805) distinguished his *A. campestris* by the branching of the stem: simple in *A. albus* vs. branched in *A. campestris*. This feature cannot be considered as diagnostic for *A. albus*, which displays various types of habit, from erect to prostrate or pulvinate, with stem simple or branched, 10 cm to 1.5 m tall (Iamonico 2015b). These variations could be related to mechanical factors such as clipping or trampling, and the morphological forms are to be considered as ecophenes without taxonomic status (Costea & Tardif 2003; Iamonico 2015b).

Amaranthus hecticus Willd., Hist. Amaranth.: 25. 1790 – *Amaranthus hybridus* var. *hecticus* (Willd.) Willd., Sp. Pl. 4: 390. 1805. – **Lectotype (designated here):** [icon] "*Amaranthus hecticus*" in Willdenow, Hist. Amaranth.: t. VII, fig. 13. 1790.

= ***Amaranthus hybridus*** L., Sp. Pl. 2: 990. 1753 [currently accepted name]. – Lectotype (designated by Townsend 1974: 19): Herb. Linn. No. 1117.19 (LINN!).

Remarks — Willdenow (1790: 25) published *Amaranthus hecticus* with a diagnostic phrase name "*Amaranthus hecticus* floribus pentandris, simpliciter spicatis, floribus axillaribus, glomeratis, foliis ovatis, acutis" and a detailed description. An unnamed variety, marked with "β" and described as "Spicis crassioribus ac obtusioribus", was also included, but it was not validly published because the varietal epithet was lacking. Moreover, Willdenow listed a synonym from Barrelier (1714: 46, t. 643), "Amaranthus minor, simplici panicula, semine nigro", and another one from Forsskål (1775: XXXIV), "*Amaranthus ruber*", the latter synonym cited with a question mark. The provenance was omitted: "Habitat - - - - - -". Two illustrations (t. VII, fig. 13 and t. XI, fig. 22) were provided, both of which, as well as that published by Barrelier, are part of the original material of *A. hecticus* and are available for lectotypification. No specimens that could be considered as part of the material have been traced. Therefore, the three illustrations comprise the only known extant original material.

All three illustrations display plants with morphology that matches the description and diagnosis of *Amaranthus hecticus*. Barrelier's illustration is less detailed than Willdenow's two and I therefore prefer to avoid it for the purpose of lectotypification. Moreover, based on the shape of the synflorescence, Barrelier's plant could probably be referred to a taxon of *Celosia* L., likely *C. argentea* var. *margaritacea* (L.) Iamonico (Iamonico 2013). The two Willdenow illustrations refer to the two morphotypes recognized by Willdenow (1790) on the basis of the synflorescence shape: "Spica … in aliis gracilis interrupta, in aliis crassa". Forms of *A. hecticus* with wider synflorescences ("Spica … crassa") correspond to Willdenow's unnamed variety "β. Spicis crassioribus ac obtusioribus" and his t. XI, fig. 22, whereas the typical form corresponds to Willdenow's t. VII, fig. 13.

On the basis of both Willdenow's illustrations and the description given in *Historia Amaranthorum*, *Amaranthus hecticus* is morphologically characterized as follows: plant annual, erect; stem glabrous, red, ribbed; leaves lanceolate, rhomboidal, green or reddish, petiolate; petiole shorter than blade; synflorescences axillary and terminal (spike-like), green or greenish; floral bracts not shorter than tepals, awned, membranous margins abruptly interrupted at c. ½ total length of bract (terminal awn slightly shorter than membranous parts of bract); tepals 5, lanceolate. According to the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Iamonico 2015b, 2017), Willdenow's *A. hecticus* can be included in the *A. hybridus* aggregate, which includes taxa closely related to each other (Stetter & Schmid 2017; Waselkov & al. 2018). The shape of the bracts allowed me to distinguish between two species of that group, i.e. *A. hybridus* sensu stricto and *A. cruentus* L. (Iamonico 2015b). These two species can be distinguished from each other by the bract/tepal length ratio (1.6–2 in *A. hybridus* vs. up to 1.5 in *A. cruentus*) and colour of the median vein of the tepals (dark green in *A. hybridus* vs. yellowish brown in *A. cruentus*). Although the tepals cannot be seen in Willdenow's illustrations, the median vein of the tepals is green according to the description of *A. hecticus* ("Calyces … nervo viridi"). Moreover, based on my experience, the bracts and their awns shown in Willdenow's illustrations are most probably more than 1.5× as long as the tepals. Both these illustrations can be referred to *A. hybridus*. Therefore, I propose to synonymize *A. hecticus* with *A. hybridus*. Willdenow's t. VII, fig. 13 is designated here as the lectotype of *A. hecticus*.

By comparing the diagnoses of *Amaranthus hecticus* and *A. hybridus*, it seems that Willdenow described the new species mainly based on the stem, which would be simple in *A. hecticus* ("simpliciter spicatis"; Willdenow 1790: 25) and branched in *A. hybridus* ("racemis … cylindricis horizontalibus"; Linnaeus 1753: 990). In fact, Willdenow (1790: 26) described *A. hybridus* as "racemis … decompositis" (see also his t. IX, fig. 17). *Amaranthus hybridus* is a morphologically variable species, especially concerning the characters of flowers and branching of synflorescence (Costea & al. 2001; Iamonico 2015b).

Amaranthus inamoenus Willd., Hist. Amaranth.: 14. 1790. – **Lectotype (designated here):** Herb. Willdenow (B -W 17504 -01 0!).

= ***Amaranthus tricolor*** L., Sp. Pl. 2: 989. 1753 [currently accepted name]. – Lectotype: see above.

Remarks — The protologue of *Amaranthus inamoenus* (Willdenow 1790: 14) consists of a diagnostic phrase name "*Amaranthus inamoenus* glomerulis subspicatis, triandris, triphyllisque, axillaribus, geminatis, foliis rhombeo-lan-

ceolatis" followed by a detailed description. Also provided were the provenance "Habitat in Japonia?", a morphological comparison with *A. mangostanus* L. (a name currently considered as a synonym of *A. tricolor* L.; Iamonico 2015a) and an illustration (t. VII, fig. 14), which is part of the original material of *A. inamoenus*.

I traced only one specimen of *Amaranthus inamoenus* in B-W (B -W 17504 -01 0). It bears the distal part of a plant with cauline leaves and synflorescences (both axillary and terminal). The morphology of the plant matches Willdenow's diagnosis and description. The specimen is part of the original material of the name and is designated here as the lectotype of *A. inamoenus*.

As regards the identity of *Amaranthus inamoenus*, on the basis of the shape and length of the floral bracts (ovate-lanceolate and awned, longer than the tepals) and the number of tepals (3), the lectotype specimen can be identified as *A. tricolor*. *Amaranthus inamoenus* is therefore synonymized with *A. tricolor* according to the current circumscription of the latter in *Amaranthus* (Mosyakin & Robertson 2003; Iamonico 2015b, 2017).

Amaranthus inamoenus represents another described form of *A. tricolor* (see the above discussion under *A. bicolor*), which, on the basis of Willdenow's protologue, would differ from *A. tricolor* by the shape of the leaves, "rhombeo-lanceolatis", vs. "lanceolatis acuminatis" in Linnaeus (1753: 990). However this difference can be included in the variability of *A. tricolor* according to the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Iamonico 2015b). A further difference, which can be highlighted by observing the lectotypes of *A. inamoenus* and *A. tricolor*, is the occurrence in Willdenow's species of a terminal synflorescence, but this feature is to be considered again as part of the morphological variation of *A. tricolor* (Mosyakin & Robertson 2003; Iamonico 2015b).

Amaranthus laetus Willd., Hist. Amaranth.: 28. 1790. – **Lectotype (designated here):** Herb. Willdenow (B -W 17519 -01 0!).

= ***Amaranthus hybridus*** L., Sp. Pl. 2: 990. 1753 [currently accepted name]. – Lectotype: see above.

Remarks — *Amaranthus laetus* was published by Willdenow (1790: 28) with a diagnostic phrase name "*Amaranthus laetus* racemis pentandris, compositis, erectis, foliis ovatis, obtusis, mucronatis", a detailed description and a morphological comparison with *A. hybridus*. The provenance was not reported: "Habitat - - - - - - -". An illustration (t. VIII, fig. 15) was included, which is part of the original material of the name.

There are three specimens in B-W (B -W 17519 -01 0, B -W 17519 -02 0 and B -W 17519 -03 0). The first two specimens bear complete plants with roots, leaves and synflorescences, whereas the third bears only the terminal part of a plant with leaves and synflorescence. This third specimen appears morphologically different from the other two, especially concerning the leaves, which have the apex acute, not obtuse as indicated by Willdenow (1790). This character is clearly in contrast with the protologue and, as a consequence, this specimen is not considered as a possible lectotype. Moreover, Willdenow (1790) stated "Distinguitur ab *Amarantho hybrido* … statura multo minori". The specimen B -W 17519 -03 0 is a terminal part, c. 30 cm long, of a larger plant, while the other two specimens are complete plants, 15–25 cm tall. I think that Willdenow considered these specimens to refer to different species. Between the first two specimens, which both match the protologue, I designate here B -W 17519 -01 0 as the lectotype of *Amaranthus laetus* because the two plants on the sheet include numerous flowers, the morphology of which has a high taxonomic value in *Amaranthus* (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b).

The lectotype specimen displays floral bracts more than 1.5× as long as the perianth, with membranous margins abruptly interrupted at c. ½ the total length of the bract, and flowers with 5 tepals. On the basis of the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2017), the lectotype of *A. laetus* can be identified as *A. hybridus*, and the two names are therefore synonymized.

There are no strong differences between Willdenow's and Linnaeus's diagnoses of *Amaranthus laetus* and *A. hybridus*, respectively. However, Willdenow (1790) highlighted that the height of the stem can be used to distinguish the two species (see also the description of *A. hybridus* by Willdenow 1790: 26). This character is not, however, diagnostic for *A. hybridus*, in which the height varies from 30 cm to 2.5 m (Mosyakin & Robertson 2003; Iamonico 2015b).

Amaranthus polystachyus Willd., Sp. Pl. 4: 385. 1805. – **Lectotype (designated here):** Herb. Willdenow (B -W 17502 -01 0!).

= ***Amaranthus viridis*** L., Sp. Pl., ed. 2, 2: 1405. 1763 [currently accepted name]. – Lectotype (designated by Fawcett & Rendle 1914: 131): Herb. Linn. No. 1117.15 (LINN!).

Remarks — The protologue of *Amaranthus polystachyus* (Willdenow 1805: 385) consists of a diagnostic phrase name "A. glomerulis triandris spicatis, spicis axillaribus et terminalibus, foliis ovato-lanceolatis emarginatis", a description, the provenance statement "Habitat in India orientali" and "v.s." (vidi siccas), indicating that Willdenow had seen at least one herbarium specimen.

I traced one specimen in B-W (B -W 17502 -01 0), which consists of a plant with leaves and terminal synflorescences. This specimen morphologically matches Willdenow's diagnosis and description, is part of the original material and is designated here as the lectotype of *Amaranthus polystachyus*.

On the basis of the morphology of the synflorescence (spike-like, thin, 3–4 mm wide), floral bracts (ovate,

shorter than perianth) and fruit (strongly rugose), the lectotype of *Amaranthus polystachyus* is identifiable as *A. viridis* according to the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2015b, 2017). Therefore, the two names are to be considered as heterotypic synonyms.

The diagnoses of *Amaranthus polystachyus* (Willdenow 1805) and *A. viridis* (Linnaeus 1763: 1405) are very similar. As regards the cited characters, only the blades of the leaves were described as different: "foliis ovato-lanceolatis" in *A. polystachyus* and "foliis ovatis" in *A. viridis*. This is clearly a slight difference and it falls within the morphological variability of *A. viridis* (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b).

Amaranthus strictus Willd., Hist. Amaranth.: 27. 1790 – *Amaranthus paniculatus* var. *strictus* (Willd.) Moq. in Candolle, Prodr. 13(2): 257. 1849. – **Lectotype (designated here):** Herb. Willdenow (B -W 17516 -02 0!).

= ***Amaranthus cruentus*** L., Syst. Nat., ed. 10, 2: 1269. 1759 [currently accepted name]. – Lectotype (designated by Townsend 1974: 12): Herb. Linn. No. 1117.25 (LINN!).

Remarks — *Amaranthus strictus* was published by Willdenow (1790: 27) with a diagnostic phrase name "*Amaranthus strictus* racemis pentandris, compositis, erectis, strictis, foliis ovatis, concavis" and a detailed description. The provenance was not reported: "Habitat - - - - - -". Willdenow also provided an illustration (t. III, fig. 5), which is part of the original material of *A. strictus*.

Two specimens were traced in B-W (B -W 17516 -01 0 and B -W 17516 -02 0). Each specimen bears a single plant with cauline leaves and one terminal, panicle-like synflorescence, the characteristics of which match the protologue. Both specimens are well preserved and include many flowers, the morphology of which has a high taxonomic value in *Amaranthus* (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b). I designate here B -W 17516 -02 0 as the lectotype of *A. strictus* because it includes more and better-preserved leaves.

Concerning the identity of the lectotype (as well as Willdenow's illustration and the specimen B -W 17516 -01 0), note that Willdenow (1790) stated (end of p. 27): "Differt ab omnibus speciebus pentandris: racemis erectis, arcte cauli adpressis, habituque toto stricto". However, on the basis of the current concept in *Amaranthus* (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b), the shape of the synflorescence has a rather low taxonomic value, except for a few cases (*A. caudatus* L., which usually has pendulous and very long, spike-like, terminal synflorescences). To identify the B-W specimens and the illustration, I considered the other Willdenow species included in the informal group of "pentandrous species". These species are: *A. caudatus*, *A. chlorostachys* (= *A. hybridus* according to Iamonico 2016a: 521), *A. cruentus*, *A. flavus* L. (= *A. cruentus* according to Iamonico 2014a: 147), *A. hecticus* (= *A. hybridus*, see above), *A. hybridus*, *A. hypochondriacus* L., *A. laetus* (= *A. hybridus*, see above), *A. paniculatus* L. (= *A. cruentus* according to Iamonico 2015b), *A. retroflexus* L., *A. sanguineus* L. (= *A. cruentus* according to Iamonico 2014a: 148) and *A. spinosus* L. Morphological comparisons between Willdenow's material and each of the above-listed species demonstrated that:

- spine-like structures (modified bracts) at the base of each leaf (a unique characteristic of *A. spinosus*) do not occur in the original material of *A. strictus*;
- the terminal synflorescence is erect, not pendulous as in *A. caudatus*;
- the tepals of the two specimens in B-W (tepals cannot be seen in the illustration) display an acute apex, not obtuse-spatulate as in *A. retroflexus*;
- the tepals have a green-coloured median vein, whereas *A. hypochondriacus* usually has tepals with a yellow-brown to reddish brown median vein;
- the floral bracts are up to 1.5× as long as the tepals, as in *A. cruentus*, whereas *A. hybridus* and *A. hypochondriacus* have a bract/tepal ratio of 1.5–2.5.

Willdenow's material of *A. strictus* can be identified as, and that name therefore synonymized with, *A. cruentus*. Various authors and online databases already accepted this synonymization (Govaerts 1995; The Plant List 2013b; Assad & al 2017; GBIF Secretariat 2017b; POWO 2019b).

Willdenow clearly distinguished his *Amaranthus strictus* from *A. cruentus* by the synflorescence. In fact, according to the protologues of these two species, the synflorescences are "racemis … compositis, erectis, strictis" (*A. strictus*; Willdenow 1790), and "racemis … compositis patulo-nutantibus" (*A. cruentus*; Linnaeus 1759: 1269). The structure of the synflorescence in *Amaranthus* is very variable, especially in the *A. hybridus* aggregate, to which *A. cruentus* belongs (Costea & al. 2001; Iamonico 2015b). However, based on my experience and the literature (Bao & al. 2003; Mosyakin & Robertson 2003; Iamonico 2015b), this character has a low taxonomic value, except in a few cases (e.g. the moniliform synflorescence in some forms of *A. hypochondriacus*).

Amaranthus tenuifolius Willd., Sp. Pl. 4: 381. 1805. – **Lectotype (designated here):** Herb. Willdenow (B -W 17491 -01 0!).

= ***Amaranthus graecizans*** L., Sp. Pl. 2: 990. 1753 subsp. ***graecizans*** [currently accepted name]. – Lectotype: see above.

Remarks — The protologue of *Amaranthus tenuifolius* (Willdenow 1805: 381) consists of a diagnostic phrase

name “A. glomerulis axillaribus triandris, foliis linearilanceolatis cuneatis retusis, caule ramoso diffuso”, a description, the provenance statement “Habitat in India orientali” and “v.s.” (vidi siccas), indicating that Willdenow had seen at least one specimen.

I traced one specimen in B-W (B -W 17491 -01 0), which consists of a plant with leaves and synflorescences. This specimen morphologically matches Willdenow’s diagnosis and description, is part of the original material and is designated here as the lectotype of *A. tenuifolius*.

The identity of the lectotype is not a simple issue and therefore deserves a detailed discussion. On the basis of the current concept in *Amaranthus* (Mosyakin & Robertson 2003; Bayón 2015; Iamonico 2015b), the lectotype belongs to *A.* subg. *Albersia* (Kunth) Gren. & Godr. sensu Mosyakin & Robertson (1996, 2003), being monoecious and showing synflorescences in axillary glomerules and flowers with three tepals. Further important characters are: bracts not spinescent, shorter than or as long as perianth; tepals ovate-lanceolate, acute, shorter than fruit; and fruit rugose. All these features allow the specimen to be considered as part of the *A. graecizans* aggregate. This aggregate currently includes taxa highly variable morphologically. Four subspecies are currently accepted under *A. graecizans* (Costea 2003; Bayón 2015; Iamonico 2015b), namely: subsp. *aschersonianus* (Thell.) Costea; subsp. *graecizans*; subsp. *sylvestris* (Vill.) Brenan; and subsp. *thellungianus* (Nevski) Gusev. *Amaranthus graecizans* subsp. *aschersonianus* and subsp. *thellungianus* are characterized by having awned tepals (awn 0.3–0.7 mm long), whereas subsp. *graecizans* and subsp. *sylvestris* have mucronate tepals (never awned). Moreover, subsp. *aschersonianus* differs from the other subspecies by its synflorescences arranged both in axillary glomerules and in terminal, spike-like structures. The lectotype of *A. tenuifolius* shows tepals mucronate and synflorescences in axillary glomerules and, as a consequence, it cannot be identified as either subsp. *aschersonianus* or subsp. *thellungianus*. *Amaranthus graecizans* subsp. *graecizans* and subsp. *sylvestris* differ from each other by the shape and size of the leaf blades: subsp. *graecizans* has blades lanceolate, 2–6 × 0.5–1.5 cm (length/width ratio 3–6), whereas subsp. *sylvestris* has blades ovate to ovate-lanceolate, 5–6 × 2.5–4 cm (length/width ratio 1.8–2.5). The leaf blades of the lectotype of *A. tenuifolius* are linear-lanceolate, 0.7–1.5 × 0.1–0.5 cm (length/width ratio 4–5) and can therefore be identified as *A. graecizans* subsp. *graecizans*.

The diagnoses of *Amaranthus tenuifolius* (Willdenow 1805) and *A. graecizans* (Linnaeus 1753: 990) differ slightly from each other based on the leaves, which are, respectively, “lineari-lanceolatis cuneatis retusis” and “lanceolatis obtusis”. These differences are, however, minimal and cannot be considered as diagnostic at the current state of knowledge.

Acknowledgements

I wish to thank N. D. Bayón (Universidad Nacional de La Plata, Argentina) for useful discussion about the identity of the lectotype of *Amaranthus tenuifolius*; also H. W. Lack (Botanischer Garten und Botanisches Museum Berlin [BGBM], Germany) for verifying that the specimens in B-W designated as lectotypes in this article bear annotations in the hand of Willdenow. Thanks are also due to S. Mosyakin (M. H. Kholodny Institute of Botany, Kyiv, Ukraine), D. Pratt (Stephen F. Austin State University, Nacogdoches, United States), an anonymous reviewer and N. Turland (BGBM) for their valuable suggestions.

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Willdenowia
Open-access online edition bioone.org/journals/willdenowia
Online ISSN 1868-6397 · Print ISSN 0511-9618 · 2018 Journal Impact Factor 1.156
Published by the Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin