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Taxonomic revision of the genus *Amaranthus* (Amaranthaceae) in Saudi Arabia

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Abstract

A taxonomic revision of the genus *Amaranthus* (Amaranthaceae) in Saudi Arabia, based on both field surveys and examination of herbarium specimens, is here presented. Collected exsiccata are kept the Herbaria PNUH and RO. An extensive literature was also analysed. Sixteen non-hybrid taxa (twelve species) are recognized. Data about nomenclature (accepted names, main synonyms, and types), morphology, chromosome number, chorology (for native taxa) or alien status (for exotic taxa), occurrence in Saudi Arabia, ecology (preferential habitat, phenology, elevation), and taxonomic annotations are provided for each taxon. A diagnostic key is proposed. Four taxa (*A. graecizans* subsp. *graecizans*, *A. graecizans* subsp. *sylvestris*, *A. graecizans* subsp. *thellungianus*, and *A. sparganicephalus*) are native, whereas the other ones are to be considered aliens. *A. dubius* and *A. blitoides* var. *blitoides* are new for the national flora. Furthermore, the name *A. sparganicephalus* is neotypified on a specimen deposited at E and a nomenclatural change (*A. blitum* var. *nanus* comb. nov.) is proposed.

Keywords: *Amaranthus*, aliens, Asia, flora, morphology, new record, nomenclatural change, typification

Introduction

Amaranthus L. (Amaranthaceae Juss.) is a genus comprising 65–70 species of which approximately half are native to the Americas (see Mosyakin & Robertson 1996, Hernández-Ledesma *et al.* 2015, Iamónico 2015) and the rest are native to Africa, Asia, and Europe (Iamónico 2020). Out of their native distribution areas, many *Amaranthus* species are able to spread and sustain self-replacing populations negatively impacting both agricultural systems and/or natural vegetation (see e.g., Costea *et al.* 2001, Iamónico 2015, Das 2016). In fact, various species are used as ornamentals, food or medicine throughout many world countries.

Since Linnaeus (1753) the genus *Amaranthus* faced many difficulties in the identification of the various taxa (see e.g., Iamónico 2015, Müller & Borsch 2005, Pratt 2003, Taia *et al.* 2020) In fact, this genus is characterized in having an high phenotypic variability which has resulted in nomenclatural confusions and misapplication of names (see e.g., Costea *et al.* 2001, Bayón 2015, Iamónico 2016a, 2016b, 2016c, 2020a, 2020b, Iamónico & Palmer 2020), hybridization as well as reduced and difficult to observe diagnostic characters are reasons in the taxonomic complicated (Assad *et al.* 2017).

Mosyakin & Robertson (1996) proposed the more recently classification of *Amaranthus* recognizing the following three subgenera: subgenus *Acnida* (L.) Aellen ex K.R. Robertson (dioecious species), subgenus *Albersia* (Kunth) Gren. & Godr. (monoecious species with usually 2–3 tepals and synflorescence usually arranged in axillary glomerules), and subgenus *Amaranthus* (monoecious species with mostly 5 tepals and synflorescence arranged in terminal elongated spike- or panicle-like structures). Furthermore, they proposed three sections for subgen. *Acnida* [sect. *Acnida* (L)

Mosyakin & K.R.Robertson, sect. *Saueranthus* Mosyakin & K.R.Robertson, and sect. *Acanthochiton* (Torr.) Mosyakin & K.R.Robertson], four sections for subgen. *Albersia* [sect. *Blitopsis* Dumort., sect. *Pentamorion* (G.Beck) Mosyakin & K.R.Robertson, sect. *Goerziella* (Urban) Mosyakin & K.R.Robertson, and sect. *Pyxidium* Moq.], and three sections for subgen. *Amaranthus* (sect. *Amaranthus*, sect. *Dubia* Mosyakin & K.R.Robertson, and sect. *Centrusa* Griseb.). A recent molecular study by Waselkov *et al.* (2018) highlighted that the classification Mosyakin & Robertson (1996) is not natural not matching the clades as identified in the phylogenetic trees.

In addition to the taxonomic issues, the nomenclature of *Amaranthus* is also highly complicate especially for the misinterpretations of the names which causes, e.g., the use different names for a same taxon [for example *A. chlorostachys* Willd. = *A. patulus* Bertol. = *A. hybridus* L. (Iamonico 2016a)], or the use of a name for a wrong taxon [for example *A. gracilis sensu auct. non* Desfontaines which is to be referred to *A. viridis* L. (Iamonico 2016b)], or the occurrence of ambiguous names [for example *A. gangeticus* L. (Iamonico 2014b)].

As part of the ongoing studies on the taxonomy and nomenclature of the genus *Amaranthus* (by DI, see e.g., Iamonico 2009, 2011, 2016a, 2017, 2020a, 2020b, Iamonico & Das 2014, Iamonico & El Mokni 2017, 2019, Sindhu *et al.* 2020, 2021) and the investigation of the alien flora of Saudi Arabia (by the other authors, se e.g., Sammour *et al.* 2020), we here present the first taxonomic revision of the genus for Saudi Arabia.

Material and methods

The present research was based on our field investigations in Saudi Arabia carried out during the period 2020–2021. Plants collected are deposited at the Herbaria PNUH and RO. Further material, used for a morphological comparison, were checked at B, BM, BR, E, FI, G, GH, HAL, IND, K, L, LINN, MPU, NY, P, RO, and US (acronyms follow Thiers 2022 [continuously update]). Relevant literature (protologues included) was also analyzed.

The following data are reported for each taxon:

- > Accepted name (in bold) following Iamonico (2015);
- > Synonyms;
- > Types;
- > Description based on personal observations (descriptions of floral bracts and ratio fruit/perianth refer to the pistillate flowers). When no finding was done during the field surveys, the description of the species was take from literature, primarily from Chaudhary (1998) who provided good illustrations which allow us to confirm that the species were correctly identified;
- > Iconography (literature references that represent good images for each taxon);
- > Phenology, based on our observations in the field or, in absence, on literature (cited) if available;
- > Habitat and elevation, based on our observations in the field or, in absence, on literature (cited) if available;
- > Chromosome number [counts are taken from Iamonico 2015, excepting for *Amaranthus dubius* Mart. ex Thell. (it does not occur in Iamonico's paper) for which references were given];
- > Alien status (only for the exotic taxa) according to Pyšek *et al.* (2002) and Richardson & Pyšek (2006). The status of naturalization, native range, residence time (archaeophyte/neophyte) are indicated on the basis of our observations in field. It was assigned on the basis of the highest stage in the invasion process documented in any region. This means that the taxa were considered to be naturalized for Saudi Arabia when naturalized in at least one region. Similarly, we defined a taxon as invasive in Saudi Arabia, when invasive in at least one region. When no field data are available, we refer to literature (cited);
- > Chorology (only for the native taxa);
- > Occurrence in Saudi Arabia at Region level, also citing floristic or taxonomic papers in which the taxon is reported;
- > Taxonomic annotations (if necessary);
- > Specimina Visa Selecta, listed in chronological order.

Taxonomic treatment

Amaranthus L., Sp. Pl. 2: 989. 1753. Type (lectotype designated by Green 1929: 188): *Amaranthus caudatus* L.

Description:—Monoecious or dioecious herbs, usually annual (therophytes), sometimes perennial (hemicryptophytes). Stems erect, ascending, or prostrate, glabrous to tomentose (trichomes uniseriate, whitish to yellowish), green, white, brownish or red, usually branched. Leaves alternate, petioled, with blade lanceolate to ovate, elliptic to deltoid to rhombic; base cuneate to obtuse; apex acute, obtuse, or emarginate, sometimes mucronate; margins entire, sometimes undulate; blade glabrous to pubescent (sometimes hairs only along the veins), with trichomes whitish to yellowish, uniseriate. Synflorescences thyrsoid paraclades arranged in terminal and/or axillary spike- or panicle-like structures or only in axillary glomerules (for details see Iamónico 2015). Bracts 1–5, ovate to lanceolate, with membranous borders thinning to apex or abruptly interrupted at the half of the total length, sometimes keeled; apex acute to obtuse. Flowers unisexual, sessile. Staminate flowers with 3–5 free and more or less equal tepals, ovate to lanceolate, usually glabrous; apex usually acute; margin entire; stamens 3–5, anthers tetrasporangiate with 2 lines of dehiscence, filaments free to the base; pseudostaminodia absent. Pistillate flowers with (0–)2–5 usually free tepals, linear to ovate-lanceolate sometimes spatulate, usually glabrous; apex acute to emarginate (sometimes mucronate); margins entire; one pistil, one ovule, 2–5 stigmas. Fruit dry (dehiscent capsule, or indehiscent utricle), globose to ellipsoid, smooth to strongly rugose on the surface, with often persistent styles; seed one, usually lenticular, smooth to reticulate; embryo annular.

General note and diagnostic key:—Twelve non-hybrid species (sixteen taxa, by considering the infraspecific taxa) were here recorded in Saudi Arabia, of which two (*A. caudatus* and *A. tricolor* L.) are cultivated only in the country. Four taxa (*A. graecizans* subsp. *graecizans*, *A. graecizans* subsp. *sylvestris*, *A. graecizans* subsp. *thellungianus*, and *A. sparganicephalus*) are autochthonous, whereas the other ones are aliens, mostly neophytes native to the Americas (Table 2).

A diagnostic key of the *Amaranthus* species occurring in Saudi Arabia follows (the characters of the flowers refer to the pistillate ones, since the features of the staminate flowers have a very low taxonomical value in the genus *Amaranthus*; see e.g., Mosyakin & Robertson 2003, Iamónico 2015). We include also the two cultivated species (*A. caudatus* and *A. tricolor*) which could be found in wild in future. Diagnostic keys for infraspecific taxa of *A. blitum* L. and *A. graecizans* are reported after the morphological descriptions of them.

1. Tepals 3 2
- Tepals > 3 7
2. Stem white to white-greenish; bracts spinescent longer than the tepals 1. *A. albus*
- Stem never white to white-greenish; bracts not spinescent, shorter than the tepals 3
3. Synflorescence spike- or panicle-like 4
- Synflorescence in axillary glomerules 6
4. Fruit indehiscent (utricle), as long as or longer than the perianth 5
- Fruit dehiscent (capsule) shorter than the perianth 3. *A. tricolor*
5. Fruit smooth or slightly on the surface 2. *A. blitum s.lat*
- Fruit strongly rugose on the surface 4. *A. viridis*
6. Fruit shorter than the perianth 3. *A. tricolor*
6. Fruit as long as or longer than the perianth 8
8. Fruit up to 2.7 mm long 4, never longitudinally sulcate 5. *A. graecizans s.lat*
- Fruit > than 2.7 mm long, the proximal half longitudinally sulcate 6. *A. sparganocephalus*
7. Tepals usually 4; stem prostrate-diffuse or ascending; synflorescence arranged in axillary glomerules 7. *A. blitoides*
- Tepals 5; stem erect; synflorescence arranged in spike- or panicle-like structures 8
8. Bracts of the first flower in the first cyme metamorphosed into a spine-like structure 8. *A. spinosus*
- Bracts spine-like absent 9
9. Terminal synflorescence usually pendulous up to 70 cm long; tepals (at least the inner ones) obovate-spathulate 9. *A. caudatus*
- Terminal synflorescence always erect; tepals ovate to lanceolate 10
10. Bracts up to 2 mm long and always shorter than the tepals 10. *A. dubius*
- Bracts > 2 mm long and always longer than the tepals 11
11. Bracts clearly longer (1.6–2.0 times) than the perianth; tepals with median vein usually dark-green 11. *A. hybridus*
- Bracts as long as or slightly longer (up to 1.5 times) than the perianth; tepals with median vein usually yellow-brown 12. *A. cruentus*

1. *Amaranthus albus* L., Syst. Nat., ed. 10. 2: 1268. 1759

Type (lectotype designated by Raus 1997: 143):—NORTH AMERICA. *Habitat in Philadelphiae maritimis*, Herb. Linn. No. 1117.1 (LINN!, image of the lectotype available at <http://linnean-online.org/11627/>).

Description:—Herbs 1–85(–120) dm tall, monoecious, annual (therophyte), rarely biennial. Stems usually erect, ± glabrous (sometimes sparsely pubescent in the inflorescence region), white to white-greenish, much branched. Leaves green (usually pale green), ovate, elliptic to spatulate (3.5–6.0 × 1.5–3.0 cm in the main axis, greater than the leaves on the branches), often with undulate margins (sometimes with a white marginal vein), apex obtuse and mucronate, base cuneate, glabrous (rarely pubescent on the veins), petioled (petiole 1.6–3.0 cm long). Synflorescences arranged in axillary glomerules, light green. Floral bracts greenish, ovate-lanceolate [(2.0–)3.0–4.0(–6.0) × 0.3–0.6 mm], 2(–2.5) times longer than the perianth, awned, margin entire, glabrous. Staminate flowers with 3 tepals, lanceolate; stamens 3. Pistillate flowers with 3 tepals, linear to lanceolate [0.9–1.1 × 0.3–0.4(–0.5) mm], with acute apex; stigmas 3. Fruit brownish-black, ellipsoidal [(1.2–)1.4–1.8 × 1.0–1.2(–1.4) mm], as long as or slightly longer than the perianth, rugose when dry, dehiscent. Seed lenticular [(0.8–)0.9–1.1(–1.3) mm in diameter], black to brownish-black.

Iconography:—Chaudhary (1998: 245, Plate. 126a–e), Bayón (2015: 304, Figura 19).

Phenology:—Flowering time April (Al-Eisawi & Al-Ruzayza 2015).

Habitat and elevation:—Human-made habitat, at about 300 m a.s.l. (Al-Eisawi & Al-Ruzayza 2015).

Chromosome number:— $2n = 32, 34$.

Alien status:—Neophyte species native to North America, it can be considered as invasive in Saudi Arabia (see Aljedani *et al.* 2021).

Occurrence in Saudi Arabia (Fig. 1):—Jizan, Qassim (El-Ghazali & Al-Soqeer 2013), Makkah (Al-Eisawi & Al-Ruzayza 2015), Tabuk and Taif (Aljedani *et al.* 2021). No finding was done during the field surveys. Further researches are necessary to verify the distribution of *Amaranthus albus* in the country.

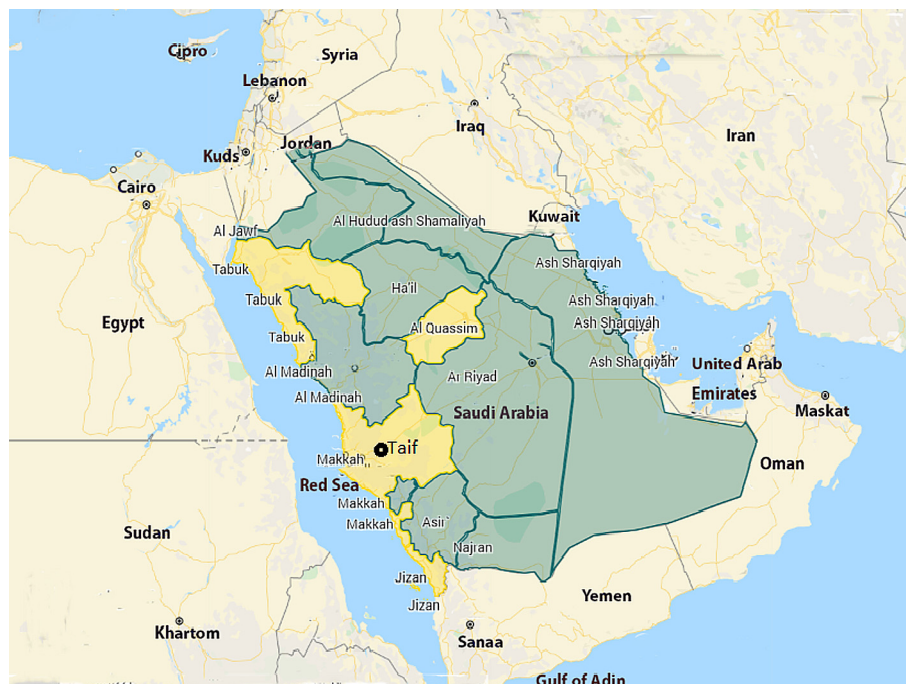


FIGURE 1. Map of *Amaranthus albus*.

2. *Amaranthus blitum* L., Sp. Pl. 2: 990. 1753

Type (lectotype designated by Filias *et al.* 1980: 149–150):—EUROPE. *Habitat in Europa temperatiore*, Herb. Linn. No. 1117.14 (LINN!, image of the lectotype available at <http://linnean-online.org/11640/>).

= *Amaranthus lividus* L., Sp. Pl. 2: 990. 1753, *nom. rejec.* (see Filias *et al.* 1980: 149–150) ≡ *Amaranthus lividus* proles *lividus* (Loisel.) Thell. in Asch. & Graebn. Syn. Mitteleur. Fl. [Ascherson & Graebner] 5: 274. 1914.

Type (lectotype designated by Reveal & Jarvis, 2009: 978):—[Icon] “*Blitum pulchrum rectum magnum rubrum*” in Bauhin & Cherler (1651: 966); image of the lectotype available at <https://www.biodiversitylibrary.org/item/246944#page/1004/mode/1up>.

= *Amaranthus ascendens* Loisel., Not. Fl. France 141. 1810 ≡ *Amaranthus blitum* var. *ascendens* (Loisel.) DC., Cat. Pl. Horti Monsp. 4. 1813 ≡ *Amaranthus lividus* proles *ascendens* (Loisel.) Thell. in Asch. & Graebn. Syn. Mitteleur. Fl. [Ascherson & Graebner].

5(1(5)): 321 (v-322). 1914 ≡ *Amaranthus lividus* subsp. *ascendens* (Loisel.) Heukels, Geïllustreerde Schoofflora voor Nederland: 169. 1934.

Type (neotype designated by Iamónico 2016a: 520):—[Icon] “*Blitum majus*“ from Dodoens (1616: 617); image of the lectotype available at <https://bibdigital.rjb.csic.es/viewer/11145/?offset=#page=633&viewer=picture&o=bookmark&n=0&q=>.

Description:—Herbs 1–5 (rarely up to 10) dm tall, monoecious, annual (therophyte). Stems prostrate-ascending, glabrous, pale green to pale brown, branched. Leaves green or green-yellowish, ovate, rhomboidal to deltoid, some subcircular [$1.5\text{--}3.5(-7.5) \times (0.7\text{--})1.5\text{--}2.5(-5.0)$ cm], sometimes fleshy, with entire or undulate margins, apex acute or rounded, often mucronate, base cuneate, glabrous, with marginal white vein, petioled (petiole 1.0–5.5 cm long). Synflorescences arranged in axillary glomerules, reddish or green. Floral bracts, green or greenish, ovate to lanceolate ($1.3\text{--}3.0 \times 0.4\text{--}0.7$ mm), shorter than the longest perianth segments, acute, margin entire, glabrous. Staminate flowers with 3(–4) tepals, ovate to lanceolate; stamens 3. Pistillate flowers with (4–)5 unequal tepals, lanceolate, elliptic [the greater $1.5\text{--}2.5(-3.5) \times (0.7\text{--})1.0\text{--}1.2$ mm], with acute to acuminate, and mucronate apex; stigmas 3. Fruit brown or reddish, ellipsoidal ($2.0\text{--}2.2 \times 1.0\text{--}1.4$ mm), as long as or longer than the tepals, usually smooth, dehiscent. Seed lenticular (1.5–1.7 mm in diameter), black.

Taxonomic annotations:—*Amaranthus blitum* shows a high phenotypic variability (both in vegetative and in generative characters) and several names (at subspecies, variety, and form ranks) were published in the past, especially in the nineteenth century (see e.g., IPNI 2008). As a consequence, misapplication of names and nomenclatural disorder exist. We here recognized two varieties which can be distinguished as follows:

1. Seed with minutely punctiform surface and diameter 1.1–1.2 mm.....var. *blitum*
- Seed with smooth surface and diameter (1.2–)1.4–1.7(–1.9) mm..... var. *oleraceus*

2a. *Amaranthus blitum* subsp. *blitum* var. *blitum*

Iconography:—Beck (1909: Tab. 300).

Phenology:—Flowering time february to april (see also Al-Eisawi & Al-Ruzayza 2015).

Habitat and elevation:—Human-made habitat on sandy soils, 250–580 m a.s.l. (see also (Al-Eisawi & Al-Ruzayza 2015).

Chromosome number:— $2n = 34$.

Alien status:—Archeophyte species native to to Mediterranean area and other parts of Europe, it can be considered as naturalized in Saudi Arabia (see also Chaudhary *et al.* 1981).

Occurrence in Saudi Arabia (Fig. 2):—Hail (El-Ghanim *et al.* 2010), Makkah (Al-Eisawi & Al-Ruzayza 2015), Riyadh (our investigation).

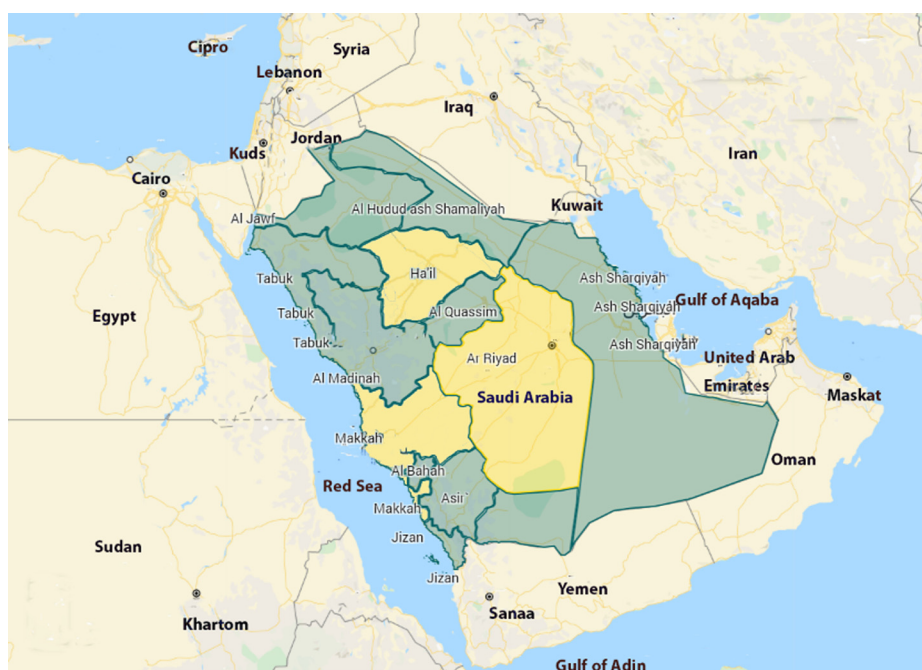


FIGURE 2. Map of *Amaranthus blitum* subsp. *blitum* var. *blitum*.

Specimina visa selecta:—SAUDIA ARABIA, Riyadh, sandy soil, 623 m a.s.l., 11 February 2021, leg. *Hassan et Alali*, det. *Iamonico* (PNUH!); *ibidem* (RO!).

2b. *Amaranthus blitum* subsp. *blitum* var. *oleraceus* (L.) Hook.f., Fl. Brit. India [J.D. Hooker] 4: 721. 1885 ≡ *Amaranthus oleraceus* L., Sp. Pl., ed. 2. 2: 1403. 1763 ≡ *Amaranthus lividus* proles *oleraceus* (L.) Thell. in Asch. & Graebn., Syn. Mitteleur. Fl. [Ascherson & Graebner] 5(1(5)): 321. 1914 ≡ *Amaranthus blitum* subsp. *oleraceus* (L.) Costea in Costea & al., Sida 19(4): 984. 2001

Type (lectotype designated by Filias *et al.* 1980: 150):—ASIA. *Habitat in India*, Herb. Linn., No. 1117.13 (LINN!, image of the lectotype available at <http://linnean-online.org/11639/>).

Iconography:—Bayón (2015: 307, Figura 22).

Chromosome number:—Unknown.

Alien status:—The origin of this taxon is uncertain at present. It probably originated from a selection of the var. *blitum* which was used as cultivated vegetable (see e.g., Costea *et al.* 2001). However, it does not appear to have been used for this purpose in Saudi Arabia. We consider var. *oleraceus* as casual in Saudi Arabia.

Occurrence in Saudi Arabia:—Var. *oleraceus* is here considered since it was listed by Thomas (2011). In fact, we did not find this variety during the field survey. Further investigations need to verify its real occurrence in Saudi Arabia.

3. *Amaranthus tricolor* L., Sp. Pl. 2: 989. 1753

Type (lectotype designated by Townsend 1974: 14):—ASIA. *Habitat in India*, Herb. Linn. No. 1117.7 (LINN!, image of the lectotype available at <https://linnean-online.org/11633/>).

= *Amaranthus melancholicus* L., Sp. Pl. 2: 989. 1753. ≡ *Amaranthus tricolor* var. *melancholicus* (L.) Lam. & Monnet, Encycl. [J. Lamarck & al.] 1: 115. 1783.

Type (lectotype designated by Townsend 1994: 11):—ASIA. *Habitat in India*, Herb. Linn., No. 1117.4 (LINN!, image of the lectotype available at <http://linnean-online.org/11630/>).

= *Amaranthus tristis* L., Sp. Pl. 2: 989. 1753. ≡ *Amaranthus tricolor* var. *tristis* (L.) Thell. in Asch. & Graebn., Syn. Mitteleur. Fl. [Ascherson & Graebner] 5: 274. 1914. ≡ *Amaranthus tricolor* subsp. *tristis* (L.) Aellen in Hegi, Ill. Fl. Mitt.-Eur. 3(2): 495. 1959.

Type (lectotype designated by Iamonico 2014: 149):—ASIA. *Habitat in China*, Herb. Linn., No. 1117.11 (LINN!, image of the lectotype available at <http://linnean-online.org/11637/>).

= *Amaranthus mangostanus* L., Cent. Pl. I. 32. 1755. ≡ *Amaranthus tricolor* var. *mangostanus* (L.) Thell. in Asch. & Graebn. Syn. Mitteleur. Fl. [Ascherson & Graebner] 5: 274. 1914. ≡ *Amaranthus tricolor* subsp. *mangostanus* (L.) Aellen, in Hegi, Ill. Fl. Mitt.-Eur. 3(2): 495. 1959.

Type (lectotype designated by Iamonico 2014a: 147):—ASIA. *Habitat in India*, Herb. Linn., No. 1117.10 (LINN!, image of the lectotype available at <http://linnean-online.org/11636/>).

= *Amaranthus polygamus* L., Cent. Pl. I. 32. 1755. ≡ *Amaranthus tricolor* subsp. *tristis* var. *polygamus* (L.) Aellen in Hegi, Ill. Fl. Mitt.-Eur. 3(2): 495. 1959.

Type (lectotype designated by Iamonico 2014a: 148):—ASIA. *Habitat in India*, Herb. Linn., No. 1117.9 (LINN!, image of the lectotype available at <http://linnean-online.org/11635/>).

Description:—Herbs 8–10 dm tall, monoecious, annual (therophyte). Stems erect or ascending, ± glabrous, green or red, branched (rarely simple). Leaves green, red, red-purple or red-yellow mixed, ovate-rhomboidal (4.0–12.0) × 1.4–6.0), with usually entire margins, apex obtuse to emarginate, often mucronate, base cuneate, glabrous, petioled (petiole 2–6 cm long). Synflorescences arranged in axillary glomerules and terminal spike-like, green to reddish. Floral bracts, usually greenish, deltoid-ovate (5.0–6.0 × 0.8–1.8 mm) as long as the perianth, awned, margin entire, glabrous. Staminate flowers with 3 tepals, ovate to lanceolate, apex acute, awned; stamens 3. Pistillate flowers with 3 tepals, ovate (3.0–5.0 × 1.5–2.5 mm); stigmas 2–3. Fruit brown, subglobose to ellipsoidal (2.0–2.5 × 0.8–1.3 mm), shorter than the perianth, rugose, dehiscent. Seed lenticular (about 1.0 mm in diameter), black or brown.

Iconography:—Chaudhary (1998: 245, Plate. 127a–f), Bayón (2015: 368, Figura 61).

Chromosome number:—2n = 34, 68, 85.

Occurrence in Saudi Arabia:—Cultivated only in Saudi Arabia according to Chaudhary (1998: 238). No wild plants were found by us during the field survey.

4. *Amaranthus viridis* L., Sp. Pl., ed. 2: 2: 1405. 1763

Type (lectotype designated by Fawcett & Rendle 1914: 131):—UNKNOWN ORIGIN. *Habitat in Europa, Brasilia*, Herb. Linn. No. 1117.15 (LINN!), image of the lectotype available at <http://linnean-online.org/11641/>.

Description:—Herbs 1–7(–8) dm tall, monoecious, annual (therophyte). Stems erect, glabrous, green to brownish, branched. Leaves black-green, ovate, rhomboidal [(2.0–4.5) × (1.5–)2.0–7.0 cm], with entire (rarely undulate) margins, apex obtuse or rounded (rarely slightly emarginate) and sometimes mucronate, base usually cuneate, usually glabrous, petioled [petiole 1.5–5.0 cm long]. Synflorescences terminal, spike- or panicle-like (sometimes axillary glomerules also occur), the main florescence 3–4 cm long, green to brown, usually thin (5–7 mm in diameter). Floral bracts yellowish or greenish, ovate to lanceolate [0.5–1.0 × 0.4–0.7 mm], shorter (up to 1/3) than the perianth, acuminate, margin entire, glabrous. Staminate flowers with 3 tepals, ovate; stamens 3. Pistillate flowers with 3 tepals, ovate-lanceolate or obovate-spathulate (1.2–1.5 × 0.3–0.6 mm), with rounded apex (sometimes acute), mucronate or not; stigmas (2–)3. Fruit brownish, subglobose [(1.2–)1.4–1.7(–1.9) × 1.4–1.6(–1.8) mm] as long as or slightly longer (up to 1/4) than the perianth, clearly rugose, indehiscent. Seed lenticular (0.8–1.2 mm in diameter), black or brownish-black.

Iconography:—Chaudhary (1998: 239, Plate. 129b), Bayón (2015: 371, Figura 64).

Phenology:—Flowering time february.

Habitat and elevation:—Human-made habitat, 400–600 m a.s.l.

Chromosome number:— $2n = 34$.

Alien status:—Neophyte species native to South America, it can be considered as naturalized in Saudi Arabia (see also Chaudhary 1998).

Occurrence in Saudi Arabia (Fig. 3):—Al hudud ash Shamaliyah (Osman & El-Ameid Abedin 2019), Bisha (Abbas *et al.* 2020), Jizan, and Taif (Abdullah *et al.* 2017).

Taxonomic annotation:—The name *Amaranthus gracilis* Desf. was cited by Mandaville (2011) as synonym of *A. viridis*. Desfontaines' name was widely discussed by Iamónico (2016b) who reached to the conclusion that it is a *nomen ambiguum* published by Desfontaines (1804) as *nomen novum pro Chenopodium caudatum* Jacq. The latter Jaquin's name was proposed as *nomen rejectendum* by Iamónico *et al.* (2015).

Specimina visa selecta:—SAUDI ARABIA, Jizan, human-made habitat, (coastal plain) 5–15 m a.s.l., 17 February 2021, leg. Masrhai *et Al-shaye* (PNUH), det. Masrhai, conf. Iamónico (RO!).



FIGURE 3. Map of *Amaranthus viridis*.

5. *Amaranthus graecizans* L., Sp. Pl. 2: 990. 1753

Type (lectotype designated by Fernald 1945: 139):—U.S.A. *Habitat in Virginia*, Herb. Clayton No. 442 (BM000051563!, image of the lectotype available at <https://data.nhm.ac.uk/object/ca635ca9-9252-42a3-9082-60ec097bc2d6/1641427200000>).

= *Amaranthus angustifolius* Lam., Encycl. [J. Lamarck & al.] 1: 115. 1783, *nom. illeg.* Art. 52.2¹ of the ICN (Turland *et al.* 2018).

1 *Amaranthus angustifolius* was described citing among synonyms an earlier legitimate name (*A. graecizans* L.).

Description:—Herbs 1–8 dm tall, monoecious, annual (therophyte). Stems erect or ascending, ± glabrous (sometimes sparsely pubescent in the distal region), pale to black-brown to reddish, usually branched. Leaves usually green, ovate-rhomboidal to lanceolate (decreasing in size towards stem apex), with entire margins, apex acute or obtuse, sometimes mucronate, base cuneate, glabrous, petioled [petiole (1.0–)2.0–5.0(–6.0) cm long]. Synflorescences arranged in axillary glomerules, often reddish. Floral bracts brown-yellowish, lanceolate (1.2–2.0 × 0.3–0.6 mm) as long as or shorter than the perianth, acute, margin entire, glabrous. Staminate flowers with 3 tepals, ovate to lanceolate; stamens 3. Pistillate flowers with 3 tepals, ovate-lanceolate [(1.3–)1.5–2.0 × 0.4–0.7 mm], with acute, and often mucronate apex; stigmas 3. Fruit brown, subglobose [(1.5–)2.0–2.5(–2.7) × (1.0–)1.4–1.5(–1.8) mm], longer than the perianth, rugose, dehiscent. Seed lenticular [1.0–1.3(–1.5) mm in diameter], black to dark-brown.

Chorology:—Paleotemperate taxon native to Europe, Central-Western Asia, and Northern Africa (Carretero 1990, Akeroyd 1993, Boulos 1999, Ghafoor *et al.* 1977, Fennane & Tatou 2005, Le Floc’h *et al.* 2008), it is considered introduced in some European countries, North America, South Africa, and Australia (POWO 2022a and literature therein). Concerning Saudi Arabia, it is native.

At subspecific rank two main distribution areas can be distinguished, the first one including Central and southern Europe plus North Africa [subsp. *graecizans* and subsp. *sylvestris* (Vill.) Brenan], the second area being the eastern Europe (Russia and adjacent territories) plus Central and southern Asia [subsp. *aschersonianus* (Thell.) Costea and subsp. *thellungianus* (Nevski) Gusev] (see Iamónico 2015: 34).

Occurrence in Saudi Arabia:—See varieties.

Taxonomic annotations:—*Amaranthus graecizans* is a species morphologically variable, especially regarding the hairiness of stem, the shape of leaves (lanceolate or ovate-rhomboidal), the structure of synflorescence (with or without terminal synflorescence), the apex of bracts and tepals (acute-mucronate or awned), the margin of seed (obtuse or acute), and the dehiscence/indehiscence of fruit. This variability is currently interpreted recognizing four subspecies, i.e. subsp. *graecizans*, subsp. *sylvestris*, subsp. *aschersonianus*, subsp. *thellungianus* (see e.g., Costea 2003). Based on our field surveys and according to Chaudhary (1998) three subspecies occur in Saudi Arabia. These taxa can be distinguished as follow:

1. Bracts and tepals awned (awn 0.3–0.7 mm long).....subsp. *thellungianus*
2. Bracts and tepals mucronate (mucro about 0.1 mm long).....3
3. Leaf blade lanceolate [2.0–3.0(–4.0) × 0.5–1.0 cm], ratio length/width of the blade 3.0–6.0 subsp. *graecizans*
- Leaf blade ovate-rhomboidal [5.0–6.0 × 2.5–3.0(–3.5) cm], ratio length/width of the blade 1.8–2.2.....subsp. *sylvestris*



FIGURE 4. Map of *Amaranthus graecizans* subsp. *graecizans*.

5a. *Amaranthus graecizans* L. subsp. *graecizans*

Iconography:—Beck (1909: Tab. 299, figures 1–7, sub *A. angustifolius*).

Phenology:—Flowering time february.

Habitat and elevation:—Human-made habitat (coastal plain), 5–15 m a.s.l.

Chromosome number:— $2n = 32$ (Baquar & Olusi 1988).

Occurrence in Saudi Arabia:—Jizan.

Specimina visa selecta (Fig. 4):—SAUDI ARABIA, Jizan, human-made habitat (coastal plain), 5–15 m a.s.l., 17 February 2021, leg. *Masrhai et Al-shaye* (PNUH), det. *Masrhai*, conf. *Iamónico* (RO!).

5b. *Amaranthus graecizans* L. subsp. *sylvestris* (Vill.) Brenan, Watsonia 4: 273. 1961 \equiv *Amaranthus sylvestris* Vill., Cat. Pl. Jard. Strasb. 111. 1807 \equiv *Amaranthus sylvestris* Desf. ex Poiret, Tabl. École Bot.: 44. 1804, *nom. nud.*, *nom. inval.* (Art. 38.2 Ex.1 of the ICN) \equiv *Amaranthus graecizans* var. *sylvestris* (Desf.) Asch., Beitr. Fl. Aethiop.: 176. 1867, *comb. illeg.* \equiv *Amaranthus graecizans* subsp. *sylvestris* (Vill.) O.Bolòs & Vigo, Butl. Inst. Catalana Hist. Nat., Secc. Bot. 38(1): 89. 1974 \equiv *Amaranthus angustifolius* proles *sylvestris* (Vill.) Thell., Syn. Mitteleur. Fl. [Ascherson & Graebner] 5(1(5)): 300. 1914 \equiv *Amaranthus angustifolius* subsp. *sylvestris* (Vill.) Heukels, Geïllustreerde Schoolflora voor Nederland: 170. 1934.

Type (lectotype designated by Townsend 1985: 31):—*Herb. Tournefort 1849* (P!).

Iconography:—Willdenow (1790: Tab. VIII, fig. 16 sub *A. viridis*), Bayón (2015: 329, Figura 34)

Phenology:—Flowering time february.

Habitat and elevation:—Human-made habitat (coastal plain), 5–15 m a.s.l.

Chromosome number:— $2n = 32$.

Occurrence in Saudi Arabia (Fig. 5):—Jizan, Makkah.

Specimina visa selecta:—SAUDI ARABIA, Makkah, Jeddah, *s.d.*, *Kruijt 48* (L 1684182!); Jizan, human-made habitat (coastal plain), 5–15 m a.s.l., 17 February 2021, leg. *Masrhai et Al-shaye*, det. *Masrhai*, conf. *Iamónico* (PNUH!, RO!).



FIGURE 5. Map of *Amaranthus graecizans* subsp. *sylvestris*.

5c. *Amaranthus graecizans* L. subsp. *thellungianus* (Nevski) Gusev, Bot. Zhurn. (Moscow & Leningrad) 57(5): 462. 1972 \equiv *Amaranthus thellungianus* Nevski, Trudy Bot. Inst. Akad. Nauk S.S.S.R., Ser. 1, Fl. Sist. Vyssh. Rast. 4: 311. 1937

Holotype:—TURKMENISTAN, In angustiis Bulak-Dara ad pedem montium Kuhitang supra pagum Karluk, 11 August 1931, Nevski 730 [LE *non vidi fide* Townsend (1985); photo of the isotype at K000814926!, image of the photo of the isotype available at <http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000814926>).

Chromosome number:—Not still counted.

Occurrence in Saudi Arabia:—Chaudhary (1998: 238) indicated this taxon as “probably doubtful” in Saudi Arabia. No finding was done during the filed surveys. Further researches are necessary to verify the occurrence of this taxon in the country.

6. *Amaranthus sparganicephalus* Thell. in Ascherson & Graebner, Syn. Mitteleur. Fl. 5: 312. 1914

Type (neotype, here designated):—OMAN, Dhofar, J. Qara, nr. Aqarnahawat, *Acacia* hollow, 880 m a.s.l., 19.09.1985, *A. G. Miller* 7693 (E00687024!, image of the neotype available at <https://data.rbge.org.uk/herb/E00687024>).

Description:—Herbs, 0.7–6 cm tall, monoecious, annual (therophyte). Stems erect, glabrous (pubescent in the upper part), yellowish, simple or branched (branches sometimes decumbent). Leaves green to dark-green, ovate (1.5–5.5 × 0.6–3.0 cm), with entire margins, apex obtuse to retuse, mucronate, base cuneate, glabrous (short hairs on the nerves of the abaxial surface), long petioled (petiole up to 6.0 cm long). Synflorescences arranged in axillary spherical glomerules, ±1 cm in diameter, brown to dark-brown. Floral bracts ovate (0.3–0.5 × ca. 0.2 cm), about 1/2 times shorter than the perianth, acute to acuminate, mucronate. Staminate flowers with 3 tepals, green, ovate-lanceolate; stamens 3. Pistillate flowers with 3 tepals, green, ovate-lanceolate (1.0–1.3 × ca. 0.3 mm), with obtuse apex, median vein green; stigmas 2. Fruits arranged in stellate heads (divergent capsules), each one brown, as a double cone (2.75–3.25 × ca. 1.5 mm), longer than the perianth, the half base longitudinally sulcate, dehiscent with point of junction of lid and base cristate-crenulate. Seeds lenticular (1.2–1.5 mm in diameter), black.

Iconography:—Townsend (1985: 33, Fig. 6).



FIGURE 6. Map of *Amaranthus sparganicephalus*.

Phenology:—Flowering time from march to april.

Habitat and elevation:—Uncultivated land, around 2000 m a.s.l.

Chromosome number:—Not still counted.

Chorology:—Species native to eastern tropical Africa (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, Tanzania), Arabian Peninsula (Saudi Arabia, Yemen, Oman), and Socotra (POWO 2022b and literature therein).

Occurrence in Saudi Arabia (Fig. 6):—Riyadh.

Typification of the name *Amaranthus sparganicephalus*:—*Amaranthus sparganicephalus* was validly published by Thellung (1914: 312, a note) by a short diagnosis (in german) in which the following two characters were highlighted: the shape of the fruiting glomerules (which resembles those of the members belonging to the genus *Sparganium* L.; the specific epithet “*sparganicephalus*” derives from this feature) and that of each fruit (“polyedrisch abgeflachten” = “polyhedral flattened”); a morphologic comparison with *A. angustifolius* Lam. (currently *A. graecizans* subsp. *graecizans*) and *A. macrocarpus* Benth. was also given. Finally the provenance (“tropischen Africa ... und Arabiens” = tropical Africa and Saudi Arabia) and three specimens (“Abessinien: Massaua: Hildebrandt n. 716!; ostafrikan. Grabenrand, 1904, Merken! ... “Chedrasch et Chedolia, Ehrenberg!”) were reported. According to the Art. 9.6 of ICN, these three citations are syntypes, original material for the name *A. sparganicephalus* (Art. 9.4 of ICN), and useful for the lectotypification purpose (Art. 9.3 of ICN).

Verdcourt (1967: 252) listed 16 specimens of *Amaranthus sparganicephalus* adding “syntype” after three of them, i.e. “ARABIA. Chedrasch and Chedolia, Ehrenberg (B)”, “ERITREA. Massawa, Hildebrandt 716 (B)”, and “TANZANIA. Grabenland, 1904, Merker (B)”. These three specimens was also cited (as “Types”) by Townsend (1985: 32) in his treatment of Amaranthaceae for the *Flora of Tropical East Africa*. According to *Shenzen Code*, neither Verdcourt (1967: 252) nor Townsend (1985: 32) proposed a correct typification, since they just re-listed the syntypes which was originally reported by Thellung (1914: 312) in the protologue. As a consequence, a lectotypification is necessary. Note moreover that both Verdecourt and Townsend reported after the syntypes the symbol “†” which would indicate that the specimen was no longer existing. R. Vogt (pers. comm.) informed one of us (DI) that no original material for *A. sparganicephalus* is preserved at B being probably lost/destroyed during the II World War. Lacking material useful for the lectotypification purpose (Arts. 9.3 and 9.4 of ICN), a neotypification is required under the Art. 9.8 of ICN. We here propose to designate, as neotype of the name *A. sparganicephalus*, a well preserved specimen at E (barcode E00687024) collected in Oman in 1985 which matches the Thellung’s description and the current application of the name (see e.g., Townsend 1985: 32).

Specimina visa selecta:—SAUDI ARABIA. Raidah Village near base of scarp. 25 km NNW of Abha, waste ground in villane, 07 April 1995, *Collinette 9337* (E00121397!).

7. *Amaranthus blitoides* S. Watson, Proc. Amer. Acad. Arts 12: 273. 1877

Type (lectotype designated by Fernald 1945: 139):—U.S.A. Iowa: Ames, gravelly or sandy soils especially around buildings and along roads, Bessey s.n. (GH00036983!, image of the lectotype available at https://kiki.huh.harvard.edu/databases/specimen_search.php?mode=details&id=58020).

Description:—Herbs (0.4–)1–5 (rarely up to 10) dm tall, monoecious, annual (therophyte). Stems prostrate-ascending, glabrous (rarely sparsely pubescent), pale green to brown, branched. Leaves usually green (sometimes with a central whitish spot), oblong-lanceolate to obovate-spathulate [1.0–3.0(–4.0) × (0.3–)0.5–1.0(–1.5) cm], sometimes fleshy, with entire or undulate margins, apex acute or rounded, often mucronate, base cuneate, glabrous, with marginal white vein, petioled (petiole 0.5–1.8 cm long). Synflorescences arranged in axillary glomerules, reddish or green. Floral bracts green or greenish, ovate to lanceolate (1.3–3.0 × 0.4–0.7 mm), shorter than the longest perianth segments, acute, margin entire, glabrous. Staminate flowers with 3(–4) tepals, ovate to lanceolate; stamens 3. Pistillate flowers with (4–)5 unequal tepals, lanceolate, elliptic [the greater 1.5–2.5(–3.5) × (0.7–)1.0–1.2 mm], with acute to acuminate, and mucronate apex; stigmas 3. Fruit brown or reddish, ellipsoidal (2.0–2.2 × 1.0–1.4 mm), as long as or longer than the tepals, usually smooth, dehiscent. Seed lenticular (1.5–1.7 mm in diameter), black.

Occurrence in Saudi Arabia:—Jizan [first record, var. *blitoides* (see below)], Makkah (Iamonico 2016c).

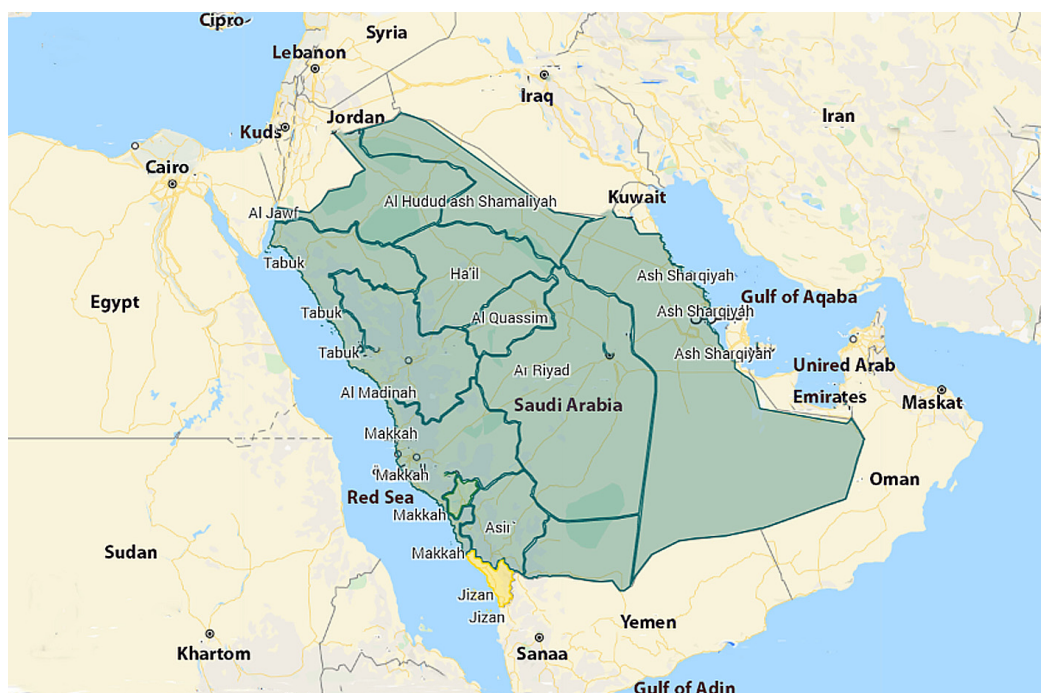


FIGURE 7. Map of *Amaranthus blitoides* var. *blitoides*.

7a. *Amaranthus blitoides* var. *blitoides*

Description:—See above.

Iconography:—Bayón (2015: 307, Figura 21).

Phenology:—Flowering time february.

Habitat and elevation:—Human-made habitat (coastal plain), 5–15 m a.s.l.

Chromosome number:— $2n = 32, 34$.

Occurrence in Saudi Arabia (Fig. 7):—Jizan (first record).

Alien status:—Neophyte species native to North America, it can be considered as casual in Saudi Arabia.

Specimina visa selecta:—SAUDI ARABIA. Jizan, human-made habitat (coastal plain), 5–15 m a.s.l., 17 February 2021, leg. *Masrhai et Al-shaye*, det. *Masrhai*, rev. *Iamonico* (PNUH!, RO!; Fig. 8); *ibidem* (PNUH!, RO!); *ibidem* (PNUH!, RO!).

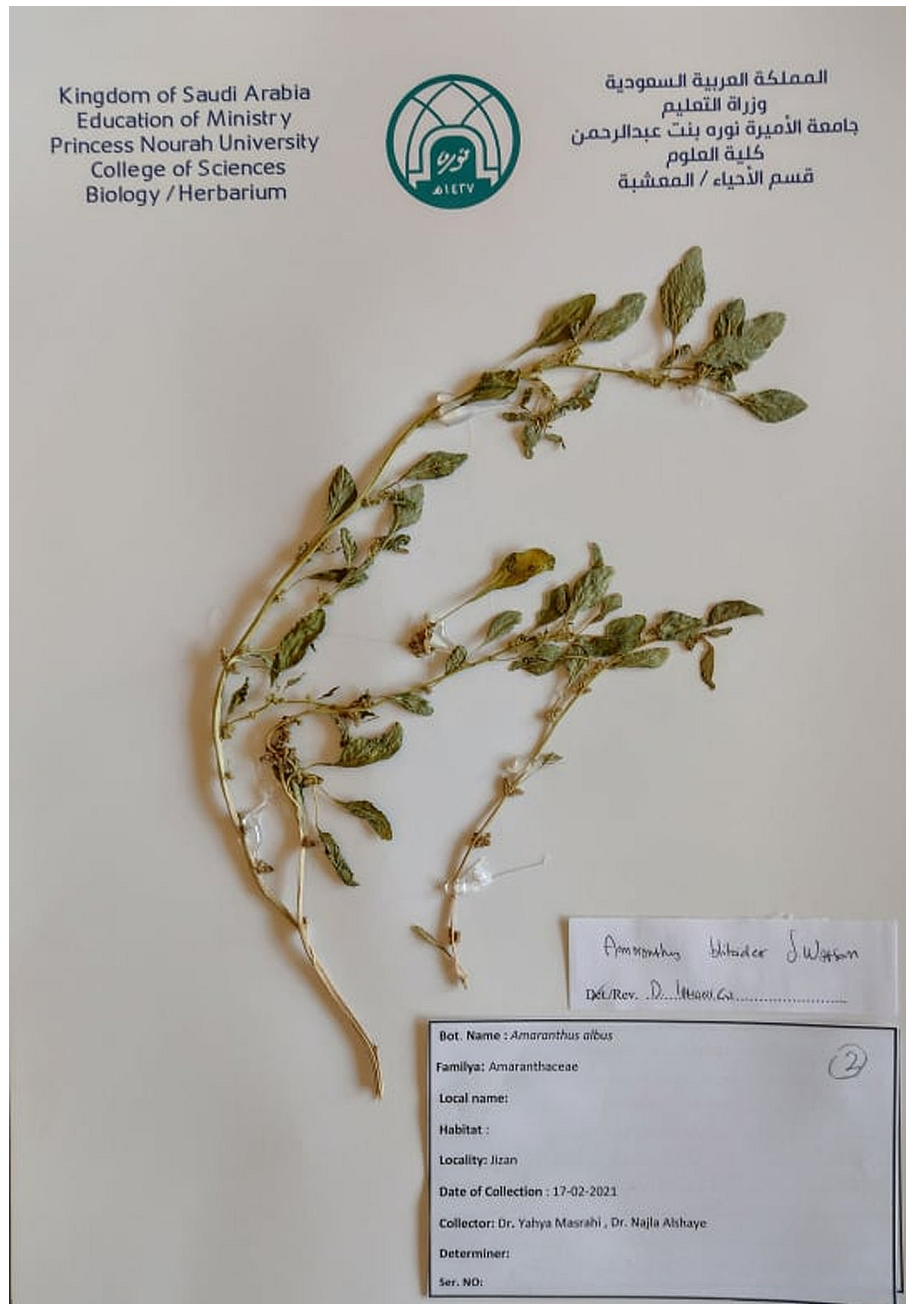


FIGURE 8. Specimen of *Amaranthus blitoides* var. *blitoides* collected at Jizan in february, 17 2021 by Y. Masrhai *et al.* (RO!).

7b . *Amaranthus blitoides* var. *nanus* (Moq.) Iamónico, *comb. nov.* ≡ *Amaranthus blitum* var. *nanus* Moq., Prodr. [A. P. de Candolle] 13(2): 263. 1849

Type (lectotype designated by Iamónico 2016c: 91):—SAUDI ARABIA. Ad cisternas Dschedda Arab feliz, 02 January 1836, *Schimper 857* (MPU022388!, image of the lectotype available at <https://herbier.umontpellier.fr/zoomify/zoomify.php?fichier=MPU022388>); isolectotypes at HAL0140219 (image of the isolectotype available at http://141.48.4.202/djatoka/jacq-viewer/viewer.html?rft_id=hal_0140219&identifiers=hal_0140219), M0241403! (image at <https://plants.jstor.org/stable/viewer/10.5555/al.ap.specimen.m0241403?loggedin=true>) and M0241404! (image at <https://plants.jstor.org/stable/viewer/10.5555/al.ap.specimen.m0241404>).

Description:—Similar to var. *blitoides* but smaller, i.e. 2.0–4.5 cm tall.

Phenology:—Flowering time January.

Habitat and elevation:—Human-made habitat, around the sea level.

Chromosome number:—Not still counted.

Alien status:—Native (endemic?) to Saudi Arabia.

Occurrence in Saudi Arabia (Fig. 9):—This species was firstly published for Saudi Arabia by Iamónico (2016c: 91–92; see below “TAXONOMIC NOTES”), sub *Amaranthus blitum* var. *nanus* Moq. on the basis of an old Schimper’s collection in Makkah (lectotype). No further finding was done during the filed surveys.



FIGURE 9. Map of *Amaranthus blitoides* var. *nanus*.

Taxonomic notes:—Iamónico (2016c: 91) lectotypified the name *Amaranthus blitum* var. *nanus* on a specimens preserved at MPU (barcode MPU022388). We found further three specimens at HAL (barcode HAL0140219) and M (barcodes M0241403 and M0241404) which can be considered as the isolectotypes, here published for the first time.

Concerning the identity of *Amaranthus blitum* var. *nanus*, Iamónico (2016c: 91–92) proposed to synonymized it with *A. blitoides* based on characters of flowers. However, no discussion was provided by Iamónico (2016c: 91–92) regarding the generative characters. Based on the examination of the types of *A. blitum* var. *nanus*, and the comparison with specimens and living plants examined by one of us (DI) during the last 15 years, Moquin-Tandon’s variety appear to be very small, i.e. 2.0–4.5 cm tall, whereas *A. blitoides* s.str. is at least 10–20 cm tall (see also Akeroyd 1993, Bao *et al.* 2003, Mosyakin & Robertson 2003, Bayón 2015, Iamónico 2015, Atlas of Living Australia 2022). Waiting further studies (floristic and molecular ones could be useful), we think that this taxon should be maintained as separate for the moment, at least at variety rank. Lacking a combination under *A. blitoides*, we here propose a nomenclatural change.

Specimina visa selecta:—SAUDI ARABIA, Makkah, Ad cisternas Dschedda Arab feliz, 02 January 1836, *Schimper 857* (MPU022388!);

8. *Amaranthus spinosus* L., Sp. Pl. 2: 991. 1753

Type (lectotype designated by Fawcett & Rendle 1914: 103):—ASIA. *Habitat in Indiis*, Herb. Linn. No. 1117.27 (LINN!, image of the lectotype available at <http://linnean-online.org/11653/>).

Description:—Herbs 1–85(–120) dm tall, monoecious, annual (therophyte), rarely biennial. Stems usually erect, ± glabrous (sometimes sparsely pubescent in the inflorescence region), white to white-greenish, much branched. Leaves green (usually pale green), ovate, elliptic to spatulate (3.5–6.0 × 1.5–3.0 cm in the main axis, greater than the leaves on the branches), often with undulate margins (sometimes with a white marginal vein), apex obtuse and mucronate, base cuneate, glabrous (rarely pubescent on the veins), petioled (petiole 1.6–3.0 cm long). Synflorescences arranged in axillary glomerules, light green. Floral bracts greenish, ovate-lanceolate [(2.0–)3.0–4.0(–6.0) × 0.3–0.6 mm], 2(–2.5) times longer than the perianth, awned, margin entire, glabrous. Staminate flowers with 3 tepals, lanceolate; stamens 3. Pistillate flowers with 3 tepals, linear to lanceolate [0.9–1.1 × 0.3–0.4(–0.5) mm], with acute apex; stigmas 3. Fruit brownish-black, ellipsoidal [(1.2–)1.4–1.8 × 1.0–1.2(–1.4) mm], as long as or slightly longer than the perianth, rugose when dry, dehiscent. Seed lenticular [(0.8–)0.9–1.1(–1.3) mm in diameter], black to brownish-black.

Iconography:—Beck (1909: Tab. 297, figures 3–5); Chaudhary (1998: Plate. 127g–j), Bayón (2015: 296, Figura 15).

Phenology:—Flowering time June (Al-Turki *et al.* 2000).

Habitat and elevation:—Human-made habitat, about sea level (Al-Turki *et al.* 2000).

Chromosome number:— $2n = 34$ (Al-Turki *et al.* 2000: 341), 68.

Alien status:—Neophyte species native to Neotropics, it can be considered as casual in Saudi Arabia (see also Chaudhary 1998).

Occurrence in Saudi Arabia (Fig. 10):—Bisha (Abbas *et al.* 2020), Jizan (Al-Turki *et al.* 2000, Aljieddani *et al.* 2021). No finding was done during the filed surveys. Further researches are necessary to verify the distribution of *A. spinosus* in the country.



FIGURE 10. Map of *Amaranthus spinosus*.

9. *Amaranthus caudatus* L., Sp. Pl. 2: 990. 1753

Type (lectotype designated by Townsend 1974: 10):—UNKNOWN ORIGIN. *Habitat in Perù, Persia, Zeylonia*, Herb. Linn. No. 1117.26 (LINN!, image of the lectotype available at <http://linnean-online.org/11652/>).

Description:—Herbs 8–15 dm tall, monoecious, annual (therophyte). Stems erect, glabrous (pubescent in the distal part), red to purple, branched. Leaves red, ovate, rhomboidal 5.0–15.0 × 2.0–8.0 cm), with entire margins, apex obtuse or acute, mucronate, base cuneate, often pubescent, petioled (petiole 1.0–12.0 cm long). Synflorescences terminal, spike-like, up to 60–70 cm long, red to purple, pendulous (terminal florescence 30 cm long or more). Floral bracts greenish to reddish, ovate to lanceolate-linear (3.0–4.0 × 0.8–1.5 mm) longer than the perianth, acute, awned, margin entire, glabrous. Staminate flowers with 5 tepals, ovate; stamens 5. Pistillate flowers with 5 tepals, lanceolate-spathulate

(1.0–2.5 × 0.3–1.3 mm), with acute (in this case mucronate) or obtuse (sometimes emarginate) apex; stigmas 3. Fruit brownish, globose (1.5–2.5 × 1.4–1.9 mm), as long as or longer than the perianth, smooth to rugose, dehiscent. Seed lenticular (1.0–1.5 mm in diameter), dark-brown to brownish-black.

Iconography:—Beck (1909: Tab. 297, figures 1–2), Bayón (2015: 277, Figura 6).

Phenology:—Flowering time december.

Habitat and elevation:—Dry and rocky places, human-made habitat, around 1700 m a.s.l.

Chromosome number:— $2n = 34, 68$.

Alien status:—Neophyte species native to South America (Argentina, Equador, Peru, and Bolivia), it can be considered as casual in Saudi Arabia (Makkah).

Occurrence in Saudi Arabia (Fig. 11):—According to Chaudhary (1998: 236) this species would be cultivated only in Saudi Arabia (as ornamental plant). Despite no wild plants were found by us during the field survey, we traced one specimen at IND, so confirming that the species occurs in Saudi Arabia.

Specimina visa selecta:—SAUDI ARABIA, Makkah, about 5 km N of Taif, dry, rocky hillside, military base, 1720 m, 11 February 1977, leg. *Humbles 100032*, det. *Johnson (IND0088369!)*.



FIGURE 11. Map of *Amaranthus caudatus*.

10. *Amaranthus dubius* Mart. ex Thell., Fl. Adv. Montpell.: 203. 1912

Type (neotype designated by Townsend 1974: 471–472):—GERMANY. Herbarium Regio Monacense, *ex horto Erlangensis*, *s.d.*, *s.c. s.n.* (M0107382!, image of the neotype available at <https://plants.jstor.org/stable/viewer/10.5555/al.ap.specimen.m0107382?loggedin=true>).

= *Amaranthus tristis* var. *xanthostachys* Moq., Prodr. [A. P. de Candolle] 13(2): 260. 1849 ≡ *Amaranthus dubius* var. *xanthostachys* (Moq.) Thell. in Asch. & Graebn., Syn. Mittel-Eur. Fl. 5: 266. 1914.

Type (neotype designated by Iamónico 2016c: 104): UNKNOWN ORIGIN. Herbarium Requien, *s.d.*, *s.coll. s.n.* (P04021942!, image of the neotype is available at <http://mediaphoto.mnhn.fr/media/14494899601942MO7c2qCCiZJWunt>).

Description:—Herbs 3–10 dm tall, monoecious, annual (therophyte). Stems erect, glabrous, green, branched. Leaves green, ovate, ± rhomboidal (2.0–)3.0–10.0 × (1.5–)2.0–6.0 cm, with entire margins, apex obtuse, mucronate, base cuneate, glabrous, petioled (petiole 0.8–5.5 cm long). Synflorescences terminal, panicle-like, green to yellowish. Floral bracts greenish-yellowish, lanceolate (1.2–2.0 mm long) shorter than the perianth, acute, awned, margin entire, glabrous. Staminate flowers with 5 tepals, ovate; stamens 5. Pistillate flowers with 5 tepals, oblong-spathulate (1.5–2.0) × 0.5–1.0 mm), with acute and mucronate apex; stigmas 3. Fruit brownish, ovoid (1.5–2.0 × 1.0–1.5 mm), shorter than the perianth, smooth to slightly rugose, dehiscent. Seed lenticular (0.8–1.0 mm in diameter), dark-brown to black.

Iconography:—Bayón (2015: 280, Figura 8).

Phenology:—Flowering time february.

Habitat and elevation:—Human-made habitat (coastal plain), 5–15 m a.s.l.

Chromosome number:— $2n = 64$ (Behera & Patnaik 1982, Baquar & Olusi 1988, Ugborogho & Oyelana 1992, Greizerstein & Poggio 1994).

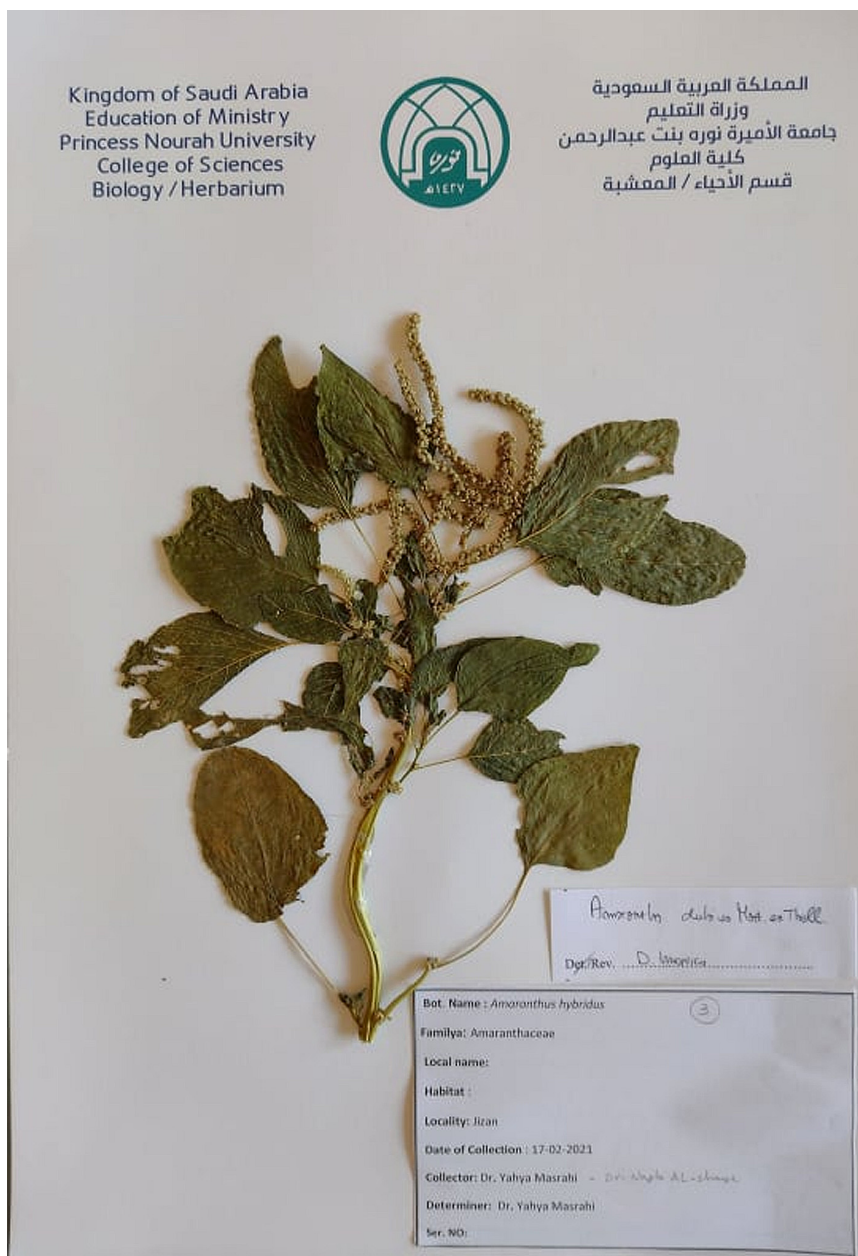


FIGURE 13. Specimen of *Amaranthus dubius* collected at Jizan in february, 17 2021 by Y. Masrahi *et al.* (RO!).

11. *Amaranthus hybridus* L., Sp. Pl. 2: 990. 1753

Type (lectotype designated by Townsend 1974: 19):—U.S.A. *Habitat in Virginia*, Herb. Linn. No. 1117.19 (LINN!, image of the lectotype is available at <http://linnean-online.org/11645/>).

= *Amaranthus chlorostachys* Willd., Hist. Amaranth.: 34. 1790.

Type (lectotype designated by Iamónico 2016a: 521):—UNSPECIFIED LOCALITY, *Hermes s.n.* (B-W17521!, image of the lectotype is available at <https://herbarium.bgbm.org/object/BW17521000>).

= *Amaranthus patulus* Bertol., Comment. Itin. Neapol. 19. 1837.

Type (lectotype designated by Iamónico 2016a: 525):—ITALY. *Campania: Napoli al Pasconcello*, September 1834, *Bertoloni s.n.* (BOLO!, image of the lectotype in Iamónico 2916^o: Figure 3).

= *Amaranthus hybridus* L. subsp. *hybridus* var. *erythrosthachys* Moq., Prodr. [A.P. de Candolle] 13(2): 259. 1849.

Type (lectotype designated by Iamónico 2016a: 522):—FRANCE. “*Hort. Tol.*”, 1844, *sine coll. s.n.* (G147762/1!, image of the lectotype available at <http://www.ville-ge.ch/musinfo/bd/cjb/chg/adetail.php?id=138993&base=img&lang=en>).

Description:—Herbs 6–20(–25) dm tall, monoecious, annual (therophyte). Stems erect, glabrous (pubescent in the upper part), green to reddish, often branched. Leaves usually green, ovate to ovate-lanceolate, rhomboidal [(2.0–)3.0–8.0(–13.0) × (1.0–)1.5–6.0(–6.0) cm], with usually entire margins, apex acute or obtuse, mucronate, base cuneate,

usually glabrous, petioled [petiole (1.0–)1.5–4.0(–6.0) cm long]. Synflorescences terminal, panicle-like, the main florescence usually up to 15 cm long (longer than the paraclades), usually green. Floral bracts greenish or yellowish, lanceolate to lanceolate-linear [(2.5–4.5(–6.0) × 1.0–1.5 mm)], 1.6–2.0 times longer than the perianth, acute, awned, with membranous border abruptly interrupted at the half, margin entire, glabrous. Staminate flowers with 5 tepals, ovate-lanceolate; stamens (4–)5. Pistillate flowers with 5 tepals, ovate to lanceolate [(1.5–)2.0–2.5(–3.0) × 0.5–0.7 mm], with acute and sometimes mucronate apex, median vein usually dark-green; stigmas 3. Fruit usually brown, ellipsoidal [1.5–2.5(–3.5) × 1.0–1.2 mm], as long as or longer than the perianth, smooth to rugose, dehiscent. Seed lenticular (0.9–1.4 mm in diameter), black to dark reddish-brown.

Iconography:—Ardenghi & Parolo (2010: 71, figs. 6b, e), Bayón (2015: 283, Figura 10).

Phenology:—Flowering time April (Al-Eisawi & Al-Ruzayza 2015).

Habitat and elevation:—Human-made habitat, at 250–300 m a.s.l. (Al-Eisawi & Al-Ruzayza 2015).

Chromosome number:— $2n = 32, 34$.

Alien status:—Neophyte species native to tropical areas of North and Central America, it can be considered as naturalized in Saudi Arabia (Chaudhary 1998).

Occurrence in Saudi Arabia (Fig. 14):—Al-Baha, Makkah (Al-Eisawi & Al-Ruzayza 2015), Tabuk (Aljieddani *et al.* 2021), Bisha (Abbas *et al.* 2020), and Taif (Abdullah *et al.* 2017). No finding was done during the filed surveys. Further researches are necessary to verify the distribution of *Amaranthus hybridus* in the country.



FIGURE 14. Map of *Amaranthus hybridus*.

Taxonomic annotations:—*Amaranthus hybridus* is a species characterized in having an high phenotypic variability, especially concerning the features of the flowers. Costea *et al.* (2001) recognized two subspecies [subsp. *hybridus* and subsp. *quitensis* (Kunth) Costea & Carretero] on the basis of the shape of the tepals (ovate and acute in subsp. *hybridus*, obovate to spatulate tepals and obtuse to truncate in subsp. *quitensis*). However, one of us (DI) believes that the taxon *quitensis* is more related to *A. retroflexus*, at least on the basis of shape and length of the tepal (a study is in progress by DI). In other cases, other taxa (e.g., *A. cruentus* L. or *A. hypochondriacus* L.) were accepted as subspecies of *A. hybridus* (see, e.g. Galasso *et al.* 2018). Anyway, further several forms were described in the past and a taxonomic revision is still lacking. We here accept the recognition of *A. hybridus* as separate species from the other member of the aggregate, according to Iamónico (2015).

12. *Amaranthus cruentus* L., Syst. Nat., ed. 10. 2: 1269. 1759

Type (lectotype designated by Townsend 1974: 12):—CHINA. *Habitat in China*, Herb. Linn. No. 1117.25 (LINN!, image of the lectotype available at <http://linnean-online.org/11651/>).

= *Amaranthus flavus* L., Syst. Nat., ed. 10. 2: 1269. 1759.

Type (lectotype designated by Iamónico 2014a: 147):—UNKNOWN ORIGIN. Herb. Linn. No. 1117.23 (LINN!, image of the lectotype available at <http://linnean-online.org/11649/>).

= *Amaranthus paniculatus* L., Sp. Pl., ed. 2. 2: 1406. 1763.

Type (lectotype designated by El Hadidi & El Hadidy 1981: 37):—AMERICA. *Habitat in America*, Herb. Linn. No. 1117.20 (LINN!), image of the lectotype available at <http://linnean-online.org/11646/>.

= *Amaranthus sanguineus* L., Sp. Pl., ed. 2. 2: 1407. 1763.

Type (lectotype designated by Iamónico 2014a: 148):—UNKNOWN ORIGIN. Herb. Linn. No. 1117.21 (LINN!), image of the lectotype available at <http://linnean-online.org/11647/>.

Description:—Herbs 5–14 dm tall, monoecious, annual (therophyte). Stems erect, ± glabrous (slightly pubescent in the upper part), red or green, often distally branched. Leaves usually green, ovate to ovate-lanceolate, rhomboidal [(3.0–)5.0–12.0(–14.0) × (1.5–)3.0–6.0(–7.0) cm], with entire margins, apex acute or obtuse (sometimes slightly emarginate), mucronate, base cuneate, glabrous or slightly pubescent, petioled (petiole 1.5–10.0 cm long). Synflorescences terminal, panicle-like, the main florescence up to 15 cm long (longer than the paraclades), red or green. Floral bracts green or greenish, lanceolate (2.0–3.5 × 0.8–1.3 mm), 1.0–1.5 longer than the perianth, acute, awned, with membranous border abruptly interrupted at the half, margin entire, glabrous. Staminate flowers with 5 tepals, ovate-lanceolate; stamens (4–)5. Pistillate flowers with 5 tepals, ovate-lanceolate [(1.5–)2.0–2.5(–3.0) × 0.6–1.5 mm], with acute and sometimes mucronate apex, median vein usually yellow-brown; stigmas 3. Fruit brown, ellipsoidal (2.0–2.5 × 1.4–1.6 mm), longer than the perianth, smooth to slightly rugose, dehiscent. Seed lenticular (1.2–1.6 mm in diameter), dark-brown to reddish-brown.

Iconography:—Willdenow (1790: Tab. II fig. 4, sub *A. paniculatus*), Beck (1909: Tab. 296, figures 3–4, sub *Euxolus patulus*), Bayón (2015: 280, Figura 7).

Chromosome number:— $2n = 32, 34$.

Alien status:—Neophyte species native to Central America, it can be considered as naturalized in Saudi Arabia (Chaudhary 1998).

Occurrence in Saudi Arabia:—Chaudhary (1998) indicated this species [sub *Amaranthus hybridus* subsp. *cruentus* (L.) Thell.] in “the southwest of Saudi Arabia”, without further data about the localities in which it occurs. No finding was done during the filed surveys. Further researches are necessary to verify the distribution of *A. cruentus* in the country.

Taxonomic annotations:—*Amaranthus cruentus* is quite variable from the morphological point of view, especially concerning the surface of the leaf blade (simple green, green with a white band arch-shaped, or green with a central red spot), the structure of the synflorescences (the paraclades can be erect to patent), and the colour of the stem and synflorescence (from green to red or dark-red). Some cultivars (*A. cruentus* is also used as ornamental plant), especially those with dark-red synflorescences, can be confused with some forms of *A. hypochondriacus*, but the two species differ each other by the characters of the bracts (see Iamónico 2015).

Discussion

A first taxonomic revision of the genus *Amaranthus* for Saudi Arabia is presented by providing, for each taxon, the currently accepted name and main synonyms, nomenclatural types, description, a reference to a good published iconography, chromosome number (if exists), chorology, occurrence in Saudi Arabia, and taxonomic annotations where necessary. A diagnostic key (at species rank and below) was provided.

Twelve non-hybrid species (16 taxa) were here recorded for Saudi Arabia.

From the floristic point of view, we discovered two new taxa for the national flora, i.e. *Amaranthus blitoides* var. *blitoides* and *A. dubius*. Concerning six taxa (*A. albus*, *A. blitum* var. *oleraceus*, *A. graecizans* subsp. *thellungianus*, *A. spinosus*, *A. hybridus*, and *A. cruentus*), no finding was made during the filed surveys and their occurrence in Saudi Arabia refer only to literature. One species (*A. tricolor*) is just cultivated as ornamental plant in the country.

From the taxonomic and nomenclatural points of views, a new combination (*Amaranthus blitoides* subsp. *nanus*) is proposed for a Moquin-Tandon's variety described from Saudi Arabia which, based on the current knowledge, occurs only in the country being possibly an endemic taxon (further researches are necessary to verify the chorology of this taxon). Moreover, we neotypified the name *A. sparganicephalus* on a specimen deposited at the Herbarium E and given a discussion about the type of *A. dubius*.

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Author contributions

WH and DI conceived the research; WH and NA carried out field surveys; WH, DI, and SA searched pertinent literature; WH and DI prepared the figures; DI wrote the first draft of the manuscript; WH, DI, NA, and SA review the text.

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