Amaranthus tunetanus (Amaranthaceae), a new species from Tunisia and a diagnostic key to the North African taxa in subgen. Albersia

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Abstract
A new species of Amaranthus (Amaranthaceae), A. tunetanus sp. nov. from Monastir Governorate (central Tunisia) is described and illustrated. The new species is morphologically similar to A. crassipes, A. crispus, A. graecizans subsp. aschersonianus, and A. scleropoides from which it differs mainly by characters of synflorescences and flowers. Distribution in Tunisia, notes of its preferred habitat, phenology, and the IUCN status of conservation are also provided. A diagnostic key to the 14 taxa of subgen. Albersia occurring in North Africa is also presented.

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1. Introduction
Amaranthus L. (Amaranthaceae Juss.) is a genus of about 70 mostly annual monoecious and dioecious species with a worldwide distribution. Approximately 40 species are native to the Americas, the remaining ones to all the other continents except Arctic and Antarctic regions (see e.g., Mosyakin and Robertson, 2003; Iamonico, 2015a). Several American species are used as ornamentals, and some of them are able to escape from cultivation, negatively impacting the agricultural systems through a reduction in both productivity and crop quality (see Iamonico, 2010).

The genus Amaranthus is critical from a taxonomic point of view due to its high phenotypic variability which has resulted in the current nomenclatural disorder and misapplication of several names (see e.g., Costea et al., 2001; Bayón, 2015; Iamonico, 2016a, 2016b, 2016c). According to Le Floch et al. (2010) and Iamonico (2015b), 10 species of Amaranthus currently occur in Tunisia.

As part of an ongoing investigation on the Tunisian Amaranthaceae s. lat. (Sukhorukov et al., 2016; Iamonico and El Mokni, 2016, 2017), we found some populations whose morphological characteristics do not match those of any other known Amaranthus taxon. We here propose A. tunetanus Iamonico & El Mokni sp. nov. as a new species to science.

2. Material and methods
The work is based on field surveys, analysis of relevant literature and examination of specimens preserved at CAT, G, FI, HFLA, K, P, RO, NY, and US (acronyms according to Thiers, 2017+) and in the personal collection of one of the authors (R. El Mokni) deposited in the herbaria of the Faculty of Pharmacy of Monastir and the Faculty of Sciences of Bizerta (not listed in Index Herbariorum).

3. Taxonomic treatment

Amaranthus tunetanus Iamonico & El Mokni sp. nov.
Type: Tunisia. Monastir south, 35°46′23.92″N, 10°40′51.57″E, meadows and roadsides, 3 m a.s.L, 13 Jan 2016, El Mokni 4163 (HFLA-4163, holo.; Herbarium El Mokni at the Faculty of Pharmacy of Monastir, iso.!) Fig. 1.

3.1. Diagnosis
Herbs 30–80 cm tall, dioecious, annual (therophyte). Stems erect, glabrous, brownish or reddish, branched. Leaves green or red (sometimes

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green in the first half of the blade and red in the distal part), ovate, rhomboidal, \((0.5–1.0–2.2(–2.5) \times (0.2–)0.5–1.0(–1.6))\) cm, glabrous, margins entire or slightly undulate, sometimes reddish, apex obtuse with apical mucro, base cuneate, petiolate; petiole \((0.1–0.3–2.5)\) cm long, with prominent white veins on the abaxial surface. Synflorescences in either axillary glomerules or a single terminal spike in the same individual; the terminal synflorescence is erect, dense or interrupted, green. Floral bracts 1, usually light green, ovate, \((1.7–2.0–2.5(–2.7) \times (2.3–)2.5–3.0(–3.2))\) mm, about half the length of the perianth, apex acuminate-mucronate, margin entire, glabrous. Staminate flowers with 5 tepals, about equal to each other, lanceolate, \(3.0–4.0(–4.5) \times 1.0–1.3\) mm, apex acute, mostly awned; stamens 5. Pistillate flowers with 5 tepals \([2.7–3.0–5.5(–5.7) \times 2.3–2.5]\) mm, connate in the proximal 1/4–1/3, spathulate with the distal part expanded, hyaline distally (veins of tepals not occurring in the hyaline part), and an apical mucro up to 0.4 mm long, median vein sometimes red in color; style branches more or less erect; stigmas \(2(–3)\). Fruit indehiscent, brown, subglobose to ellipsoidal, \((1.5–3.0 \times 1.0–2.5)\) mm, slightly longer than the perianth, and verrucose at maturity. Seed lenticular, \(0.9–1.0(–1.1)\) mm in diameter, dark, shiny, smooth at the center, and slightly striate on the margin (width of the striate margin about 1/4 of the diameter of seed).

3.2. Etymology
The species epithet is dedicated to the country Tunisia.

3.3. Iconography
See Fig. 2.

3.4. Proposed vernacular name
Tunisian amarant.

3.5. Phenology
Two periods of flowering and fruiting were observed in the populations found. The first period ranges from November to February.
(flowering time November–January; fruiting time December–February), the second period ranges from April to July (flowering time April–June; fruiting time May–July).

3.6. Distribution and habitat

*Amaranthus tunetanus* is restricted to two localities of the Monastir Governorate: Monastir (two populations), and Jemmel (two populations). The species grows on clay and sandy substrates in meadows, margins of cultivated fields and railroads, uncultivated lands, and flower beds, at 32 m a.s.l. (type recorded at 3 m a.s.l.).

3.7. Origin status (sensu Pyšek et al., 2004)

The question regarding the status as native or not to the region is a crucial matter (see e.g., Pyšek et al., 2004). Webb (1985) and Preston (1986) provided the following useful criteria for presuming the origin status of a taxon: paleobotanical data, historical records, habitat, geographical distribution, genetic diversity, reproductive biology, and related phytophagous. According to Pyšek et al. (2004), most of these criteria are still relevant. Lacking desirable fossil and/or DNA evidence for *Amaranthus tunetanus*, we must consider the other criteria for evidence of its native status.

No historical records were confirmed for *Amaranthus tunetanus* as we have not traced specimens that could be matched to the new species, including any of the European and American herbaria consulted (see e.g. the list of 45 herbaria in Iamonico, 2015a). The distribution area of the new Tunisian amaranth appears to be restricted to the central-eastern part of Tunisia. According to Webb (1985: 233–234), the restricted distribution of *A. tunetanus* indicates that it is a native of Tunisia. In addition, another criterion to which we can refer is the reproductive biology (Webb, 1985: 235). Since *Amaranthus tunetanus* is observed to reproduce only by seeds, we may assume that *A. tunetanus* is native.
In contrast, its preference for man-made habitats suggests that A. tunetanus is an alien species (Webb, 1985: 234). Pyšek et al. (2002, 2004) specified that plants introduced to a region after ca. 1500 should be named ‘Archeophytes’. Pyšek et al. (2004: 138) also pointed out that “Since many archaeophytes now occur only in human-made habitats, we can ask, on the basis of the knowledge of their ecology, whether we can identify their potentially native habitat in the landscape before it was affected by people”. Hence, A. tunetanus could be considered as archeophyte, but potentially native.

In addition to the criteria proposed by Webb (1985) and Preston (1986), and the discussion made by Pyšek et al. (2002, 2004), we can consider the following taxonomic and nomenclatural question: are the plants found in central-eastern Tunisia already been named elsewhere? No plant showing morphological characteristics of A. tunetanus appears to be described up till now. This is based on our 1) studies at national or continental levels (e.g., Iamonico, 2015a, 2015b; Iamonico and Das, 2014; Iamonico and El Mokni, 2017), II) analysis of recent literature (e.g., Bayón, 2015; Das, 2015; Iamonico, 2015b; Sánchez-Del Pino et al., 2017 – see also literature therein) and III) discussions with many other Amarants’ experts (e.g., N. Bayón from S-America, I. Sánchez-Del Pino from C-America, S. Das from India, J. Palmer from Australia). Furthermore, any of the hundred names which were studies from the nomenclatural point of view (analysis of protologues, original material and types) by one of us (Di, see see Iamonico, 2014a, 2014b, 2016a, 2016b; Iamonico and Clementi, 2016) matched the Tunisian material of A. tunetanus.

All things stated, we here consider Amaranthus tunetanus as a native species of Tunisia.

3.8. Conservation status

The distance between the two sites where A. tunetanus occurs is about 30 km. The Monastir populations are about 4 to 5 km apart while the Jemmel’s populations are 3–4 km apart. The known AOO is about 27.87 km², while the EOO is 110.94 km². No protection plans exist for the areas where the new species occurs. Threats are represented by: residential and commercial development (urban areas), transportation and service corridors (roads), human intrusions and disturbances (recreational activities), and pollution (agricultural effluents). On the basis of the application of the IUCN criteria B1 and B2a, bii (2014), A. tunetanus can be categorized as Endangered (EN).

3.9. Taxonomic notes

Amaranthus tunetanus is morphologically similar to species belonging to the subgenus Albersia (Kunth) Gren. & Godr. sect. Pentamorion (G.Beck) Mosyakin & K.Roberson sensu Mosyakin and Robertson (1996), namely: A. cressipes Schltldl. s.str., A. crispus (Lesp. & Thévenau) A. Braun ex J.M.Coul., & S.Watson, A. scleropoides Uline & W.L., and A. standleyanus Parodi ex Covas (Table 1). All these species share a common character, viz. the shape of the tepals which are spathulate and expanded distally. However, they differ in a number of ways: A. scleropoides has circumsiccise dehiscent fruits, whereas the fruits of A. tunetanus as the other species (i.e. A. cressipes, A. crispus, A. standleyanus) are indehiscent. The new Tunisian species differs from A. scleropoides and A. cressipes in having the synflorescence not thickened at any stage of the life cycle, while in the latter two species the synflorescence is thickened, becoming indurate (= hardened) at maturity, a unique feature of Amaranthus. A. standleyanus differs from A. tunetanus by the following characters: shape and length of bracts [ovate-lanceolate, 0.5−2.0 vs. narrow ovate, (2.3−2.5−3.0(−3.2) mm)], structure of the perianth (tepals free vs. connate in the proximal 1/4−1/3), expansion of tepals of pistillate flowers (uniform vs. hyaline in the distal part), length of tepals of pistillate flowers [1.5−2.8 vs. (2.7−)3.0−5.5(−5.7) mm]. A. crispus can be easily distinguished from A. tunetanus by its habit (prostrate to ascendent vs. erect), leaf blade margin (highly undulate vs. entire or slightly undulate), expansion of tepals of pistillate flowers (uniform vs. hyaline

| Habit | Leaf length (mm) | Synflorescence | Tepals structure (pistillate flowers) | Perianth (pistillate flowers) | Tepals structure (staminate flowers) | Perianth (staminate flowers) | Fruit | Seed color | Seed surface |
|-------|-----------------|----------------|--------------------------------------|-----------------------------|------------------------------------|-----------------------------|------|------------|-------------|
| Mostly decumbent | Mostly extended | Mostly extended | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free |
| Mostly erect | Mostly extended | Mostly extended | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free |
| Mostly erect | Mostly extended | Mostly extended | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free |
| Mostly erect | Mostly extended | Mostly extended | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free |
| Mostly erect | Mostly extended | Mostly extended | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free | Mostly free |

Table 1: Morphological comparison among Amaranthus crassipes, A. crispus, A. cressipes, A. standleyanus, A. scleropoides, A. tunetanus and A. standleyanus. The characters which are diagnostic among A. tunetanus and the other five taxa are underlined.
in the distal part), length of tepals of pistillate flowers [1.3–2.0 vs. (2.7–)3.0–5.5(–5.7) mm], seed surface (dotted on the margin vs. slightly striate on the margin).

A further taxon which could be confused with A. tunetanus, due to their leaf shape and the terminal spike-like synflorescence, is A. graecizans L. subsp. aschersonianus Thell. The main difference between these two taxa is that the tepals are spathulate with an expanded distal part in A. tunetanus, as opposed to ovoid-lanceolate without an expanded distal part in A. graecizans.

### 3.10. Taxonomic notes on Amaranthus subgen. Albersia in North Africa

According to SANBI (2012 and literature therein), Iamonico (2015b) and Sukhorukov et al. (2016), the number of taxa in subgen. Albersia sensu Mosyakin and Robertson (1996) currently occurring in North Africa is 14 (including three subspecies and two varieties). We here present a diagnostic key to these taxa (the sexual characters reported in the key refer to the pistillate flowers – see e.g., Bayón, 2015; Iamonico, 2015a).

Key to the N-African species of Amaranthus belonging to subgen. Albersia sensu Mosyakin and Robertson, 1996:

1a. Tepals 2 ...........................................................................................................

1b. Tepals more than 2 ........................................................................................ 2

2a. Tepals 3 .........................................................................................................

2b. Tepals 4, leaf blades lanceolate to oblange-spathulate with marginal white vein .................................................. A. blitoides

3a. Lamina of leaf ovate-rhomboidal (ratio length/width 3.0–6.0).......................... A. graecizans subsp. graecizans

3b. Lamina of leaf ovate-rhomboidal (ratio length/width 1.5–2.5).......................... A. graecizans subsp. syvæstris

4a. Synflorescence arranged in glomerules .......................................................... 5

4b. Synflorescence arranged in terminal spike-like structures ................................ 5

5a. Leaf apex emarginate to bilobed ................................................................. A. emarginatus

5b. Leaf apex acute ............................................................................................. 6

6a. Fruit shorter than the tepals ................................................................. A. tricolor

6b. Fruit as long as the tepals ............................................................................. A. graecizans s.lat.

7a. Lamina of leaf lanceolate (ratio length/width 3.0–6.0)................................. A. graecizans subsp. graecizans

7b. Lamina of leaf ovate-rhomboidal (ratio length/width 1.5–2.5) ....................... A. graecizans subsp. syvæstris

8a. Tepals spathulate with expanded distal part .............................................. 8

8b. Tepals ovate-lanceolate, 0.5–2.0, tepals 1.5–2.8 mm long, free, with expansion uniform ................................................ A. standleyanus

9b. Bracts narrow ovate, (2.3–)2.5–3.0(–3.2) mm, tepals (2.7–)3.0–5.5(–5.7) mm long, conflate in the proximal 1/4–1/3, with expansion uniform vs. hyaline in the distal part .......................................................................................................................... A. tunetanus

10a. Fruit rugose to strongly rugose on surface .............................................. 10

11a. Fruit indehiscent ......................................................................................... A. viridis

11b. Fruit dehiscent .... A. graecizans subsp. thellungianus

10b. Fruit smooth or slightly rugose on surface; stem prostrate or ascending .... 10

12a. Fruit pear-shaped, 2 times longer than the tepals ...................................... A. deflexus

12b. Fruit subglobose or ellipsoid (up to 1.5 times longer than tepals) ............. A. blitum s.lat.

13a. Seed diameter 1.1–1.2 mm .... A. blitum var. blitum

13b. Seed diameter 1.3–1.9 mm ......................................................................... A. blitum var. oleraceus

14a. Tepals 4, leaf blades lanceolate to oblange-spathulate with marginal white vein .................................................. A. blitoides

14b. Tepals 5, leaf blades linear to linear-lanceolate, without marginal white vein .................................................. A. muricatus

### 3.11. Representative specimens examined

Tunisia. MONASTIR: Monastir north, 35°45′55.55″N, 10°49′48.00″E, flowerbeds in public gardens, 16 m a.s.l., 03 Oct 2015, El Mokni s.n. (Herb. El Mokni); ibidem 18 Mar 2016, El Mokni s.n. (Herb. El Mokni); ibidem, 11 Oct 2016, El Mokni s.n. (Herb. El Mokni); ibidem, 06 Nov 2016, El Mokni s.n. (Herb. El Mokni); Zaoüiet Kontich, 35°39′02.63″N, 10°46′06.77″E, margins of cultivated field and roadsides, about 30 m a.s.l., 23 Jul 2016, El Mokni s.n. (Herb. El Mokni); Jemmel, 35°37′06.26″N, 10°45′23.55″E, uncultivated lands in urban areas, about 32 m a.s.l., 16 Jul 2016, El Mokni s.n. (Herb. El Mokni).

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