

Amaranthus palmeri, a second record for Africa and notes on *A. sonoriensis* nom. nov.

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Dates:

Received: 09 May 2016

Accepted: 13 Dec. 2016

Published: 24 Feb. 2017

How to cite this article:

Iamónico, D. & El Mokni, R.,
2017, '*Amaranthus palmeri*, a
second record for Africa and
notes on *A. sonoriensis* nom.
nov.', *Bothalia* 47(1), a2100.
<https://doi.org/10.4102/abc.v47i1.2100>

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Background: *Amaranthus* is a critical genus from a taxonomic point of view because of its high phenotypic variability, which has led to nomenclatural disorder, misapplication of names, and erroneous species identification. As a whole, floristic and taxonomic studies on this genus are still incomplete.

Objectives: The main objective was to record the North American species *Amaranthus palmeri* in Tunisia for the first time and to point out a second occurrence for Africa. At the same time, we highlight some nomenclatural confusion concerning the name *A. palmeri* var. *glomeratus* which appears to be untypified and which should be treated at species rank.

Method: The work is based on field surveys, analysis of relevant literature and examination of specimens preserved in the herbaria GH, FI, HFLA, K, MICH, NEBC, NY, MO, P, RO, US, and the Herbarium of Bizerta University.

Results: A population of *Amaranthus palmeri* was discovered in Bizerta Province, representing the first record for the national flora. This record also represents the second record for Africa. Morphological characters, as well as ecological data are provided. Nomenclatural notes are provided for *A. palmeri* var. *glomeratus* (lectotype at GH, here designated; isolectotypes at MICH and US), and a new name (*A. sonoriensis*) is proposed.

Conclusion: *Amaranthus palmeri* is an alien species in Tunisia, growing along roadsides and in public gardens. Future monitoring of the populations found will be necessary to verify possible naturalisation and spreading of *A. palmeri* in Tunisia. If this happens, actions for eradication of the plants will be necessary.

Introduction

Amaranthus L. (Amaranthaceae Juss.) is a genus of about 70 mostly annual, monoecious and dioecious species with worldwide distribution. Approximately 40 species are native to the Americas and the remaining species are native to the other continents (see e.g. Costea, Sanders & Waines 2001; Iamónico 2015a). Several American species are used as ornamentals, and others are cultivated for grains or as leafy vegetables. In many areas *Amaranthus* species have escaped cultivation and have become problematic for agricultural systems, causing economic loss and for biodiversity because the species compete with indigenous species for resources such as light and nutrients.

Amaranthus is a challenging genus from a taxonomic perspective because of its high phenotypic variability, which has led to nomenclatural disorder and misapplication of names (see e.g. Costea et al. 2001; Iamónico 2015a; Mosyakin & Robertson 1996; Nestor 2015). No comprehensive molecular study has been done yet, and the more recent infrageneric classification was proposed by Mosyakin and Robertson (1996) who recognised three subgenera: subgenus *Acnida* (L.) Aellen ex K.R. Robertson with three sections, subgenus *Albersia* (Kunth) Gren. & Godr. with four sections, and subgenus *Amaranthus*, with three sections and two subsections.

According to Mosyakin and Robertson (1996), the subgenus *Acnida* (= *Acnida* L.) would include the dioecious species, which were classified into three sections, sect. *Acnida* (L.) Mosyakin & K.R. Robertson (pistillate flowers with 0–2 tepals and mostly indehiscent fruits), sect. *Sauveranthus* Mosyakin & K.R. Robertson (pistillate flowers with five tepals and dehiscent fruits) and sect. *Acanthochiton* (Torrey) Mosyakin & K.R. Robertson (pistillate flowers with broad, deltate and foliaceous bracts). All the taxa belonging to the subgenus *Acnida* are native to North America while they occur in other continents as aliens, sometimes as invasive (see e.g. Iamónico 2015b).

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The Flora of Africa (see SANBI 2012 and literature therein; Iamónico 2015b) currently includes only one species belonging to the subgenus *Acnida*, *Amaranthus palmeri* S. Watson, which was recorded only in Egypt (Boulos 2009:57).

As part of an ongoing study on the genus *Amaranthus* (see e.g. Iamónico 2014a, 2014b, 2015a, 2015b, 2016a, 2016b, 2016c; Iamónico & Das 2014) and the Tunisian Amaranthaceae (Sukhorukov et al. 2016), field surveys were carried out and resulted in the identification of a population of *A. palmeri* and this represents the first record of the species for Tunisia and only the second for Africa. Morphological notes, data on the habitat, as a nomenclatural study of the name *Amaranthus palmeri* var. *glomeratus* Uline & W.L. Bray (which appears still untypified) and notes on the name *A. palmeri* are presented here.

Material and methods

The work is based on field surveys (July 2014–October 2015), analysis of relevant literature and examination of specimens preserved in the following herbaria: GH, FI, HFLA, K, MICH, NEBC, NY, MO, P, RO, US (acronyms according to Thiers 2016+) and the Herbarium of Bizerta University (not listed in Index Herbariorum).

The articles cited through the text refer to the Melbourne Code, ICN (McNeill et al. 2012).

Results and discussion

Typification of *Amaranthus palmeri* var. *glomeratus*

Uline and Bray (1894:272) described the var. *glomeratus* on the basis of specimens collected by E. Palmer in the Sonoran Desert in 1889, as reported in the protologue. According to the protologue, differential features are the habit (ascending), the plant height (shorter than the typical form) and the synflorescence structure [cymes aggregated in dense glomerules (3–5 cm in diameter) at the base of the plant].

Two specimens (No. 953 and 958) were cited in the protologue, and they are syntypes according to the Art. 9.5 of the ICN. We found these exsiccata at GH (barcodes 00037017 and 00037028, images, respectively, available at <https://s3.amazonaws.com/huhwebimages/C29365768E19428/type/full/37027.jpg> and <https://s3.amazonaws.com/huhwebimages/20824DD7B74F449/type/full/37028.jpg>), MICH (barcode 1115701) and US (barcodes 00106254 and 00106255). We here designate the GH-00037028 as the lectotype of the name *Amaranthus palmeri* var. *glomeratus* since it perfectly matches the diagnosis by Uline and Bray (1894:272). The specimens at MICH and US are isoelectotypes.

Concerning the identity of the var. *glomeratus*, it cannot be associated with *A. palmeri* in our opinion. Unfortunately citations of this taxon are rare in the literature. No citation was found for Australia, Asia, Europe and Africa (see e.g. Bojian, Clemants & Borsch 2003; Iamónico 2015b; Palmer 2009;

SANBI 2012). Even the *Flora of North America* (Mosyakin & Robertson 2003) does not report this taxon. Shreve and Wiggins (1964:457–458) and Abrams (1994:99) listed the var. *glomeratus* as heterotypic synonym of *A. palmeri*. However, only the description reported in the *Vegetation and Flora of the Sonoran Desert* (Shreve & Wiggins 1964) corresponds to the original concept by Uline and Bray (1894), while that by Abrams (1994) completely refers to the typical form. Furthermore, the taxon *glomeratus* appears to occur only in the Sonoran Desert, a unique area of the world which includes part of the United States (Arizona, California) and Mexico (Baja California, Sonora, Sinaloa), and which is characterised by high levels of species richness and endemism (see e.g. Shreve & Wiggins 1964).

Based on the evidence presented here, we think that var. *glomeratus* should actually be at the rank of species. Since an *Amaranthus glomeratus* was already published by Pospichal (1897:375), we cannot propose a new combination of the var. *glomeratus* by Uline and Bray (1894:272), because this would make it a homonym and illegitimate name according to the Art. 53.1 of ICN. Moreover, Pospichal's concept of *A. glomeratus* cannot be related to that of the var. *glomeratus* by Uline and Bray (1894) since the Pospichal's species is monoecious and belongs to the *A. hybridus* group *sensu* Iamónico (2015b) (*Amaranthus* sect. *Amaranthus*). As a consequence, a new name has to be given (see the paragraph 'Taxonomic treatment').

Note of the typification of *Amaranthus palmeri*

Sauer (1955:31) correctly typified the name *Amaranthus palmeri* with a specimen collected by J.L. Berlandier on the banks of the Rio Grande, California, in July 1834. This specimen is preserved at GH (barcode 00037007) and represents one of the syntypes listed by Watson (1877:274) in the protologue ['on the banks of the Rio Grande, by Berlandier (n. 2407) in 1834']. We found a further two specimens, which are part of the Berlandier's collection: the first one at MO (barcode 247471, image available at <http://www.tropicos.org/Image/66322>), the other one at NY (barcode 1043131, image available at <http://sweetgum.nybg.org/vh/specimen.php?irn=1187636>). Both these specimens are numbered as no. 2407, and so they represent isoelectotypes for the name *Amaranthus palmeri*.

Watson (1877:274) also listed another specimen, 'At Larkin's Station: San Diego County, California, by Dr. E. Palmer (n. 323 of his collection)'. We found three specimens at GH (barcode 00037006, image available at <http://ids.lib.harvard.edu/ids/view/2520948>), K (barcode 000814911, image available at <http://apps.kew.org/hercat/getImage.do?imageBarcode=K000814911>) and MO (barcode 247470 image available at <http://www.tropicos.org/Image/66321>), which correspond (label data) to Watson's citation. These specimens are syntypes.

Taxonomic treatment

Amaranthus palmeri S. Watson, Proc. Amer. Acad. Arts 12:274 (1877).

Type: USA, California: banks of Rio Grande, July 1834, *Berlandier* 2407 (GH-00037007! lectotype, designated by Sauer 1955:31, image available at <http://ids.lib.harvard.edu/ids/view/2520952>; isolectotypes at MO-247471, image available at <http://www.tropicos.org/Image/66322>, and NY-1043131, image available at <http://sweetgum.nybg.org/vh/specimen.php?irn=1187636>). Syntypes: USA, California: San Diego, Larkin station, 1875, *Palmer* 323 (GH-00037006, MO-247470 and, K-000814911, images, respectively, available at <http://ids.lib.harvard.edu/ids/view/2520948>, <http://www.tropicos.org/Image/66321>, and <http://apps.kew.org/herbcat/getImage.do?imageBarcode=K000814911>).

Description: Herbs 5–20 cm tall, dioecious, annual (therophyte). Stems erect, glabrous or nearly so, green or reddish, branched. Leaves green; the lower ones ovate, rhomboidal (1.5–7.0 × 1.0–3.5 cm); the upper leaves lanceolate, glabrous, margins entire, apex obtuse to acute, mucronulate, base broadly cuneate, petioled (petiole 0.5–3.5 cm long). Synflorescences terminal, spike- or panicle-like type, drooping or erect, often interrupted in the proximal part, green, the main florescence up to 25 cm long. Floral bracts 1, usually light green, lanceolate [(0.5–)1.0–2.5(–3.0) × 4.0–6.0 mm], 2.0–2.5 times longer than the perianth, sometimes carinate, apex acuminate, margin entire, glabrous. Staminate flowers with 5 unequal tepals, lanceolate (2.0–4.0 × 0.5–1.5 mm), apex acute, awned (especially the inner tepals); stamens 5. Pistillate flowers with 5 tepals, obovate-spathulate [(1.5–)1.7–3.8(–4.0) × 0.4–0.6 mm]; style branches spreading, stigmas 2(–3). Fruit usually brown, subglobose or ellipsoidal (1.5–2.0 × 1.0–2.0 mm), shorter than the perianth, usually smooth, dehiscent. Seed lenticular [(1.0–1.2) mm in diameter], dark-reddish to brown.

Phenology: Flowering time July–August, fruiting time September–October.

Habitat: Ruderal on roadsides and public gardens.

Elevation: 3–8 m a.s.l.

Chromosome number: 2n = 34 (Reveal & Spellenberg 1976).

Distribution: 18–20 individuals were found all referring to a single scattered population, which occupies an area of about 3–4 ha.

Alien status: Neophyte species native to North America and which is considered casual in Tunisia according to Pyšek et al. (2002). Despite this, monitoring is necessary to verify a possible naturalisation and spreading of *A. palmeri* in Tunisia and, if this is found to be the case, actions for eradication of the plants will be required.

Occurrence in Tunisia: Bizerta (Nadhour, North of Tunisia).

Specimina visa: ITALY. **Emilia-Romagna:** Cervia, via Romea Nord (SS16), 2 m a.s.l., road embankment with ruderal vegetation, 08 Oct 2014, *Faggi, Iamónico & Ardenghi s.n.* (HFLA! five sheets). TUNISIA. **Bizerta:** North-Bizerta,

Nadhour, 03–08 m a.s.l., 29 July 2015, *El Mokni & Iamónico s.n.* (HFLA!); *ibidem* 00137 (Herb. Bizerta University). USA. **California:** banks of Rio Grande, July 1834, *Berlandier* 2407 (GH-00037007!, lectotype); *ibidem* (MO-247471!, NY-1043131!); San Diego, Larkin station, 1875, *Palmer* 323 (GH-00037006!, MO-247470! and K-000814911!, syntypes); **Massachusetts:** Malden, 04 Sep 1886, *Collins s.n.* (NEBC-00735067!); South Lawrence, 23 Sep 1902, *Pease* 510 (NEBC-00735066!). **Los Angeles:** N La Verne, light sunny soil in Citrus grove, 01 Oct 1932, *Wheeler* 1418 (P-05159602!).

Amaranthus sonoriensis Iamónico & El Mokni, *nom. nov. pro* *Amaranthus palmeri* var. *glomeratus*, Bot. Gaz. 19(7):272 (1894) non *Amaranthus glomeratus* Posp., Fl. Oesterr. Küstenl. i. 375 (1897).

Type: Mexico, Sonora, Lerdo, 24–26 Apr 1889, *Palmer* 953 (GH-00037028! lectotype, here designated, image available at <https://s3.amazonaws.com/huhwebimages/20824DD7B74F449/type/full/37028.jpg>; isolectotypes at MICH-1115701, image available at <http://plants.jstor.org/stable/history/10.5555/al.ap.specimen.mich1115701>, and US-00106254, and US-00106255, image available at <http://collections.nmnh.si.edu/search/botany/#new-search>).

Description: Herbs 15–50 cm tall, dioecious, annual (therophyte). Stems ascending, glabrous or nearly so, green or brownish, branched. Leaves green, ovate to ovate-lanceolate, rhomboidal (0.5–2.5 × 0.3–1.0 cm), glabrous, margins entire, apex obtuse to acute, mucronulate, base cuneate, petioled (petiole 0.5–3.0 cm long). Synflorescences terminal, spike-like type, erect, the main florescence up to 15 cm long; cymes at the base of plants arranged in dense glomerules with diameters up to 5 cm. Floral bracts 1, green, lanceolate (0.5–2.0 × 4.0–6.0 mm), 2.0–2.5 longer than the perianth, apex acuminate, margin entire, glabrous. Staminate flowers with 5 tepals, ovate-lanceolate (1.5–3.0 × 0.5–1.5 mm), apex acute, awned; stamens 5. Pistillate flowers with 5 tepals, obovate-spathulate (1.0–4.0 × 0.4–0.5 mm); style branches spreading, stigmas 2(–3). Fruit brown, subglobose or ellipsoidal (1.0–1.5 × 0.5–1.5 mm), shorter than the perianth, usually smooth, dehiscent. Seed lenticular (about 1.0 mm in diameter), brown.

Etymology: The specific epithet refers to the Sonoran Desert.

Phenology: Flowering and fruiting times February–April.

Habitat: Desert washes.

Chromosome number: Unknown.

Distribution area: Lower Sonoran area¹.

Specimina visa: MEXICO. Baja California: Lerdo, Sonora Desert, 24–26 Apr 1889, *Palmer* 953 (GH-00037028!, lectotype); *ibidem*, *Palmer* 958 (GH-00037027!); Guaymas: Sonora Desert, 01 Mar 1905, *Palmer* 321 (NY-324458!).

1. Further investigations need to define the exact distribution area.

Acknowledgements

We are grateful to directors and curators of all quoted official herbaria and colleagues of the cited personal herbaria for their support during our visits, loan of specimens or photographs, or for providing interesting information.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

D.I. examined and confirmed the identification of the specimens as *A. palmeri*, as well as carried out the nomenclatural study on *Amaranthus palmeri* var. *glomeratus*. He also prepared and structured the original text of the manuscript. R.E.M. collected the plants in the field, provided data about distribution, ecology and status of naturalisation of *A. palmeri* in Tunisia, and amended the original text by the addition of this information.

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