Article

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# Two new annual weeds in Morocco: *Amaranthus palmeri* and *Chenopodium ficifolium* subsp. *ficifolium* (*Amaranthaceae*)

**Abstract**

Tanji, A.: Two new annual weeds in Morocco: *Amaranthus palmeri* and *Chenopodium ficifolium* subsp. *ficifolium* (*Amaranthaceae*). — Fl. Medit. 33: 91-99. 2023. — ISSN: 1120-4052 printed, 2240-4538 online.

During recent field surveys with special emphasis on the weeds occurring in Moroccan farmlands and gardens, two new weed species were discovered for the first time in the country. *Amaranthus palmeri* plants have been collected in October 2020 along streets in Rabat and in a corn field in Tit Mellil (East of Casablanca), it is to be considered naturalized in Morocco. *Chenopodium ficifolium* subsp. *ficifolium* plants have been observed in a public garden in February 2022 in Berrechid, it is to be considered casual alien in Morocco. These reports indicate that Morocco needs more thorough botanical explorations especially in urban areas and agroecosystems. Both species enrich the *Amaranthaceae* of the country, but could be a threat to biodiversity, sustainable agriculture, food security, and human livelihoods.

*Key words*: alien species, new weeds, description, distribution, taxonomy.

## Introduction

In Morocco, there are nearly 200 introduced weed taxa, involuntarily brought by humans or by other means such as rivers, winds, birds, etc… (Fennane & al. 2023). Exotic plants coming into areas outside their natural range threaten biodiversity and pose a huge global threat to sustainable agriculture, food security, and human livelihoods (see e. g. Lambdon & al. 2008; Early & al. 2016; Gervilla & al. 2019; Arianoutsou & al. 2021). Furthermore, their spread and impact is growing due to climate change, globalisation, trade, and tourism.

Some of these exotics succeed to adapt to their new environments and end up settling there permanently and becoming invasive (Tanji & Taleb 1997; Tanji, 2020; Fennane & al. 2023). For instance, *Amaranthus spinosus* L., found in 2022, is now expanding in gardens, streets, and roadsides of Casablanca, Mohammedia, Rabat, and Kénitra (Sukhorukov & al. 2023). *Cardamine occulta* Hornem. was collected in 2022 in greenhouses, flower pots, and nurseries in Rabat and Kénitra (Sukhorukov & al. 2023). *Oxybasis glauca* was observed in Laayoune and Ad-Dchira (Chambouleyron & al. 2022). *Cenchrus longispinus* (Hack.)

Fernald, found in 1985, is now invading the Loukkos irrigated perimeter (Tanji 2020). *Dinebra retroflexa* (Vahl) Panz., recently discovered in 2015, is now invasive in summer crops in the Gharb and Tadla irrigated perimeters (Tanji 2020). *Solanum elaeagnifolium* Cav., found in 1944 in Casablanca near the seaport, is now located throughout the country (Bouhache 2010; Ben-Ghabrit & al. 2019). *Heterotheca subaxillaris* (Lam.) Britton & Rusby, seen near Kénitra in 2000, is now invading roadsides in Kénitra, Sidi Yahya, and Salé (Fennane & al. 2014). *Arctotheca calendula* (L.) Levyns, collected in Chaouen, North of Morocco, in 1928 (Jahandiez & Maire 1934), is now distributed in Taza, Rabat, and along the Atlantic Ocean coastline (Ibn Tattou, pers. comm.).

During the floristic surveys in Moroccan cultivated crops and gardens, two new weed species were collected for the first time in the country. Photos, descriptions, distributions, and impacts of these newly introduced species were provided in the present note.

## Materials and methods

Live plants of *Amaranthaceae* s. lat. were collected from cultivated fields and public gardens during the period 2020-2022, in various Moroccan locations. The *Amaranthus* species was found at both flowering and fruiting stages, whereas *Chenopodium* plants were removed from public gardens at the vegetative stage, planted in pots, and kept outdoors at home until maturity. Specimens of collected plants are preserved at the National Herbarium of the Institut Scientifique, Université Mohammed V, Rabat. For the identification of these taxa, various references and websites were used including the "Flore Pratique du Maroc" (Fennane & al. 1999), "Biodiversité végétale du Sud-Oued Marocain" (Peltier, www.teline.fr), "Flore du Maroc" (Dobignard, www.floramaroccana.fr), "efloramaghreb" (www.efloramaghreb.org), Fuentes-Bazan & al. (2012), "Flora Gallica" (Tison & de Foucault 2014), and Iamonico (2015). For the nomenclature, various references and websites were used including "African Plant database" (http://africanplantdatabase.ch), "Plants of the World Online" (https://powo.science.kew.org), "World Flora Online" (www.worldfloraonline.org), "Flora of North America" (http://beta.floranorthamerica.org), "CABI" (www.cabi.org/isc), "EPPO global database" (https://gd.eppo.int), and "Tela Botanica" (www.tela-botanica.org).

## Results

***Amaranthus palmeri*** S. Watson

*Amaranthus palmeri* is a new species to be added to the flora of Morocco. In fact, Fennane & al. (1999) and Dobignard (www.floramaroccana.fr) cite 11 *Amaranthus* taxa : *A. albus* L., *A. blitoides* S. Watson, *A. blitum* L., *A. cruentus* L., *A. deflexus* L., *A. graecizans* L. subsp. *silvestris* (Vill.) Brenan, *A. hybridus* L., *A. hypochondriacus* L., *A. muricatus* (Moq.) Hieron, *A. retroflexus* L., and *A. viridis* L.

*Distribution and ecology in Morocco*

Several plants of *A. palmeri* have been found on October 2, 2020, in Rabat and in an irrigated corn (*Zea mays* L.) field near Tit Mellil, East of Casablanca (33° 30′ 36″ N, 7°

23′ 41″ W, 180 m altitude) (Fig. 1). They were at the flowering and fruiting stages, and stems were 2 to 3 m tall and drew my attention. They were growing in an area where daily temperatures in summer usually exceed 30 C, nightly temperatures are around 20 C, and the photoperiod is 14 hours. Palmer amaranth is therefore considered, under local climatic conditions, a summer annual weed naturalized in Morocco.

*Description*

Several references provided detailed descriptions of Palmer amaranth plants (Ward & al. 2013; Roberts & Florentine 2022, etc.). The plant is dioecious, erect, up to 3 m tall, with a deep taproot system. Stems are reddish-green, highly branched. Leaves are alternate, obovate (1.5–7 × 1–3 cm), with entire margins, glabrous, petioled, some with a whitish V-shaped central spot. The synflorescence is structured as erect linear spikes (up to 60 cm) along with several small clusters of flowers (2 to 4 mm). Bracts of pistillate flowers are 4–6 mm, longer than tepals. Bracts of staminate flowers are 4 mm long, equaling or longer than outer tepals. Tepals of pistillate flowers are 1.7–3.8 mm, acuminate, mucronulate. Tepals of staminate flowers are unequal, 2–4 mm, apex acute. Inner tepals have prominent midribs excurrent as rigid spines. Utricles are tan to brown, obovoid to subglobose, 1.5–2 mm, shorter than tepals. Fruits are obovoid, small (about 1.5 mm diameter), with thin walls and containing a single small (about 1 mm diameter) dark-red to brown seed.

*Chorology*

Native to the North American Southwest (from southern California to Texas) and northern Mexico, alien, often invasive in North America as well as in South America and other continents (see e.g. POWO 2023) where populations spread in urbanized and agricultural areas by human activities e. g. trade and tourism. In the Mediterranean region and surrounding areas, it was recorded in Tunisia, Egypt, Israel, Turkey, Greece, Italy, France, Spain, and Portugal (Dobignard & Chatelain 2011; Tison & De Foucault 2014; Iamonico & El Mokni 2017; Torra & al. 2020; APD 2023; CABI 2023; Danin & Fragman-Sapir 2023; EPPO 2023), and it was recently found in South Africa by Sukhorukov & al. (2021).

*Notes*

*Amaranthus palmeri* is an herb with C4 photosynthetic pathway which translates into a very fast-growing, competitive weed that can grow 0.18–0.21 cm per growing degree day (Horak & Loughin 2000). Palmer amaranth interference reduced dry edible bean yield by 77% at a weed density of 2 plants $m^{-1}$ row compared to the weed-free control (Miranda & al. 2021). Each plant is able to produce 200,000 to 600,000 seeds when growing without plant competition (Keeley & al. 1987). It is among the most troublesome and economically important weed species as a result of its high genetic diversity, a deep root system, rapid growth rate, high fecundity, high competitiveness, high water use efficiency, tolerance to high temperatures and drought, and ability to develop herbicide resistance (Ward & al. 2013; Leon & Van Der Laat 2021; Roberts & Florentine 2021; Milani & al. 2021). Menges (1987 & 1988) reported inhibition of crop growth resulting from Palmer amaranth's allelopathic properties. Considering the potential economic impact of this species, the EPPO Panel on Invasive Alien Plants suggested its addition to the EPPO Alert List (EPPO 2023). Palmer amaranth possesses toxic properties including high concentrations of nitrates and oxalates that are harmful to livestock (Yu & al. 2021).

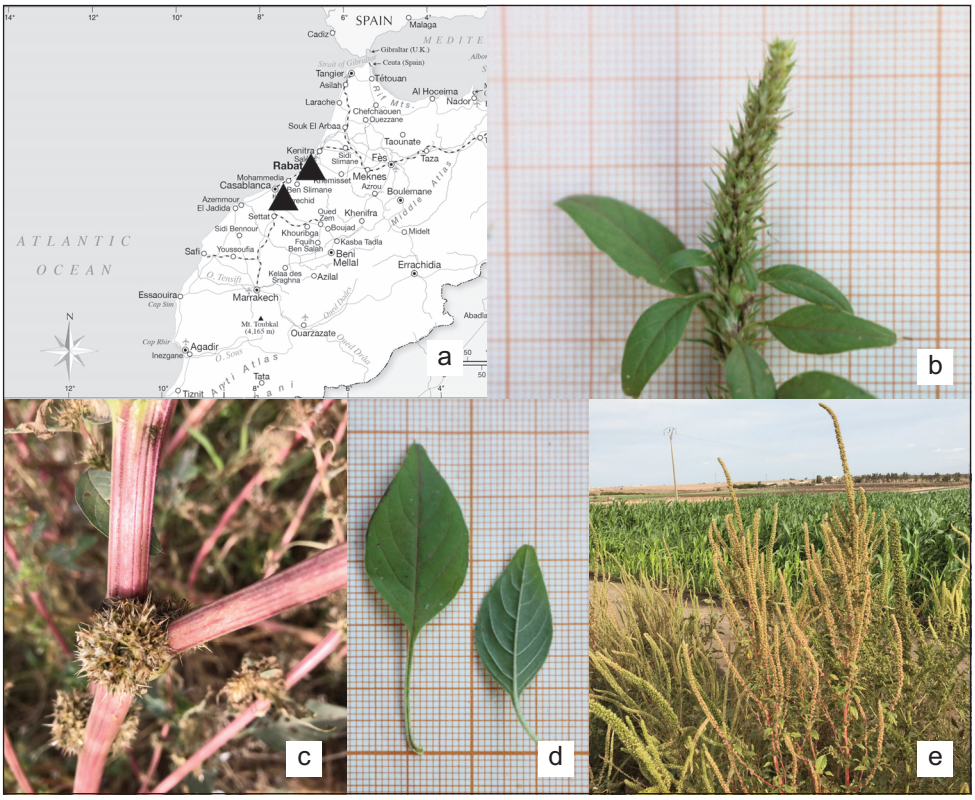


Fig. 1. *Amaranthus palmeri*: a) distribution in the map of Morocco; b) details of the inflorescence; c) stem; d) leaves; e) habit. Photos by the author.

***Chenopodium ficifolium*** Sm. subsp. ***ficifolium***
≡ *C. album* subsp. *ficifolium* (Sm.) Hook. f.

*Chenopodium ficifolium* subsp. *ficifolium* is a new species to be added to the flora of Morocco. In fact, Dobignard (2023) cite only 3 *Chenopodium* taxa: *C. album* L. subsp. *album*, *C. album* L. subsp. *opulifolium* (WDJ) Koch & Ziz) Batt., and *C. vulvaria* L. However, several other *Chenopodium* cited by Fennane & al. (1999) were recently rearranged in other genera such as *Blitum, Chenopodiastrum*, *Dysphania*, and *Oxybasis* (Dobignard 2023).

*Distribution and ecology in Morocco*

In Morocco, two plants of *Chenopodium ficifolium* subsp. *ficifolium* were found for the first time on February 12, 2022, in a public garden in Berrechid, 20 km South of Casablanca (33° 15′ 33″ N, 7° 34′ 53″ W, 220 m altitude) (Fig. 2). Both plants were at the vegetative stage. They were removed, planted in a pot, and kept outdoors at home until maturity. In February, daily temperatures are usually 20 to 25 C, nighlty temperatures are 10 to 15 C, and the photoperiod is 12 hours. Figleaved goosefoot is therefore considered a fall/winter annual plant (Fig. 2). It is a new weed, and is to be considered as a casual alien.

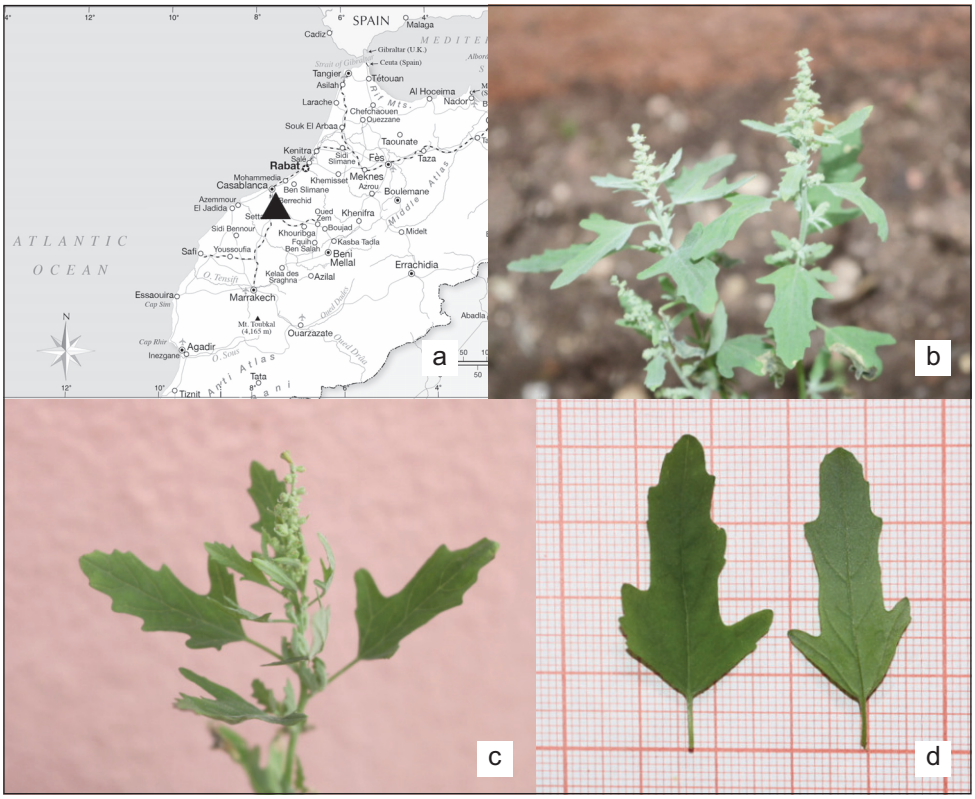


Fig. 2. *Chenopodium ficifolium* subsp. *ficifolium* : a) distribution in the map of Morocco; b) habit; c) inflorescence; d) leaves. Photos by the author.

*Description*

Plant description has been reported in various references (″Flora of North America″ 2023; HYPPA, 2023; ″Tela Botanica″ 2023; WFO 2023; etc…). Fig-leaved goosefoot stems are erect, green, striate, 20-50 cm tall. Leaf blades are ovate-oblong, 2.5–5 × 1–3.5 cm. Their margins are usually 3-lobed. The central lobes are subentire to sinuate-dentate, and the lateral lobes are positioned in proximal 1/3 or near base of leaf blade. Flowers are in terminal panicles on upper branches. The perianth has 5 segments, connate at base into 0.3 mm tube; lobes ovate, 0.5–0.9 × 0.5–0.8 mm, apex acute, farinose, keeled, covering fruit at maturity; stamens 5; stigmas 2, 0.3 mm. The utricles are depressed-ovoid; pericarp nonadherent, smooth. Seed are horizontal, black, 1 mm in diameter.

*Chorology*

Fig-leaved goosefoot is native to the mountains of South and Central Europe and Western Asia (Flora of North America 2023). It is found in the 5 continents, and is usually distributed in housing neighborhoods, roadsides, vacant lots, fields, orchards, and pastures (POWO 2023; WFO 2023). In the Mediterranean region and surrounding areas, it was

reported in Algeria, Egypt, Israel, Turkey, Greece, Italy, France, and Spain (Dobignard & Chatelain 2011; Tison & de Foucault 2014; Hannachi 2019; Mosyakin & de Lange 2020; APD 2023; Danin & Fragman-Sapir 2023; EPPO 2023; Heap 2023; POWO 2023; www.efloramaghreb.fr 2023).

*Notes*

Figleaved goosefoot is a weed in Kuwait (Mathew & al. 2012), Tajikistan (Nowak & al. 2014), New Zealand (Mosyakin & de Lange 2020), and Korea (Kim & al. 2019). It is a weed that has resisted to the atrazine herbicide in Germany and Switzerland (Heap 2023).

Various compounds were isolated from *Chenopodium ficifolium* plants (Gohar & al. 2002). Furthermore, Le Dang & al. (2010) found that extracts of *C. ficifolium* have insecticidal properties for controlling *Aphis gossypii* infesting cucumber plants. Subedi & al. (2021) reported that *C. ficifolium* is a potential diploid model system for the genetic study of quinoa.

Two subspecies are usually recognized within *Chenopodium ficifolium*: subsp. *ficifolium* and subsp. *blomianum* (Clemants & Mosyakin 2003). These subspecies are distinguished mainly by their pericarp, seed testa sculpture, and leaf shape (Mosyakin 2016). The subsp. *blomianum* occurs in southern and southeastern Asia as well as in the USA, and differs from *C. ficifolium* subsp. *ficifolium* in having leaves with spreading basal lobes almost perpendicular to the central lobe and seeds with shallow elongate depressions (Mosyakin 2016). Clemants & Mosyakin (2003) reported that in Europe *C. ficifolium* occasionally hybridizes with other species, including *C. album.*

## Conclusion

Two new aliens belonging to *Amaranthaceae* s. lat. have been discovered for the first time in Morocco in human-made habitat (urban areas and agroecosystems). They were probably introduced into the country by tourists, imported animals, crop seed, vehicles, or machinery. These newly introduced weed species indicate that the country needs more thorough botanical explorations. They inevitably enrich the Flora of Morocco, but pose a huge global threat to biodiversity, sustainable agriculture, food security, and human livelihoods. In fact, *Amaranthus palmeri* and *Chenopodium ficifolium* subsp. *ficifolium* have the capacity to become invasive weeds in agricultural systems, cities, and uncropped areas.

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