Article

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Two new species alien to the flora of Morocco: *Amaranthus spinosus* (*Amaranthaceae*) and *Cardamine occulta* (*Brassicaceae*)

Abstract

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During field investigations in Morocco, two new alien species, *Amaranthus spinosus* (*Amaranthaceae*) and *Cardamine occulta* (*Brassicaceae*), were discovered as new to the country. Additionally, *C. occulta* seems to be the first record for continental Africa. The distribution and ecology of these species are discussed.

Key words: alien flora, new records, chorology, North Africa.

Introduction

Habitats linked to human activities host a large number of nitrophilous and synanthropic species. They are the major centres for the introduction and expansion of non-native species, these datasets provide a rich source of information on biological invasion and habitat homogenization (Domina & al. 2019; Panitsa & al. 2020).

During a field trip in Morocco in autumn 2021, the authors collected *Amaranthus spinosus* L. and *Cardamine occulta* Hornem.: two species that appear to be new plants alien to the flora of the country. Complementary field investigations were then undertaken in 2022, to better determine the actual distribution of these taxa.

Materials and methods

A field trip was made on the Atlantic coastline of Morocco from October 31 to November 19, 2021, to collect autumnal species of this area. Fifty-nine stations were inventoried from Tangier to Tan-Tan (ca. 1000 km). The collected plants are stored in herbaria ECWP, MW and RAB. Complementary field investigations were performed from January to July 2022 in the Rabat region, where *Amaranthus spinosus* and *Cardamine occulta* had been discovered during the previous autumnal trip.

Results and discussion

Over 500 herbarium vouchers were collected during this autumnal trip. Identification of specimens revealed two new records of vascular plants for Morocco: *A. spinosus* and *C. occulta.*

***Amaranthus spinosus* L.** (Fig.1)
(*Amaranthaceae*)
New localities:

Morocco (Fig. 2): Mehdia, Sidi Boughaba, 34.20760/-6.68136, 20 m a.s.l., roadside, 6.11.2021, *M. Chambouleyron, J.-F. Léger & A. Sukhorukov s. n.* (ECWP, MW); Temara, 33.90615/-6.98740, 10 m a.s.l., ornamental roadside plantations, 8.1.2022, *J.-F. Léger s. n.* (ECWP); Kenitra, 34.24959/-6.61133, pavement, 13.2.2022, *J.-F. Léger s. n.* (ECWP); Sidi Bouknadel, 34.10387/-6.73310, cultivation, 13.2.2022, *J.-F. Léger s. n.* (ECWP); Sidi Taïbi, 34.14895/-6.71762, ornamental tree nursery, 13.2.2022, *J.-F. Léger s. n.* (ECWP, RAB113705); Rabat, 34.01152/-6.85022, garden, 20.2.2022, *J.-F. Léger s. n.* (ECWP); Skhrirat, 33.85889/-7.04947, wasteland, 27.2.2022, *J.-F. Léger s. n.* (ECWP); Rabat, 34.01890/-6.82586, 20 m a.s.l., pavement, 19.7.2022, *J.-F. Léger s. n.* (ECWP); Mohammadia, 33.67762/-7.41388, 15 m a.s.l., sewage run-off, 23.7.2022, *J.-F. Léger s. n.* (ECWP); Casablanca, 33.57655/-7.55093, 60 m a.s.l., nursery, 23.7.2022, *J.-F. Léger s. n.* (ECWP).

Fig. 1. Image of *Amaranthus spinosus* (Mehdia, Sidi Boughaba, 6.11.2021, *M. Chambouleyron*).

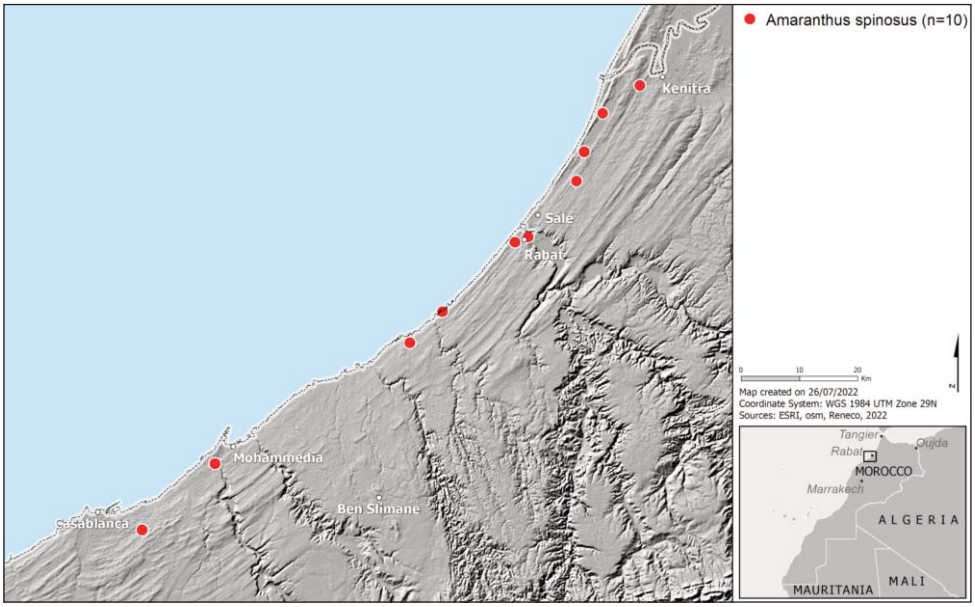

Fig. 2. Records of *Amaranthus spinosus* on North-Atlantic plains of Morocco.

Amaranthus spinosus is easily recognizable due to its annual habit and the presence of two spines on leaf nodes. It originates from the tropics of America (Sauer 1967) and since recently is considered an invasive plant in many tropical countries of the world (e.g. Waterhouse 1994; Singh & Dahiya 2002; Bojian & al. 2003; Sukhorukov & al. 2021). Some records from subtropical and temperate countries are also known (e.g. Robbrecht & Jongepier 1986; Gonen & Urgur 2000; Mohamadzadeh & al. 2005; Klaassen & Kwembeya 2013; Iamonico 2015). In continental North Africa, *A. spinosus* was reported from Egypt (Tackholm & El Gazzar 1977) and recently from Tunisia (Iamonico & El Mokni 2018).

The species is reported neither in Morocco in major floristic accounts (Ouyahya 1999; Rutherford & Jury 2002; Dobignard & Chatelain 2011; Dobignard 2022; Fennane 2022; African Plant Database 2022) nor in sources specializing in weeds (Observatoire du Sahara et du Sahel 2020; EPPO Global Database 2022; Invasive Species Compendium 2022) and at the Global Biodiversity Information Facility (2022). More locally, Atlantic plains of northern Morocco are well inventoried since distant past because botanists' team from the Institut Scientifique Chérifien (now known as Institut Scientifique de Rabat) has been located in Rabat since 1920, and many field studies have been conducted in the Rabat region (*s. l.*) during one century (e.g. Boitel 1921; Perrin de Brichambaut 1951; Sauvage 1961; Bouhache & al. 1994; Bensellam & al. 1997; Dobignard 2009; Zidane & al. 2010; Tanji & al. 2015; Khamar & al. 2021). Thus, the introduction of *A. spinosus* into the region seems to be recent. Our field observations are centred around Casablanca-Kenitra Region corresponding to "Maâmora/Zemmour/Zaër" (Man-3) and Chaouïa/Doukkala (Mam-1) geographical units (as delimited by Fennane & Ibn Tattou 2005). Just as in other African

countries (Baker & Clarke 1909; Hutchinson & Danziel 1927; Maire 1962; Germishuizen 2003), *A. spinosus* grows at disturbed sites in Morocco (pavements, roadsides, wastelands, cultivations, and gardens) where it is already abundant (where we found it: several individuals to over 1000 per locality). We consider it a locally naturalized plant in Morocco. Additional research in nurseries, eutrophic cultivated fields or ruderal places in other regions of Morocco will also probably lead to additional records of this species.

***Cardamine occulta* Hornem.** (Fig. 3)
(*Brassicaceae*)
New localities:

Morocco (Fig. 4): Mehdia, Sidi Boughaba, 34.20781/-6.68234, 20 m a.s.l., Plants nursery, 6.11.2021, *M. Chambouleyron, J.-F. Léger & A. Sukhorukov s. n.* (ECWP, MW); Kenitra, 34.28782/-6.52110, greenhouse, 13.2.2022, *J.-F. Léger s. n.* (ECWP); Rabat, 34.01314/-6.83082, flower pot, 20.2.2022, *J.-F. Léger s. n.* (ECWP); Sidi Taïbi, 34.20574/-6.67491, greenhouse, 26.2.2022, *J.-F. Léger s. n.* (ECWP, RAB113706).

This annual species from East Asia is still often confused with other species of *Cardamine* L., especially *C. hirsuta* L. and *C. flexuosa* With., and some significant differences between these species have been summarized in several papers (e.g. Marhold & al. 2016; Dalavi & al. 2019; Hruševar & al. 2021).

Fig. 3. Herbarium specimen of *Cardamine occulta* (Mehdia, Sidi Boughaba, 6.11.2021, *M. Chambouleyron, J.-F. Léger & A. Sukhorukov s. n.* (ECWP).

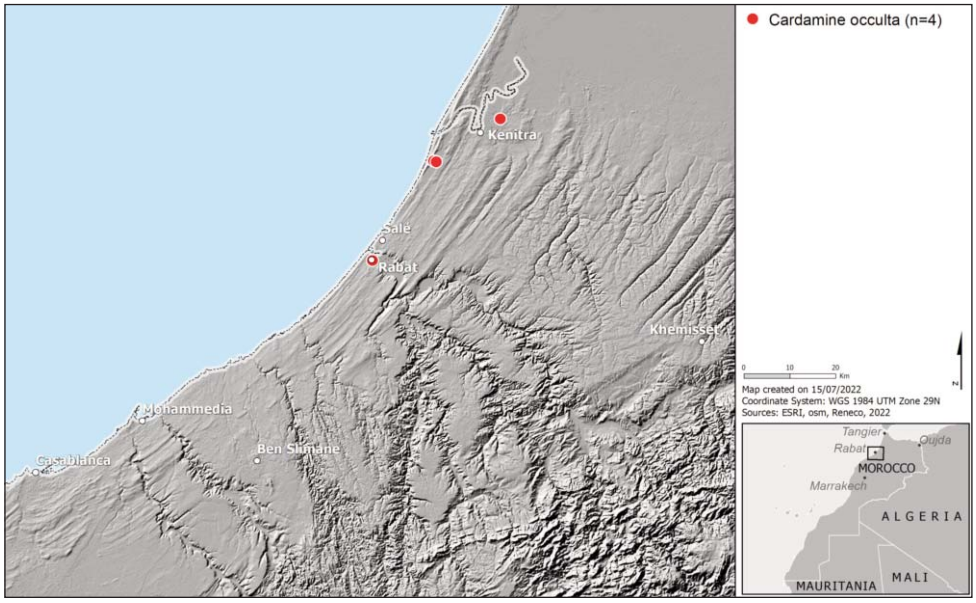

Fig. 4. Records of *Cardamine occulta* on North-Atlantic plains of Morocco. Out of four records, only three are shown on the map because two locations are too close to each other.

Cardamine occulta was recently found in many European countries (e.g. Marhold & al. 2016; Verloove 2018; Dzhus 2019; Leostrin & Mayorov 2019; Pliszko 2020; Hruševar & al. 2021) as well as in Central and North Americas (Rollins 1993; POWO 2022; unpubl. data by A. Sukhorukov as collected in Grenada, West Indies).

Our collections seem to be the first records of *C. occulta* in continental Africa and have not been mentioned earlier in any accounts (e.g. African Plant Database 2022; Global Biodiversity Information Facility 2022; Invasive Species Compendium 2022), but it was recently found on the Canary Islands (Verloove & Reyes-Betancort 2011, sub *C. flexuosa* auct. on With.). Nonetheless, due to its strong resemblance with *C. flexuosa* (present in Morocco and Algeria) and with *C. hirsuta* (a common species in North-West Africa) and to historical repeated confusion of these species with each other in Europe since time immemorial, we assume that this taxon has been overlooked in North Africa. Our field observations are centred around Rabat-Kenitra Region, corresponding to the "Maâmora/Zemmour/Zaër" (Man-3) geographical unit (as delimited by Fennane & Ibn Tattou 2005).

In the countries where *C. occulta* has been introduced, it has mostly been found in urban and disturbed areas (e.g. flower pots, roadsides, and pavements) (Marhold & al. 2016; pers. obs. by A. Sukhorukov in Moscow, Russia). In Morocco, we found it only in plant nurseries and greenhouses, which is precisely the most common way to introduce this species in many countries, according to Marhold & al. (2016); the same situation was also noted in Grenada (West Indies) by one of us (A. Sukhorukov, pers. obs.). Although it is regarded as an invasive species in Europe by Marhold & al. (2016), this status is not appropriate here in Morocco judging by our field observations, where found only several or up

to a few hundred individuals in very artificialized habitats: inside nurseries and flower pots. Its eventual expansion is worth studying.

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