An Annotated Checklist to the Chenopod Flora of Sudan

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Abstract: The aims of the present study are to provide biodiversity assessment and to contribute to the updating the flora of Sudan. A total of (28) species belonging to (15) genera were compiled to comprise members of the family Chenopodiaceae in the Sudan, with the addition of (12) new records. Range extension of (6) species and habitat-specific trends of (10) species were recorded. These species were compiled as a result of comprehensive literature review, herbarium collections and long-term field surveys. *Anabasis ehnbergii*, *Kochia cana*, *Sevada schimperi* were previously recorded in the main flora but were no longer reported by subsequent floristic studies (specialy along the Red Sea Coastal region), and may be regarded as extinct or vanished. The disappearance of these species was attributed to destruction of natural habitats and climatic changes, suggesting the need for conservation efforts.

Keywords: New Records, Range Extension, Habitat-Specific, Extinction, *Kochia cana*

Introduction

Sudan is one of the African countries whose flora and vegetation are scarcely studied and the available data are limited to few regions and families or are relatively old, and in need for an update or revision.

The Chenopods of the Sudan were last documented by Andrews (1950). Since then, numerous changes have occurred in the flora and no attempt was made for updating. Many floristic studies reporting new records, have already been published or are included in academic theses, dissertations or reports, covering different regions of Sudan, should be added to the flora. They are dispersed in local, regional and international sources and are often difficult to access and less frequently compiled. Moreover, many plants have changed names in view of recent taxonomic studies and many plants have been introduced and became naturalized.

Chenopodiaceae (Goosefoot family) is a vascular plant family with probably 110 genera and 1700 species and inhabiting mainly arid to semi arid, deserts, disturbed, agricultural, coastal and saline habitats (Zhu et al. 2003, Kadereit et al. 2003). Members of this family are mostly herbs or shrubs, rarely dwarf trees, mostly xerophytic or halophytic (Freitag et al. 2001). The family was previously placed in Caryophyllales, Chenopodiacles, Centrspermae and Curvembryeae by Cronquist (1981), Thorne (1992), Ulbrich (1934) and Bentham & Hooker (1880) respectively. Recently, Angiosperm Phylogeny Group (APG 1998, 2003, 2009, 2016) have included the family Chenopodiaceae in the family Amaranthaceae on molecular bases, whereas Hernandez-Ledesma et al. (2015) regarded it as a distinct family and separated from the Amaranthaceae.

According to Andrews (1950), the family Chenopodiaceae is represented by 16 species belonging to 9 genera. This number of species appear to be low considering the country size, presence of several climatic and vegetation belts (FAO 2005).

The aim of the present study is to bring together more recent information on members of the family Chenopodiaceae documented in diverse sources and herbaria in an attempt to provide the basis for further studies on indigenous species, biodiversity assessments, and to facilitate subsequent taxonomic works contributing to update the flora of Sudan.

Material and Methods

The present study has been compiled based on literature sources, herbarium collections deposited at (KHU), and long-term field surveys. The literature surveys was conducted on various sources documenting the presence and distribution of members of the family Chenopodiaceae in Sudan. Updated nomenclature of the species compiled has been verified using "The Plant List" published at (http://www.theplantlist.org/, version 1:1 (2003), and according to Akhani et al. (2007), Mosyakin & Clemants (2008), Fuentez-Bazen et al. (2012), Hernandez-Ledesma et al. (2015) and Piirainen et al. (2017).

As far as possible, scientific name of each plant is given together with the author of the binomial,
synonyms only when the plant name has changed since the publication of the Flora and geographical distribution at the regional level together with citation of source.

All the species (native or naturalized) compiled for the family Chenopodiaceae in the Sudan both recently occurring and previously reported (extinct or vanished), were included and arranged alphabetically, and new species records are marked with an asterisk.

### Results

The present study resulted in an updated checklist of members of the Chenopodiaceae known to occur in Sudan, which include (28) species belonging to (15) genera, with an increase of (12) species regarded as new records for Sudan. All the species compiled to comprise members of the Chenopodiaceae in Sudan are documented below."
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| Page | Species                                      | Reference                                                                 |
|------|---------------------------------------------|---------------------------------------------------------------------------|
| 23   | *Salicornia fruticosa* (L.) L. (= Sarcocornia fruticosa (L.) A.J. Scott.) | Red Sea Coasts (Andrews 1950, Hassan 1974, Alawad 1994, Karrar 2010).     |
| 24   | *Sevada schimperi* Moq. (= *Suaeda schimperi* (Moq.) Ulbr., *S. vermiculata* Forsk., var. *puberula* C.B. Clarke.) | Red Sea Coasts (Broun & Massey 1929, Andrews 1950, Hassan 1974, Boulos *et al.* 1991). |
| 25   | *Suaeda aegyptiaca* (Hasselq.) Zohary (=Schanginia hortensis (Forsk.) Moq., *Suaeda hortensis* Forsk. ex J.F. Gmel.) | Red Sea Coasts (El Amin 1990, Alawad 1994).                               |
| 26   | *Suaeda fruticosa* Forsk. ex J.F. Gmel (=*Suaeda volkensii* C.B. Clarke.) | Red Sea Coasts (Broun & Massey 1929, Andrews 1950, Kassas 1957, Hassan 1974, El Amin 1990, Alawad 1994, Sugga 1999, Woldewahid *et al.* 2007 Karrar 2010), Kassala (Alhti *et al.* 1973). |
| 27   | *Suaeda monoica* Forsk. ex J.F. Gmel. Northern Sudan (Broun & Massey 1929, Andrews 1950), Red Sea Coasts (Kassas 1957, Hassan 1974, El Amin 1990, Alawad 1994, Sugga 1999, Woldewahid *et al.* 2007, Karrar 2010, Nuri *et al.* 2016), Kassala (Alhti *et al.* 1973). |
| 28   | *Suaeda vermiculata* Forsk. ex J.F. Gmel. Red Sea Coasts (Andrews 1950, Kassas 1957, Hassan 1974, Sugga 1999, Karrar 2010), Suakin (Broun & Massey 1929). |

**Discussion and conclusion**

A total number of (28) species were compiled to comprise members of the family Chenopodiaceae in Sudan, with the addition of (12) species belonging to (8) genera, regarded as new records not previously documented in the main flora of Sudan (Andrews 1950). These (12) newly recorded species were identified as a result of an extensive literature review on various floristic studies published from different regions of Sudan, herbarium collections deposited at (KHU), and long-term field surveys.

(20) species out of the (28) species (≈70%) of the species compiled are reported from the Red Sea Coastal salt Marshes. This area is situated at the northeastern corner of Sudan and is extensively studied unlike other regions of the country. The floristic composition of the Red Sea Coastal region was studied by Kassas (1957), Berry (1964), Hassan (1974), El Shourbagy *et al.* (1987), Alawad (1994), Sugga (1999), Hegazy *et al.* (2007), Woldewahid *et al.* (2007), Karrar (2010), Vetaas *et al.* (2012), in addition to annual expeditions to the area by undergraduate students of various Universities.

In addition to the species newly recorded in recent studies at the Red Sea Coasts (e.g. *Bassia eriophora*, *Chenopodium murale*), some other species (e.g. *Anabasis ehrenbergii*, *Kochia cana*, *Suaeda schimperi*), although were previously recorded by Andrews (1950), Kassas (1957) and Hassan (1974) in the same area, were not documented by subsequent floristic studies and may be regarded as extinct or vanished. Such changes in the floristic composition were attributed to browsing, climatic changes (Vetaas *et al.* 2012), and destruction of natural habitats due to salt pans construction and pollution from Port-Sudan and Suakin harbours (Karrar 2010).

The present study also reported geographical range extension of (6) species to new locations found beyond their known range previously cited in the Flora by Andrews (1950). These species include: *Atriplex farinosa*, *Chenopodiasterum murale*, *Caroxylon monacantha*, *Halocnemum strobilaceum*, *Caroxylon imbricatum* and *Caroxylon vermiculatum*. While some plants are adapted to a wide range of environmental conditions and have range extension, many others are quite habitat-specific (e.g. *Anabasis setifera*, *Anabasis ehrenbergii*, *Bassia eriophora*, *Caroxylon ehrenbergii*, *Caroxylon spinescens*, *Caroxylon villosum*, *Salicornia fruticosa*, *Suaeda aegyptiaca*, *Sevada schimperi* and *Suaeda vermiculata*).

The taxonomic status of the botanical name *Kochia cana* is still doubtful and not standardized. According to The Plant List (http://www.theplantlist.org) the status of *Kochia cana* is unresolved. The Royal Horticultural Society (https://www.rhs.org.uk) regarded *Kochia cana* a tentatively accepted name, the African Plant Database (http://www.ville-ge.ch) consider it as an accepted name, whereas according to (https://sv.wikipedia.org) it is regarded as a synonym to *Bassia stellaris* (Moq.) Bornm. Scott (1978) reported that the presence of winged or spinescent accrescent perianth, which distinguish the genera *Kochia* and *Bassia*, is not sufficient justification for maintaining them as separate genera and were amalgamated in the genus *Bassia*. *Kochia cana* is an intermediate species with the accrescent perianth in the form of scales or horizontal crests. Moreover, Turki *et al.* (2008) rejected the amalgamation and supported their treatment as different genera.

**Acknowledgements:**

I am grateful to professor Helmut Freitag, Universitat Kassel, Germany, and professor Alexander P. Sukhorukov, Lomonosov Moscow State University, Russia, for their valuable comments and suggestions on the previous preprint version of the manuscript.

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http://www.ijSciences.com  Volume 9 – August 2020 (08)
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