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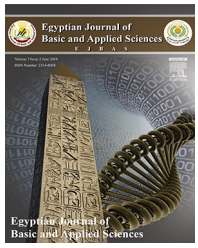

Full Length Article

Vegetation structure and soil characteristics of five common geophytes in desert of Egypt

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ARTICLE INFO

Article history:
Received 20 October 2015
Received in revised form 1 March 2016
Accepted 1 March 2016
Available online 17 March 2016

Keywords:
Vegetation
Biodiversity
Soil factors
Geophytes
Desert

ABSTRACT

Geophytes are kind of plants having the capability to survive under arid environmental conditions; parts of their bodies are dormant fleshy underground as bulbs, corms, tubers or rhizomes. The present study was designed to throw light on the ecological features of five representative geophytes, namely, *Cyperus capitatus, Cyperus conglomeratus*, *Elymus farctus*, *Lasiurus scindicus* and *Panicum turgidum*. The soil characteristics and the associated species of these geophytes are described in their natural habitats of coastal desert (Deltaic Mediterranean coast) and inland desert (Cairo-Suez desert road). A total of 119 species (65 perennials, 3 biennials and 51 annuals) belonging to 97 genera and 28 families constituted their floristic composition. Asteraceae, Poaceae, Fabaceae and Chenopodiaceae are the largest families. Therophytes and chamaephytes are the most abundant life forms. The chorological analysis of the study area revealed that 63.02% and 47.33% belong to Saharo-Arabian and Mediterranean taxa, respectively. The highest species richness value (1.42 species stand^{-1}) is recorded in the coastal desert. The application of TWINSPAN analysis yielded six distinct vegetation groups (A, B, C1, C2, D1 and D2); each is linked to one or more of the studied geophyte plants. The main soil factors affecting the study geophytes are electrical conductivity, organic carbon, sulphates, chlorides and bicarbonates as well as its silt composite.

1. Introduction

Geophytes are plants with underground storage organs (bulbs, corms, tubers or rhizomes) that appeared as promising raw materials for various economic uses [1]. The leaves of these plants die annually. No evergreen plants are considered to be geophytes [2]. These geophytes have high diversity in the Mediterranean-type ecosystems, where they are considered as most common in seasonal climates [3,4].

The economic value of these species is attributed to collection and exporting their natural bulbs as ornamental plants. In addition, geophytes are used in medicine and food industry [5].

The Mediterranean desert coastline is an area of relatively high bio-diversity; 10% of the world's higher plants can be found in this area, which represents only 1.6% of the Earth's surface [6]. The northern Mediterranean coast of Egypt is characterized by highly diverse edaphic, topographic and climatic characteristics and as a consequence, by different vegetation

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http://dx.doi.org/10.1016/j.ejbas.2016.03.001

groups [7]. During relatively high rainfall periods; most of species are annuals that flourish during the rainy season. However, during the longer dry periods, the characteristic woody shrubs and perennial herbs constitute the scrub vegetation, scattered sparsely in parts and grouped in denser distinct patches [8,9]. On the other hand, the plant life in the Eastern Desert is much richer than that of the Western Desert. The flora of wadis and mountains of the north Eastern Desert has strong relations with that of the Sinai Peninsula [10].

Cyperaceae are the third largest monocotyledonous family [11] and constitute a specialized group of plants, particularly in relation to their generative structure [12]. *Cyperus* is a large genus with about 600 species, which are distributed throughout all continents in both tropical and temperate regions. *Cyperus capitatus* and *Cyperus conglomeratus* are distributed in the coastal region of Egypt. These species are able to survive extreme climatic conditions [13].

C. capitatus is a perennial creeping sedge that occurs in coastal sandy habitats and mobile dunes of southern Europe and the Mediterranean coast of Egypt [13,14]. This species produces extensive rhizomes, and it is one of the earliest species to colonize newly deposited dunes contributing to the initial stabilization of sand dunes in arid and semiarid coastal areas [15]. *C. conglomeratus* is a creeping yellowish-green, drought-resistant perennial wild species with short and branched rhizomes that are covered with acute brown scales. It grows in widely distributed in arid regions from Senegal to Pakistan. In Egypt, it is growing in the coastal and inland sand dune habitats [13].

Poaceae are also one of the most ecologically and economically important plant families with about 670 genera, 10,000 species and are distributed worldwide [13,16]. *Elymus farctus* (sand couch-grass) is a perennial rhizomatous grass with erect, rigid 60–90 cm long culms. It is a facultative halophyte and has the ability to fix sand, therefore, it is considered as the pioneer of the psammosere [17,18]. *Lasiurus* is a genus of Asian and African plants in the grass family, found primarily in arid regions. *Lasiurus scindicus* is a perennial herb with culms often woody below, up to 90 cm in length, erect from a thick woody rhizome that occurs in sandy, stony and rocky soils [13]. *Panicum turgidum* is a glaucous perennial wild species, widely distributed in all phytogeographical regions of Egypt except the western Mediterranean coastal desert [19,20]. It is also considered to have tolerant drought and soil salinity levels, and is an effective sand binding xerophyte and could be used to fix sand dunes [9,21].

This study was designed to throw light on the ecological features of the abovementioned five geophytes growing in the Mediterranean coast and Cairo-Suez road through studying their associated plant species and edaphic factors controlling their richness and distribution in the study area.

2. Materials and methods

2.1. Study area

The middle section of the Mediterranean coastal land of Egypt (Deltaic coast) extends from Abu-Quir (in the west, Long. 32°19′ E) to Port-Said (in the east Long. 31°19′ E) with a length of about 180 km, and a width in a N-S direction for about 15 km from the coast. On the other hand, Cairo-Suez desert road is about 130 km in length, located in the northern section of the Eastern Desert of Egypt (The Galalah Desert), which extends east of the Nile Delta. It represents the natural xeric habitat mainly inhabited by xerophytic vegetation. The gravel habitat is one of the most characteristic features of this road [9].

The study area is located in some Governorates in the northern part of the Nile Delta and Eastern Desert regions of Egypt, which comprises different habitats (Fig. 1). These include: Deltaic Mediterranean coast and inland desert habitat (Cairo-Suez desert road and Wadi Hagul).

According to the map of the world distribution of the arid regions [22], the climatic conditions of the Deltaic Mediterranean coast of Egypt is rather arid to semi-arid, where the rate of evaporation exceeds many times the rate of precipitation [23]. On the other hand, the Cairo-Suez desert road belongs to arid mesothermal type of Thornthwaite [24] and the arid or extreme arid climate of Walter [25]. Meteorological data of the studied area are presented in Table 1.

2.2. Vegetation analysis

After a reconnaissance survey that was conducted between 2014 and 2015, 95 sample stands (10 m × 10 m) were randomly selected to represent a wide range of physiographic and environmental variation in the studied deserts. Specimens of the selected geophyte plants as well as the other associated species were collected from the Deltaic Mediterranean coastal strip and Cairo-Suez desert road. The studied geophyte species were *Cyperus capitatus* Vand., *Cyperus conglomeratus* Rottb., *Elymus farctus* (Viv.) Ranemark ex. Melderis., *Lasiurus scindicus* Henrard. and *Panicum turgidum* Forssk.

The relative density and cover of each species have been estimated in the studied stands [27,28]. Relative values of density and cover as well as importance value (IV = 200) for each plant species in each stand were calculated. A floristic count list was taken from the 95 sites to represent the five geophyte plants in the study sites: 80 from the Deltaic Mediterranean coast and 15 from Cairo-Suez desert road. Taxonomic nomenclature and analysis of phytogeographic ranges were used according to Zohary [29], Tackholm [20] and Boulos [30].

2.3. Soil analysis

Each of the 95 study sites was represented by three soil samples that were collected at depths of 0–20, 20–35 and 35–50 cm. The samples were mixed together to form a single composite sample, which was then spread over sheets of paper and left to dry in the air. Soil texture, water holding capacity (WHC), organic carbon and sulphate were determined according to Piper [31]. Calcium carbonate content was determined by titration against 1N NaOH and expressed as a percentage [32]. Determination of electrical conductivity and pH was determined in soil–water (1:5) suspension by the method adopted by Jackson [32]. Carbonates and bicarbonates were determined by titration using 0.1 N HCl [33]. Sodium and potassium were determined by flame photometry, while calcium and magnesium were estimated using atomic absorption spectrometer [34].