

The African Paleotropical Influence on the Biogeography of the Flora of Jazan, KSA

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To put all selected species in their proper place as in the phytogeographical affinities for each region.

Study Design: Field and jazan herbarium design was used in this study.

Place and Duration of Study: A total of 201 plant species were selected from Jazan of Saudi Arabia.

Methodology: About 201 plant species (seven species of Pteridophytes, one species of Gymnosperms and 193 species of Angiosperms) related to 59 families were recorded from a total of 524 species previously recorded in 2013 from Jazan region of Saudi Arabia. The selected plant species were revealed a distribution relationships between the three African paleotropical floristic regions and showed 9 African paleotropical floristic elements.

Results: The chorological analysis revealed the highest percentages of 51.24% was inhabiting in Afromontane archipelago-like regional center of endemism (AF) of the total recorded species. The distribution relationships among the African paleotropical floristic elements was subjected to

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numerical analysis which showed the similarity and dissimilarity between the elements based on the UPGMA dendrogram software.

Conclusion: The program was constructed two main groups, the first group (I) were included with Afromontane archipelago-like regional center of endemism (AF) flowed by the Guineo-Congolian regional center of endemism (GC). The second group (II) in which Sahara Regional Subzone (SS1) was recognized in a separated in a single level.

Keywords: Floristic elements; numerical analysis; paleotropical; Jazan; Saudi Arabia.

1. INTRODUCTION

Jazan region considers the part of Arabia shield which is a part of the Precambrian crustal plate and consists of igneous and metamorphic rocks [1]. The southern Arabian woodlands found mostly in southwestern parts of the Arabian Peninsula (mostly Yemen, parts of western Oman and southwestern Saudi Arabia) include a few permanent and seasonal forests with elements of the East African and Ethiopian floras. Other woodlands are distributed among the land; these are very small and are predominated Juniper or Acacia wood-lands [2,3]. Phytogeographically, Africa are rolled by two kingdoms, they are Capensic which were represented the southern corner of the continent and the second Kingdome included the paleotropical region which rolled most of the continent expect the northern part which effected by Mediterranean, as last line of Holarctic kingdom. Following the scholar works as [4,2,5] on the phytogeographical paleotropical kingdom included the three main floristic regions and ten phytogeographical elements. On the other hand, the paleotropical kingdom in Africa was divided into 18 phytochoria areas, in which nine regional centers of endemism were separated by six regional transition zones and three regional mosaics, from them six or seven regions as chorological sketch map of the Northern and Central Africa was manulled [6]. White's system was modified by [7,8]. Also, [2] had placed Saudi Arabia within two phytogeographical categories: Eritero-Arabian Province (ER-A), which is part of the Sudanian region and Saharo-Arabian region (SA). Jazan region of Saudi Arabia as part of the African continents. Two phytogeographical regions were represented within the study area, viz. the Somali-Masai regional center of endemism (SM) and Afro-Montane archipelago-like regional centre of endemism (AF). It is known that, Jazan region can be broadly divided into Mountains area, Tihama foothills, Tihama wadies, low land Tihama and the Farasan islands. The two regions are parts of the oldest agricultural centers of the Arabian Peninsula

[9,10]. Our aim of the work to put all selected species in their proper place as in the phytogeographical affinities for each region.

2. MATERIALS AND METHODS

A total of 201 plant species were selected along Jazan of Saudi Arabia during the period from October 2016 to May 2018 [11,12,13]. Biogeographical links based on the distribution of plant species in the physiogeographic districts and vegetation zones of Jazan and following White's classification for Africa [14] and Léonard's extension of the phytochoria into SW Asia [7,5]. We construct our observations on the distribution of all taxa treated in the published volumes of the Flora of Saudi Arabia [15,16]. Flora of Jazan [9,10] and our finding during researching on the plant of Jazan, during the period from 2016-2018. 201 collected plant species out of a total of 512 species recorded by [10] from Jazan of Saudi Arabia were examined among the African paleotropical floristic regions and elements by using the following literature: [17,18,10,19,20,21,22,23,24,25,26,27,28]. On the other hand, the distribution relationships of the studied plant species with African paleotropical floristic elements were showed as a dendrogram by using the Group Average Method as a sorting strategy, also known as UPGMA (Unweighted Pair-Group Average Linkage) method (Primer-E, 2001). Plant specimens were deposited in Jazan University Herbarium, KSA (JAZUH), Biology Department, Faculty of Science.

The study area

The Jizan region is part of south-western part of Saudi Arabia 16°20'N to 17°40' N and 41°55' E to 43°20' E, about 260 km long coastal area on the western side, stretching from Al-Muwassam in the south to Al Shuqaiq in the north [9]. The study area approximately 13,500 km² along the southern Red Sea coast, just north of Yemen. It lies within the subtropical dry zone and has very hot summers and mild winters [29]. The diversity

and species distribution were correlated with annual rainfall. It is considered to be favorable for plant growth due to stagnant water after rainfall.

The lowest monthly minimum temperature were recorded in June (33°C) and January (14°C) respectively [9].

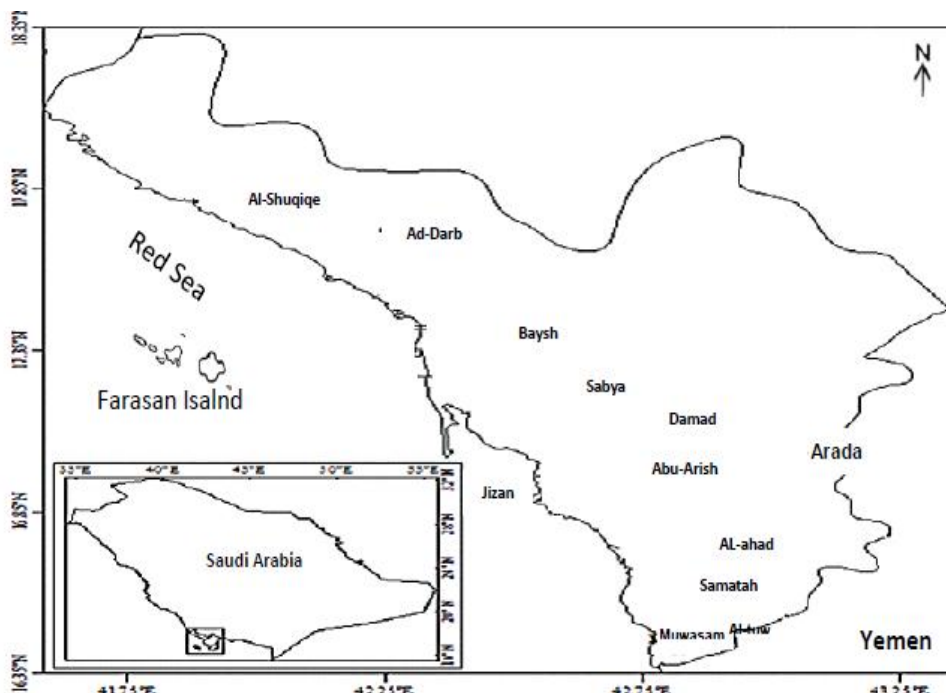


Fig. 1. Location map of Jazan region of Saudi Arabia

Table 1. Distribution of species among the 10 African paleotropical elements

Family	Species	Phytogeographical elements								
		SSI	SA	Z	S	SM	AF	GC	GCZ	GCS
I- Pteridophytes										
Adiantaceae	<i>Cheilanthes coriacea</i> Decne	-	-	-	-	-	+	+	-	-
Actinopteridaceae	<i>Actinopteris semiflabellata</i> Pichi- Sermoli	-	-	-	-	-	+	+	-	-
	<i>Actinopteris radiata</i> (Swartz) Link	-	-	-	-	-	+	+	-	-
Aspleniaceae	<i>Asplenium aethiopicum</i> (Burm.f.) Becherer	-	-	-	-	-	+	-	-	-
Selaginellaceae	<i>Selaginella imbricata</i> (Forssk.) Spring.	-	-	-	+	-	-	+	-	-
	<i>Selaginella yemensis</i> (Swartz) Spring.	-	-	-	-	-	+	+	-	-
Woodsiaceae	<i>Hypodematium crenatum</i> (Forssk.) Kuhn	-	-	-	-	-	+	-	-	-
II-gymnosperms										
Cupressaceae	<i>Juniperus procera</i> Hochst	-	+	+	-	-	-	+	-	-
III- Angiosperms										
Acanthaceae	<i>Barleria bispinosa</i> (Forssk.) Vahl	-	-	-	-	-	+	+	-	-
	<i>Barleria proxima</i> Lind.	-	+	-	-	-	-	+	-	-
	<i>Crossandra wissmanii</i> O. Schwartz	-	+	-	-	-	-	+	-	-
	<i>Peristrophe cernua</i> Nees	-	+	-	-	-	-	+	-	-
	<i>Hypoestes forskalei</i> (Vahl) Soland.	-	+	-	-	-	-	-	-	-
	<i>Justicia flava</i> (Vahl) Vahl.	-	+	-	-	-	+	-	-	-
	<i>Justicia odora</i> (Forssk.) Vahl	-	-	-	-	+	-	-	-	-
Aizoaceae	<i>Anisotes triculcus</i> Nees	-	-	-	-	-	+	+	-	-
	<i>Sesuvium sesuvioides</i> (Fenzl) Verdc.	-	-	-	-	-	+	-	-	-
	<i>Trianthema crystallina</i> (Forssk.) Vahl	-	+	-	-	+	-	-	-	+
	<i>Trianthema sheilae</i> A.G. Miller	-	+	-	-	-	-	-	-	+
	<i>Zaleya pentandra</i> (L.) Jeffrey	-	-	-	-	-	+	-	-	-
Amaranthaceae	<i>Aizoon canariensis</i> L.	+	-	-	-	-	+	-	-	-
	<i>Chenopodium fasciculosum</i> Aellen	-	-	-	-	-	-	+	+	-
	<i>Atriplex farinosa</i> Forssk	+	-	-	-	-	-	+	-	-
	<i>Arthrocnemum macrostachyum</i> (Moric) Koch	+	+	-	-	-	-	+	-	-

Family	Species	Phytogeographical elements								
		SSI	SA	Z	S	SM	AF	GC	GCZ	GCS
	<i>Suaeda vermiculata</i> Forssk	+	-	-	-	-	-	+	-	-
	<i>Suaeda monoica</i> Forssk.	+	-	-	-	-	-	+	-	-
	<i>Suaeda aegyptiaca</i> (Hasselq.) Soh.	+	-	-	-	-	+	-	-	-
	<i>Celosia trigyna</i> L.	-	-	-	-	-	+	-	-	-
	<i>Nothosaerva brachiata</i> (L.) Wt.	-	-	-	-	-	+	-	-	-
Aristolochiaceae	<i>Aristolochia bracteolata</i> Lam	-	-	-	-	+	+	-	-	-
Apocynaceae	<i>Desmidorchis retrospiciens</i> (Defl.) Plowes	-	-	+	-	-	-	-	-	-
	<i>Acokanthera schimperi</i> (DC.) Oliv.	-	-	-	-	-	+	-	-	-
	<i>Periploca visciformis</i> (Vatke) K. Schum.	-	-	-	-	-	-	+	-	-
	<i>Kanahia laniflora</i> (Forssk.) R. Br.	-	+	-	-	-	-	-	-	-
	<i>Gomphocarpus sinaicus</i> Boiss.	-	+	-	-	-	-	-	-	-
	<i>Calotropis procera</i> (Ait.) R. Br.	+	-	-	-	-	+	-	-	-
	<i>Cynanchum gerrardii</i> (Harv.) Liede	+	-	-	-	-	-	+	-	-
	<i>Sarcostemma viminale</i> (L.) R. Br.	-	-	-	+	-	-	-	-	-
	<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	-	-	-	-	-	-	+	-	-
	<i>Leptadenia arborea</i> (Forssk.) Schweinf.	+	-	-	-	-	-	+	-	-
	<i>Angolluma wissmannii</i> (Schwartz) Plowes	-	-	-	-	-	-	-	-	-
	<i>Pergularia daemia</i> (Forssk.) Chiov	+	-	-	+	-	-	-	-	-
Arecaceae	<i>Hypphaene thebaica</i> (L.) Mart.	+	+	-	-	-	-	+	-	-
Asparagaceae	<i>Sansevieria ehrenbergii</i> Schweinf	-	-	-	-	-	+	+	-	-
	<i>Dipcadi viride</i> Moench	-	-	-	-	-	+	-	-	-
Boraginaceae	<i>Cordia sinensis</i> Lam.	-	-	-	-	-	+	+	-	-
	<i>Cordia africana</i> Lam.	-	-	-	-	-	+	+	-	-
	<i>Heliotropium pterocarpum</i> Steud. & Hochst.	-	-	-	-	-	+	-	-	-
	<i>Arnebia hispidissima</i> (Lehm.) DC.	+	-	-	-	-	-	+	-	-
	<i>Trichodesma trichodesmoides</i> (Bunge) Guerke	-	+	-	-	-	-	-	-	-
Brassicaceae	<i>Farsetia longisiliqua</i> Decne	-	+	-	-	-	-	+	-	-
	<i>Sisymbrium irio</i> L.	+	-	-	-	-	-	-	-	-
	<i>Sisymbrium orientale</i> L.	+	-	-	-	-	-	-	-	-
	<i>Brassica juncea</i> (L.) Czern. & Coss	-	-	-	-	-	-	-	-	+
Caesalpiniaceae	<i>Pterolobium stellatum</i> (Forssk.) Brenan	-	-	-	-	-	+	+	-	-
	<i>Senna alexandrina</i> Mill.	+	+	-	-	-	-	-	-	-
	<i>Chamaecrista nigricans</i> (Vahl) Greene	-	-	-	-	-	+	-	-	-
Capparaceae	<i>Maerua oblongifolia</i> (Forssk.) A. Rich	-	-	-	-	-	+	-	-	-
	<i>Capparis decidua</i> (Forssk.) Edgew	+	-	-	-	-	+	-	-	-
	<i>Capparis cartilaginea</i> Decne.	-	-	-	-	-	-	+	-	-
	<i>Cadaba glandulosa</i> Forssk.	-	-	-	-	-	-	+	-	-
	<i>Cadaba rotundifolia</i> Forssk.	-	-	-	+	-	-	-	-	-
	<i>Cadaba farinosa</i> Forssk.	-	-	-	-	-	+	-	-	-
	<i>Cadaba longifolia</i> DC.	-	-	-	-	-	+	+	-	-
Caryophyllaceae	<i>Cometes abyssinica</i> R.Br.	-	-	-	-	-	+	+	-	-
	<i>Paronychia chlorothyrsa</i> Murb	+	-	-	-	-	-	-	-	-
	<i>Polycarpaea repens</i> (Forssk.) Asch. & Schw.	+	-	-	-	-	-	-	-	-
	<i>Polycarpaea spicata</i> Arn.	-	-	-	-	-	+	+	+	-
	<i>Minuartia filifolia</i> (Forssk.) Mattfeld	-	-	-	-	-	+	-	-	-
Celastraceae	<i>Maytenus senegalensis</i> (Lam.) Exell,	-	-	-	+	+	-	-	-	-
	<i>Catha edulis</i> (Vahl) Forssk. ex Endl.	-	-	-	-	-	-	+	-	-
Cleomaceae	<i>Cleome scaposa</i> DC.	+	-	-	-	-	-	-	-	-
	<i>Cleome brachycarpa</i> Vahl ex DC.	-	-	-	-	-	+	+	-	-
Combretaceae	<i>Combretum aculeatum</i> R. Br. ex D. Don.	-	-	-	-	-	+	-	-	-
	<i>Terminalia brownie</i> Fresen.	-	-	-	-	+	+	+	-	-
Cucurbitaceae	<i>Kedrostis gijef</i> (J.F. Gmel.) C. Jeffrey	-	-	-	-	-	+	-	-	-
	<i>Corallocarpus epigaeus</i> (Rottler) Hook.	-	-	-	-	-	+	+	-	-
	<i>Corallocarpus schimperi</i> (Naud.) Hook. f.	-	-	-	-	-	+	+	-	-
	<i>Cucumis dipsaceus</i> Spach	-	-	-	-	-	+	-	-	-
Convolvulaceae	<i>Cressa cretica</i> L.	-	-	-	-	-	-	+	-	-
	<i>Convolvulus austroaegyptiacus</i> Abd. & Saad	-	-	-	-	-	+	-	-	-
	<i>Convolvulus prostratus</i> Forssk.	+	+	-	-	-	-	-	-	-
	<i>Convolvulus glomeratus</i> Choisy	-	+	-	-	-	-	+	-	-
	<i>Convolvulus rhyniospermus</i> Hochst.	+	-	-	-	-	-	+	-	-
	<i>Ipomoea eriocarpa</i> R. Br.	-	-	-	-	-	+	+	-	-
	<i>Ipomoea sinensis</i> (Desr.) Choisy	-	-	-	-	-	+	-	-	-
Ebenaceae	<i>Diospyros mespiliiformis</i> Hochst ex DC.	-	-	-	-	-	+	-	-	-
	<i>Euclea schimperi</i> (DC.) Dandy.	-	-	-	+	-	+	+	-	-
Euphorbiaceae	<i>Erythrococca abyssinica</i> Pax	+	-	-	-	-	-	+	-	-
	<i>Acalypha fruticosa</i> var. <i>fruticosa</i> Forssk.	-	-	-	-	-	+	-	-	-
	<i>Acalypha indica</i> L.	-	-	-	-	-	+	+	-	-
	<i>Jatropha pelargonifolia</i> Courb.	-	-	-	-	+	-	-	-	-
	<i>Euphorbia scordifolia</i> Jacq.,	-	-	-	+	-	-	-	-	-

Family	Species	Phytogeographical elements								
		SSI	SA	Z	S	SM	AF	GC	GCZ	GCS
	<i>Euphorbia granulata</i> Forssk.	+	-	-	-	-	+	-	-	-
	<i>Euphorbia arabica</i> Hochst. & Steud.	+	-	-	-	-	-	+	-	-
	<i>Euphorbia cactus</i> Ehrenb. ex Boiss.	-	-	-	-	-	-	+	-	-
	<i>Euphorbia fractiflexa</i> Carter & Wood	-	-	-	-	-	-	+	-	-
	<i>Euphorbia triaculeata</i> Frossk.	-	-	-	-	-	-	+	-	-
Fumariaceae	<i>Fumaria abyssinica</i> Hammar	-	-	-	-	-	-	+	-	-
	<i>Fumaria parviflora</i> Lam	+	+	-	-	-	-	-	-	-
Geraniaceae	<i>Geranium mascatense</i> Boiss.	-	-	-	-	-	+	-	-	-
	<i>Geranium trilophum</i> Boiss.	-	-	-	-	-	-	+	-	-
	<i>Geranium biuncinatum</i> Kokwaro	-	-	-	+	+	-	-	-	-
	<i>Pelargonium multibracteatum</i> Hochst.	-	-	-	-	+	+	+	-	-
Hypericaceae	<i>Hypericum annulatum</i> Moris	-	-	-	-	-	-	+	-	-
Lamiaceae	<i>Premna resinosa</i> (Hochst.) Schau	-	-	-	-	-	+	-	-	-
	<i>Leucas martinicensis</i> R. Br.	-	-	-	-	-	+	-	-	-
Linderniaceae	<i>Craterostigma pumilum</i> Hochst.	-	-	-	-	-	+	-	-	-
Lophiocarpaceae	<i>Corbichonia decumbens</i> (Forssk.) Exell	-	-	-	-	-	+	-	-	-
Malpighiaceae	<i>Caucanthus edulis</i> Forssk.	-	-	-	-	-	+	-	-	-
Maesaceae	<i>Maesa lanceolata</i> Forssk.	-	-	-	+	-	-	-	-	-
Malvaceae	<i>Grewia tenax</i> (Forssk.) Fiori	-	-	+	+	-	+	-	-	-
	<i>Corchorus depressus</i> (L.) Stocks	-	-	-	-	-	+	-	-	-
	<i>Corchorus tridentata</i> L.	-	-	-	-	-	+	-	-	-
	<i>Melhania ovata</i> (Cav.) Spreng.	-	-	-	-	-	-	-	+	-
	<i>Hibiscus micranthus</i> (L.F.) Cuf.	-	-	-	-	-	+	-	-	-
	<i>Hibiscus ovalifolius</i> (Forssk.) Vahl,	-	-	-	-	-	+	+	-	-
	<i>Hibiscus deflersii</i> Schweinf.	-	-	-	-	-	+	-	-	-
	<i>Hibiscus purpureus</i> Forssk.	+	-	-	-	-	-	+	-	-
	<i>Hibiscus palmatus</i> Forssk.	-	-	-	-	-	+	-	-	-
	<i>Hibiscus aristaevalvis</i> Garcke	-	-	-	-	-	+	-	-	-
	<i>Pavonia procumbens</i> (Wall.) Wight & Arn.	-	-	-	-	+	-	-	+	-
Mimosaceae	<i>Acacia hamulosa</i> Benth Hook	-	-	-	-	+	-	-	-	-
	<i>Acacia asak</i> (Forssk.) Willd	+	-	-	+	-	-	-	-	-
	<i>Acacia etbaica</i> Schw.	-	-	-	+	-	-	+	-	-
	<i>Acacia oerfota</i> (Forssk.) Schweinf	+	-	-	-	-	+	-	-	-
Menispermaceae	<i>Cocculus pendulus</i> (J.R.&G.Forst.) Diels	+	-	-	-	-	+	+	-	-
	<i>Tinospora bakis</i> (A. Rich.) Miers	-	-	-	-	-	-	-	-	-
Moraceae	<i>Dorstenia foetida</i> (Forssk.) Schweinf	-	-	-	-	-	+	+	-	-
	<i>Ficus palmata</i> Forssk	+	-	-	-	-	-	+	-	-
	<i>Ficus sycomorus</i> L.	+	-	-	-	-	-	-	-	-
	<i>Ficus cordata</i> Thunb	+	+	-	-	-	-	-	-	-
	<i>Ficus ingens</i> (Miq.) Miq.	-	-	-	-	-	-	-	+	-
	<i>Ficus glumosa</i> Del.	-	-	+	-	-	+	-	+	-
	<i>Ficus vasta</i> Forssk	-	-	-	-	-	+	-	+	-
Myrtaceae	<i>Syzygium guineense</i> (Willd.) DC.	-	-	-	-	-	+	-	-	-
Nyctaginaceae	<i>Boerhavia repens</i> L.	-	-	+	-	-	-	-	-	-
	<i>Commicarpus grandiflorus</i> (Rich.) Standl.	-	-	-	-	-	+	-	+	-
	<i>Commicarpus plumbagineus</i> (Cav.) Standl	-	-	-	-	-	+	-	-	-
	<i>Commicarpus helenae</i> (Schultes) Meikle	-	-	-	-	-	+	-	-	-
Papilionaceae	<i>Cadia purpurea</i> (Picc.) Ait.	+	-	-	-	-	+	+	-	-
	<i>Argyrolobium arabicum</i> (Dec.) Jaub. & Spach	-	-	-	-	-	+	+	-	-
	<i>Crotalaria pycnostachya</i> Benth & Hook.	-	-	-	-	-	+	+	-	-
	<i>Crotalaria microphylla</i> Vahl	-	-	-	+	+	-	-	-	-
	<i>Crotalaria senegalensis</i> (Pers.) DC.	-	-	-	-	-	+	-	-	-
	<i>Tephrosia uniflora</i> Pers	-	+	-	-	+	+	-	-	-
	<i>Tephrosia pumila</i> (Lam.) Pers	-	-	-	-	-	+	+	-	-
	<i>Indigofera linifolia</i> (L.f.) Retz.	-	-	-	-	-	+	+	-	-
	<i>Indigofera arabica</i> Jaub. & Spach.	+	-	-	-	-	-	+	-	-
	<i>Indigofera spinosa</i> Forssk.	+	-	-	-	-	-	+	-	-
	<i>Indigofera argentea</i> Burm.f.	-	-	-	-	-	-	+	-	-
	<i>Indigofera articulata</i> Gouan	-	-	-	-	-	-	-	-	+
	<i>Indigofera arrecta</i> Hochst. ex A. Rich.	+	-	-	-	-	-	+	-	-
	<i>Indigofera volkensii</i> Taub	-	-	-	-	-	+	-	-	-
	<i>Sesbania sesban</i> (L.) Merr.	-	-	-	-	-	+	+	-	-
	<i>Astragalus vogelii</i> (Webb) Bornm	-	-	-	+	-	+	+	-	-
	<i>Astragalus atropilosulus</i> (Hochst.) Bunge	+	-	-	-	-	+	-	-	-
	<i>Rhynchosia buramensis</i> Hutch. & Bruce	-	-	-	-	-	+	+	-	-
	<i>Rhynchosia variegata</i> (Defl.) J.R.I. Wood	-	-	-	-	-	-	-	-	-
	<i>Rhynchosia corallina</i> (Thunb.) DC.	-	-	-	-	-	-	-	-	-
	<i>Vigna membranacea</i> A. Rich.	-	-	-	-	-	-	+	-	-
	<i>Vigna ambacensis</i> Welw. ex Bak	-	-	-	+	-	-	+	-	-

Family	Species	Phytogeographical elements							
		SSI	SA	Z	S	SM	AF	GC	GCS
	<i>Abrus precatorius</i> L.	-	-	-	-	-	+	+	-
	<i>Taverniera cuneifolia</i> (Roth.) Arn.	-	-	-	-	-	+	-	-
	<i>Alysicarpus rugosus</i> (Willd.) DC.	-	-	-	+	-	+	-	-
Peraceae	<i>Clusia lanceolata</i> Forssk.	-	-	-	-	+	-	+	-
Plumbaginaceae	<i>Plumbago zeylanica</i> L.	-	-	-	-	+	-	+	-
Orobanchaceae	<i>Strigaher monthica</i> (Del.) Benth.	+	-	-	-	-	+	-	-
	<i>Cistanche tubulosa</i> (Schrenk) Wt.	+	-	-	-	-	-	+	-
Plantaginaceae	<i>Schweinfurthia pterosperma</i> (Rich.) A. Br.	-	-	-	-	-	-	+	-
	<i>Campylanthus pungens</i> O. Schwartz	-	+	-	-	-	-	+	-
Poaceae	<i>Dichanthium faveolatum</i> (Del.) Roberty	+	-	-	-	-	-	+	-
Polygalaceae	<i>Polygala irregularis</i> Boss.	-	-	-	-	-	+	-	-
	<i>Polygala erioptera</i> DC.	-	-	-	-	-	+	-	-
	<i>Polygala abyssinica</i> R. Br. ex Fresen.	-	-	-	+	-	-	+	-
Polygonaceae	<i>Oxygonum sinuatum</i> (Hoch.&Steud) Dam.	-	-	-	-	-	+	-	-
	<i>Rumex steudelii</i> Hochst. ex A. Rich.	-	-	-	-	+	-	-	-
Ranunculaceae	<i>Clematis hirsuta</i> Guill. & Perr.	-	-	-	-	-	+	-	-
Rhamnaceae	<i>Sageretia thea</i> (Osbeck.) M. C. Johnston	-	-	-	-	-	+	+	-
	<i>Berchemia discolor</i> (Klotzch) Hemsl.	+	-	-	-	-	+	-	-
	<i>Ziziphus spina-christi</i> (L.) Willd.	+	-	-	-	-	-	+	-
Rosaceae	<i>Rosa abyssinica</i> Lind.	-	-	-	+	+	-	-	-
Salvadoraceae	<i>Dobera glabra</i> (Forssk.) Poir.	-	-	-	+	-	-	+	-
Salicaceae	<i>Oncoba spinosa</i> Forssk	-	-	-	-	+	-	-	-
Solanaceae	<i>Datura metel</i> L.	+	-	-	-	-	+	-	-
	<i>Solanum schimperianum</i> Hochst.	-	-	-	-	-	+	-	-
	<i>Solanum incanum</i> L.	+	-	-	-	+	-	-	-
	<i>Solanum coagulans</i> Forssk.	+	-	-	-	-	+	-	-
Stilbaceae	<i>Nuxia oppositifolia</i> (Hochst.) Benth.	-	-	-	+	+	-	-	-
Urticaceae	<i>Parietaria alsinifolia</i> Del	+	-	-	-	-	-	-	-
	<i>Parietaria debilis</i> G.Forst.	+	-	-	-	-	-	-	+
	<i>Forsskaolea tenacissima</i> L.	+	-	-	-	-	-	-	+
	<i>Forsskaolea viridis</i> Ehrenb	-	+	-	-	-	+	-	-
	<i>Urtica urens</i> L.	-	-	-	-	-	-	-	+
Verbenaceae	<i>Lantana viburnoides</i> (Forssk.) Vahl	-	-	-	-	-	+	-	-
Vahliaceae	<i>Vahlia digyna</i> (Retz.) Kuntze	-	-	-	+	-	+	-	-
Vitaceae	<i>Rhoicissus tridentate</i> Planch.	+	-	-	-	-	+	-	-
	<i>Cissus quadrangularis</i> L.	-	-	-	-	-	-	+	-
	<i>Cyphostemma digitatum</i> (Forssk.) Desc	-	-	-	+	+	-	-	-
Zygophyllaceae	<i>Fagonia indica</i> Burm.	-	-	-	+	+	-	-	-
	<i>Fagonia schweinfurthii</i> (Hadidi) Hadidi	+	-	-	+	-	+	-	-

SSI: Saharan regional sub zone, SA: Saharo-Arabian S: Sudanian regional central of endemism, SM: Somalia-Masai regional center of endemism, AF: Afromontane archipelago-like regional center of endemism, Z: Zambezian regional center of endemism, GC: Guineo-Congolian regional center of endemism, GCZ: Guinea-Congolian/ Zambezia regional transition zone and GC: Guinea-Congolian / Sudania Regional Transition Zone

3. RESULTS AND DISCUSSION

201 plant species (seven species of Pteridophytes, one species of Gymnosperms and 193 species of Angiosperms) related to 59 families were collected and identified from Jazan region of Saudi Arabia to indicate the affinities with the African paleotropical floristic categories. The highest species number of 25 species were recorded in family Papilionaceae followed by Apocynaceae (12 species). 16 families have two species and the lowest one species was recorded in 20 families (Fig. 2). According to the point of view of the chorological data, a total of 79 species with percentage of 39.30% of the total recorded species inhabiting the monoregional region. In this area the highest number of 47 species were native to the Afromontane archipelago-like regional center of endemism followed by Guineo-Congolian regional center of

endemism (GC) were recorded about 18 species. The second sub zone was inhabiting the Saharan regional which recorded by 8 species (3.98%). In addition Sahel regional Transition Zone (SA) region were represented by four species of *Kanahia laniflora*, *Gomphocarpus sinaicus*, *Trichodesma trichodesmoides* and *Hypoestes forskalei* (Table 1). The predominance of Saharo Arabian in this study may be due to this area mainly deserted and located within the belt of Saharo-Sindian also it is a part of that belt between Saharo and Sindian [11]. The different species of Saharo-Arabian were covered a vast deserted area of Sindian region which inhabiting the area of red sea coast and the area of Gulf coast through the Empty Quarter desert [11,12,13]. Guinea-Congolian/Sudania Regional Transition Zone (GCS) was estimated by only two species of *Boerhavia repens* and *Farsetia longisiliqua*

(Table 2). Also both Guinea-Congolian/Zambezia Regional Transition Zone (GCZ) and Sudanian Regional Centre of Endemism (Z) were recorded by only one species from the total recorded species.

Table 2. Chorological analysis of total species in phytochoria region species represent mono, bi and tri-regional elements

Phytochoria type	Number	%
SS1	51	25.71
SA	22	10.94
Z	3	1.49
S	26	13.0
SM	21	10.44
AF	103	51.24
GC	81	40.29
GCZ	10	4.97
GCS	5	2.48

On the other hand, bi regional region was included the large bulk of species number where the highest number was recorded in sub region of Afromontane archipelago-like regional center of endemism and Guineo-Congolian regional center of endemism followed by Saharan Regional Subzone (SS1) and Guineo-Congolian regional center of endemism 18 species constituted (8.95 %). In this area Afromontane archipelago-like regional center of endemism and Saharan Regional Subzone have 12 species (Fig. 3). On the other hand, three regions of Afromontane archipelago-like regional center of endemism (AF) and Sahel Regional Transition Zone (SA) has 13 species with 6.46%, Afromontane archipelago-like regional center of

endemism (AF) and Guinea-Congolian/Zambezia Regional Transition Zone (GCZ) were shared by four species (1.97%). The remainder bi-regional area such as Saharan regional sub zone with Guinea-Congolian/Zambezia Regional Transition Zone was recorded by two species. Also, Pleuriregional area revealed that the highest number of species was recorded in the categories of the Afromontane archipelago-like regional center of endemism (AF), Somalia-Masai regional center of endemism (SM), Zambezi Regional Center and Guineo-Congolian (GC) regional center of endemism (GC) (Table 3).

Table 3. Chorological analysis of no. of species in each phytochoria region represent mono, bi and tri-regional elements

Types	Number	%
SS1	8	3.98
SA	4	1.99
Z	1	0.49
GC	18	8.95
GCS	2	0.99
AF	47	23.38
GCZ	1	0.49
AF+GC	32	15.92
SSI+ GC	18	8.95
AF +SSI	12	5.97
AF+GCZ	4	1.97
AF+SA	13	6.56
SSI+GCZ	2	0.99
AF+SM + GC	2	0.99
AF+ GC+GCZ	1	0.49
SA+Z+GC	1	0.49

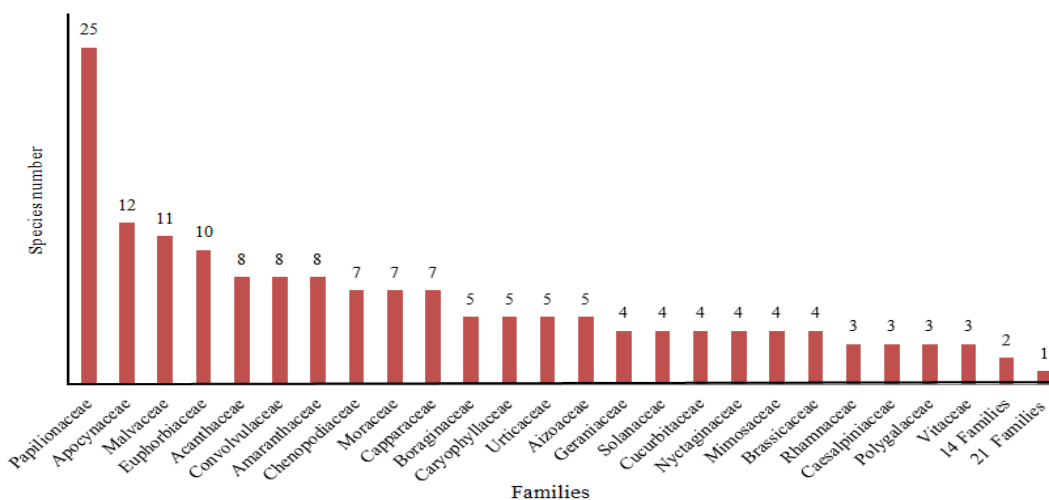


Fig. 2. Species number in the recorded families of the study area

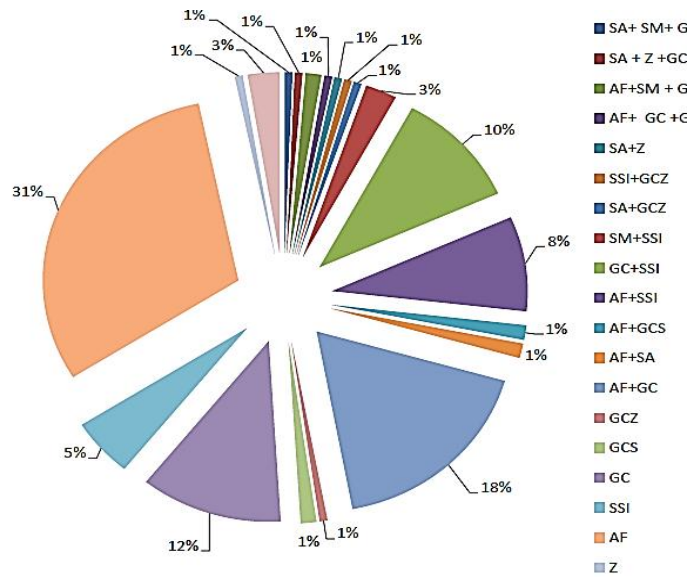


Fig. 3. Species distribution among the selected 9 African paleotropical elements (For abbreviations see Table 1)

The chorological analysis revealed that the area of the Sudano-Zambezian chorotypes consider as good indicators of a desert environment therefore decrease moving north and were replaced by Mediterranean and Irano-Turanian chorotypes [30,15,12,11]. Guinea-Congolian Regional Transition Zone and Afromontane archipelago-like regional center of endemism were predominated because this area mainly deserted and located within the belt of Saharo-Sindian also it is a part of that belt between Saharo and Sindian regions. Saharo-Arabian species are covered most of the deserted area of Sindian from the red sea coast to the Gulf coast through the empty quarter desert. On the other hand, Afromontane Archipelago-Like Regional Centre of Endemism than the other nine African

paleotropical floristic elements. This corresponds to the findings of [5] which placed the southwestern mountains of the Arabian Peninsula within the Afromontane Archipelago-Like Regional Centre of Endemism.

The dendrogram resulting from the UPGMA method divides the 9 African paleotropical floristic elements on the basis of their species composition into two main groups at a relative similarity level of 1.20 (Fig. 4). The highest level in group I concerned with Afromontane archipelago-like regional center of endemism (AF), Guineo-Congolian regional center of endemism (GC) were recorded as the highest level whereas the Guinea- Congolian Regional Transition Zone (GCZ), Sudanian Regional

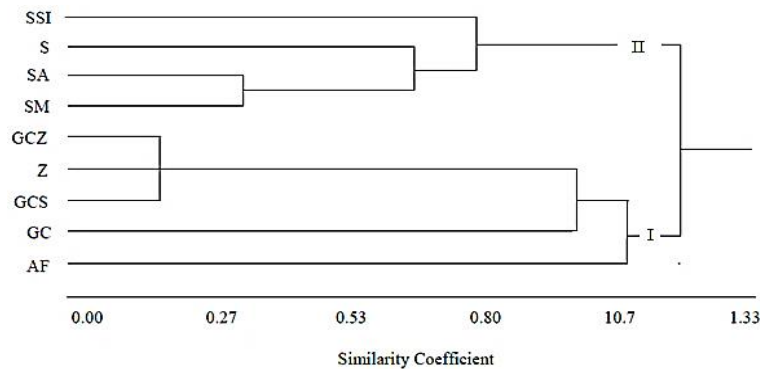


Fig. 4. Cluster analysis of the 9 African paleotropical floristic elements based on the similarity of their species composition by the UPGMA method. For abbreviations see Table 1

Centre of Endemism (Z) and Sudania Regional Transition Zone (GCS) were recorded as sub group level. The second group (II) included the remainders regions. In the second group, the Saharan Regional Subzone (SS1) was the larger subzone was recognized as a separate level (Fig. 4). The lowest cluster in this group were included the two area of Sahel Regional Transition Zone (SA) and Somalia-Masai regional center of endemism. On the other hand, Wickens [31] and Boulos [32] mentioned that the Saharo-Arabian region is characterized by the presence of few endemic species and genera. Also, the recorded species in the Saharo-Arabian region were restricted in their distribution to the central strip of Saudi Arabia and more abundant in their habitats with more favorable micro environmental conditions [33,30].

4. CONCLUSION

201 plant species (seven species of Pteridophytes, one species of Gymnosperms and 193 species of Angiosperms) related to 59 families were collected and identified from Jazan region of Saudi Arabia. The selected plant species were revealed under a nine African paleotropical floristic elements from the known ten African elements which divided by [2,4] and a recent map presented by [5]. The chorological analysis revealed a total of 79 species with percentage of 39.30% of the total recorded species inhabiting the monoregional region in this area the highest percentages of 51.24% was inhabiting in Afromontane archipelago-like regional center of endemism (AF) of the total recorded species followed by the Regional Center and Guineo-Congolian (GC) which recorded by 40.29 %. On the other hand, the bi regional region has 81 species in which, the highest number of species was recorded in the area of Afromontane archipelago-like regional center of endemism (AF) and Guineo-Congolian regional center of endemism followed by Saharan Regional Subzone (SS1) and Guineo-Congolian regional center of endemism 18 species constituted (8.95 %). The relationships between the 9 African paleotropical floristic elements were subjected to the numerical analysis to reveal the similarity and dissimilarity. Two main groups were constructed from the program, the first group (I) was included with Afromontane archipelago-like regional center of endemism (AF) followed by the Guineo-Congolian regional center of endemism (GC). The second group (II) in which Sahara Regional

Subzone (SS1) was recognized as a separated in a single level.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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