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ORIGINAL ARTICLE

Potentials of Geodiversity for Biodiversity at Ga'ara Depression, Iraqi Western Desert

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ABSTRACT
An intrinsic relationship between geological and biological diversity was found at Ga´ara Depression, in the Iraqi Western Desert, about 400 km west Baghdad. Diversity of geologic resources at the studied includes: rock beds, landforms, water resources and soil types that represented in creation of well-diverse landscape of different habitat types. Biodiversity comprises wide range of plants and animals including annual and perennial grasses and shrubs and fungi, mammals, birds, reptiles, arthropods, and mollusks. Present results showed sort of distribution patterns of biotic groups related to geologic features. This correlation was obvious in some species of vertebrate as well as invertebrates.
Keywords: Geodiversity, Biodiversity, Ga'ara Depression, Plants, Vertebrates, Invertebrates.

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INTRODUCTION

Geodiversity has been defined as "the link between people, landscape and their culture: it is the variety of geological environments, phenomena and processes that make those landscapes, rocks, minerals, fossils and soils which provide the framework for life on earth" [1]. It incorporates many of the environmental patterns and processes that are considered drivers of biodiversity [2]. It constitutes, also, the abiotic equivalent of biodiversity and defined as "the natural range of geological (rocks, minerals, fossils), geomorphological (landforms, processes) and soil features [3]. The geologic bedrock is viewed as the foundation of the ecosystem. Geologic resources and processes sustain biotic resources and biosystems. These relationships are integrated at the ecosystem, community, species, organism, cellular, and genetic levels. In recent decades the relationships between geodiversity and biodiversity become more recognized by modern ecologists and natural resource specialists [4]. An increasing number of research publications and conferences focus on the integration of modern "bio-geo systems". On the other hand, only a few taxonomic groups of animals occurring in the desert areas of Iraq have been studied [5]. This is rather true for plants as well. The aim of this study is to investigate and correlate between biotic and geologic components of the Ga'ara Depression.

METHODOLOGY

The source of the data presented in this study was mainly the surveys and field trips of the authors to the Ga'ara Depression during the three past decades, and numerous interviews with the local Bedouins and settlers of the area. Some of the animal species identifications were referred to their tracks including feces, pellets, feathers, hair, and foot prints etc., others on pictures shot in the field or by close monitoring. Another group of identification was from the Iraq Natural History Museum-University of Baghdad specimens collected at the general vicinity of the study area.
Determination of vertebrate specific identity was possible following suitable keys and guides including [6] for plants, [7,8] for reptiles, [9] for birds and [10] for mammals.

Location: The depression is located at western sector of Iraq, about 400 kilometers west of Baghdad City and 50 kilometers north to Rutba Town (Fig. 1). According to [11], it has sub-oval shape 70 kilometers long and 35 kilometers wide, and elongated in E-W direction. Its area about 2000 square kilometers and is confined between the following coordinates:
Longitude: 40° 00' 00 ″- 40° 50' 00″ E
Latitude: 33° 20' 00″– 33° 45' 00″N
The elevation ranges from 460 meters above sea level, near Ghadir Al-Sufi on the floor of the depression to about 660 meters on the southern rim (Fig.1).

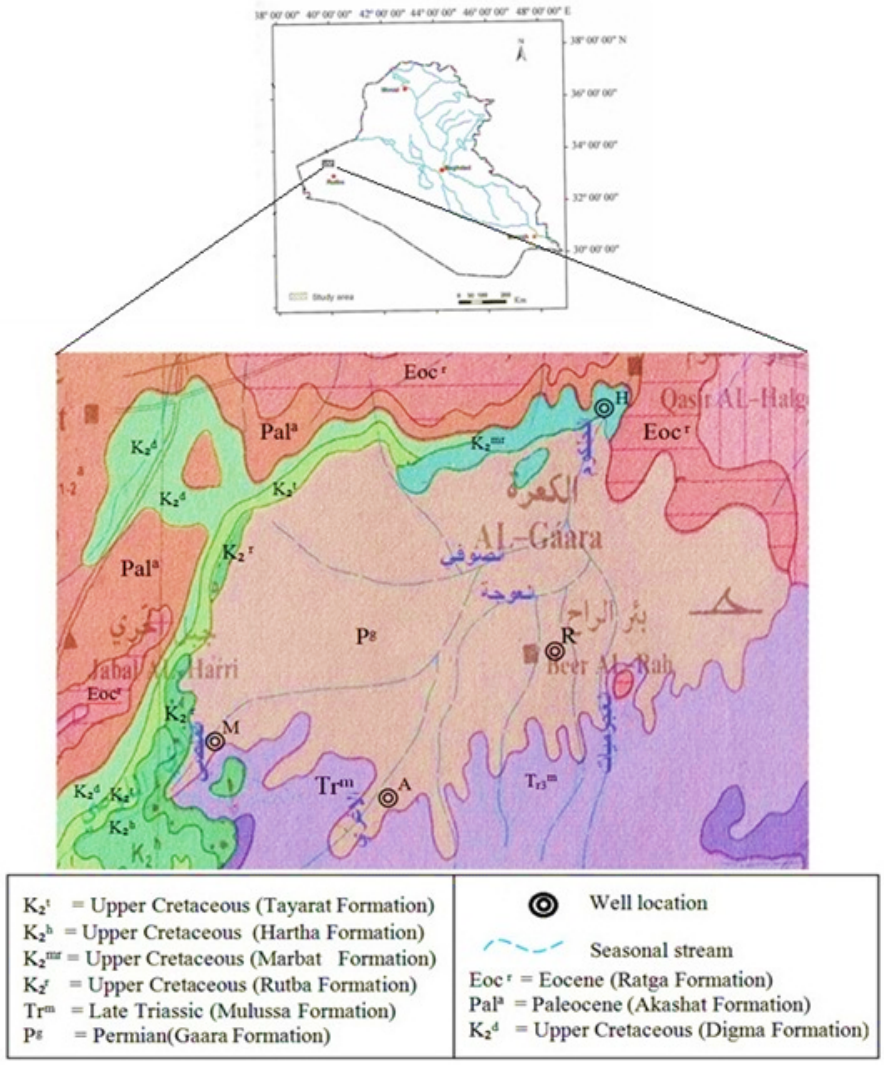


Fig. 1: Location and geological map of Ga'ara Depression- Iraqi Western Desert (Sissakian, 2000).

RESULTS AND DISCUSSION

Climate: The meteorological data from Rutba station shows that the mean annual precipitation ranges from 125-167 millimeters/year, mean air temperature 1.9-42.3℃ and wind speed 1.8-5.4 m/sec. The studied area has two clear annual periods: cold, fairly wet period (October- May) and a hot dry period (June- September). According to the above data, the study area can be classified as arid area. Prevailing wind direction is from north, northwest and west. Torrential rains are characteristic to the area, during which, and/or later, the ephemeral streams become flooded with fast flowing water. **C**limatic information of the neighboring stations can be shown in table 1.

Table 1: Climatic information of Rutba, Qaim, Ana and Haditha (source: IGOMI [12]).

Station	Max. temp ˚C	Min. temp ˚C	Wind speed m/sec.	Annual precipitation (ml/year)	Annual evaporation (ml/year)
Rutba	14.6-38.3	1.9-22.8	2.3-4	125.3	2720
Qaim	14.5-40.5	3.3-24.3	1.9-4.1	142.2	2646.3
Ana	14.6-41.6	2-32.7	1.8-5.4	167.4	2716.9
Haditha	15.3-42.3	4.1-25.5	2.1-5.4	141.7	3368.9

Geodiversity: The geodiversity of Ga'ara Depression comprises rock units of different formations exposed at the studied area (stratigraphy), land forms, natural processes, hydrology and soil features.
Rock units: The Ga'ara Formation (Permocarboniferous) is the oldest exposed unit in western Iraq and is exposed at the Ga'ara Depression that composed of sandstone, siltstone, and claystone. The Ga'ara Formation is over lined by many formations at different localities on the surrounding rims [13]. The exposed rock units on the rims of Ga'ara depression are expressed in (table 2).

Table 2: Rock units of the study area (M: member, U: unit) (source: Sissakian [14]).

Age	Formations	Members,Unit and Lithology
Eocene	Ratga	**DamlukM.:Limestone, recrystalised.** **Swab M.: Limestone, recrystalised and silicified at top.**
Paleocene	Akashat	**Dwaima M.: Limestone** **Hirri M.: Phosphorite and phosphatic limestone** **Traifawi M.: phosphatic limestone and marl.**
Late Cretaceous	Tayarat	**Dolostone, limestone and dolomatic limestone**
	Marbat	**Pebbly sandstone and sandy dolostone**
	Hartha	**Upper M: Alternation of fossiliferousdolostone, marl, marlydolostone and subordinate sandstone.** **Lower M.: Conglomerate to Conglomeratic sandstone, calcareous sandstone and sandy dolostone.**
Cenomanian-Turonian	Rutba- Msad	**The upper part is carbonate and the lower is friable sandstone.**
L. Triassic (Rhaetian)	Zor- Hauran	**U. C: Alternating thin marl and thin dolostone.** **U. B: Marl and dolostone.** **U. A: Marl, claystone and dolostone.**
L. Triassic (Carnian-Norian)	Mulussa	**U.C: Dolostone with chert horizon in the middle.** **U. B: Thin bedded dolostone and thin marl.** **U. A: thick dolostone, marl and subordinate sandstone.**
L. Carboniferous E. Permian	Ga'ara	**Afaif U.: Alternating sandstone and mudstone with ferruginous lenses.** **Rumliya U.: Dominantly sandstone.**

Landforms: The landforms of study area reflect arid and semi-arid conditions [15]. It is resulted from both erosion and sedimentation on the structural elements[11]. According to field survey by [11] and authors observations, many landforms (figs. 2,3) were recognized, such as:
Plateaus: These are extensive and surround the depression. Many plateau levels were recognized at northern and western rims of the depression, and named according to the lithology of the harder beds as: Marbat, Na'aja, Safra, Hirri, Swab and Damluk [16]. In the south and southwest, four other plateau levels recognized and named by [17]. The lowermost is the Mulussa Plateau, followed by Zor-Hauran, Msad, and Hartha Plateaus.
Escarpment: The hard carbonates (dolostone) which form the plateaues surfaces generally form precipitous to vertical scarp-faces whereas, the softer Ga'ara Formation forms steep to gentle slope.
Pediments: They are extensive and form continuous belt parallel to the escarpments and formed as a result of the depositional processes through the down slope washing of finer material.
Mesas and Buttes: They have rounded flat top and reflect an advance stage of plateau dissection. They are characterized by flat tops, almost vertical cliffs and their altitudes match that the original plateaus from which they have departed. The Afaif hills, Azzlat Al-Agharri and many others may be placed under this category.

Undulated hills: are formed by differential erosion. The caps are usually made of hard rocks, whereas the sides are made of softer sediments. Sometimes the hills form a continuous chain, or they remain isolated. Such landforms are: Ghabd Al-Mulussa and Telul Al-Humr.
Floodplains: These plains accompany the ephemeral streams such as Shaib Al-Agharri and Shaib Al-Oja. The sediments of these depositional features consist of semi-friable mixture of clay, silt and lime carbonates.
Channel sediments: These sediments composed of gravel and coarse sand and restricted to the main ephemeral streams, such as Ghadir Al-Sufi and Wadi Al-Mulussa. Channel deposits reflect high flow energy during rainy days.
Caves: These caves are naturally formed when slightly acidic rain water dissolves limestone along joints and bedding planes. They are naturally formed within carbonate rock beds of Zor-Hauran and Mlussa Formations and near the contact between these two formations and friable clastic rocks of Ga'ara Formation.
Sand Sheet and Nebkha: The sand sheet is well developed in the eastern part of the Ga'ara depression in Al-Gar area. It has suboval shape (15x7 kilometers) and its thickness reaches about 3.5 meters. Nebkha is developed on the sand sheet owing to a plant growth.
Hydrology: Very limited rainfall does occur in the study area, but sometimes large amount of rain precipitate at a short time, in which the water runs rapidly over the earth surface, particularly were vegetation is sparse. Flow water is largely controlled by geology and geomorphology. Ephemeral stream water flows during rainy days drained from surface plateaus, 660m a.s.l. toward the depression floor, about 460 m a.s.l. Also, there are many shallow hands-dug wells with depth of 12 m contain water from unsorted Quaternary sediment. The bedrock succession of Ga'ara depression comprises sandstone and claystone beds and this lead to form aquifer within sandstone bed which underlined by impervious claystone bed.
Soil: Soils (referred to sediments accumulated at study area) are the link between the abiotic and biotic worlds; their composition and chemistry are directly related to the surrounded bedrock, and consequently, the distribution of many plant taxa is dependent upon the mineralogical and chemical composition of the soil [4]. For the desert soil of central Iraq, very little chemical variation was found although considerable diversity in texture and stratification occurred [18]. Soil of Ga'ara Depression is produced by physical and chemical weathering processes acting to break down bed rocks that exposed on the rims. Bed rocks mostly composed of sandstone, mudstone, claystone, limestone, dolostone and phosphatic limestone (Fig.2). Field survey on soil of Ga'ara shows five types of soils according to thickness, grain size and landforms on which they found. They are: Floodplains, Hamada, Depression fill (Faidhat), Pediments soil and sandy soil (fig. 2).
Floodplains soil :This type of soil is deposited on both sides of ephemeral streams such as Shaib Al-Aghari and Shaib Al- Oja as well as narrow and shallow soil of the main valleys of southern and eastern rims such as WadiAl- Ajrumiyatand Wadi Al-Mulussa.
Hammada soil: The deflation of the fine grains exposes residual gravels of different sizes and shapes on the flat and low gradient surfaces and on the top of surrounded plateaus such as Mulussa and Zor- Hauran plateaus.
Depression fills (Faidhat): It is recognized at the small flood basins. These sediments transported by the flow of rain water and deposited at shallow small basin on the plateaus, locally named Faidhat, especially on the surface of the Zor-Hauran and Mulussa plateaus.
Pediment soil: It is developed on the low gradient surfaces of valleys that connected the plateau surfaces and valley floors. These soils are formed as a result of the depositional processes of fine grains between coarse rock fragments of carbonate. Fine and coarse materials usually derived from upper surface of plateaus. Such soil was found at the Wadi Al- Ajrumiyat and Wadi Al- Tarfat, the later drained toward Wadi Al- Mulussa. High density of wild wheat grows on such soil.
Sandy soil: They are found on the floor of the study area and the slopes of the hills near eastern rim as a sand sheet. It is well-sorted, fine sand and its thickness ranged from 3.5 meters to 5 meters.
Habitats: The diversity of geologic features and processes provides an almost infinite array of habitat types to sustain life [4]. Presence of wide plateaus dissected by large and deep valleys such as Wadi Al-Mulussa, Wadi Al-Ajrumiyat, Wadi Al-Njeli, and WadiDwekhla, escarpments and pediments contributes for growing certain plants in minor flood plains like members of family Graminae which represent a favorable food for Galliform birds. These natural elements (plateau surface, escarpment, pediment, deep valley and flood plain plants) compose a typical ecosystem for game birds breeding like Chukar partridge *Alectorischukar* which is a common game bird in rock hills of western parts of Iraq [19], Seesee partridge *Ammoperdixgriseogularis*, wheatears *Oenanthe* spp. and others. This system offers food and water in

minor flood plains, help the birds in fast climbing of pediments to the upper surface of plateau when feel danger, and provide nesting sites and safe shelters in the caverns between rocks for chukar and certain passerines like *Oenanthe* spp. and Trumpeter finch *Bucanetesgithagineus*. Gazelles also get benefits from this system which provides food and escaping quickly from danger. The Oxeye *Asteriscuspygmaeus* (Family Compositae) is common in pediments among rock fragments and characterized by great tolerance to high temperature and drought for its structural and anatomical adaptations. Also, *Helianthemumledifolium* (Family Cistaceae) which is parasitized by truffles *Terfeziaclavery* and *Tirmanianivea* (Fungi) in undulated hills pediment, especially in its proximal part near flat areas with soil composed of sand and clay particles. The apexes of rocky escarpments, especially in the southern rim of the depression provide a good resting places as well as a general landscape sight for falconiform birds enabling them watching their preys like hares *Lepuscapensisarabicus* and certain small mammals during migratory periods such as Steepe eagle *Aquila nipalensis* and Golden eagle *A. chrysaaetos*. Messas and buttes like that of Afaif hills provided typical nesting places for Saker falcon *Falco cherrug* (Falconiformes), but this bird is no more breeding in the depression since at least two decades due to human interference although these messas have steepe slope escarpment and it is too difficult for man or animal to reach the apex unseen.

Caves among limestone and marly limestone at rocky pediment of Ga'ara rims as well as the fallen rocks near and at the cave entrances represent a good living and breeding places and help in protection and hiding the dens for wolf, *Canis lupus* and Stripped hyaena, *Hyaenahyaena* which had been frequently seen by the authors and locals at the area. In addition their feces were observed at caves entrances. Foxes, *Vulpesvulpes* and *V. ruppellii* dig their dens at the friable marlylimestones and phosphaticlimestones.

The wide floodplains neighboring Ghadeer Al-sufi, Shaebalagheri and Shaebaloja in rainy days to colorful carpet of lavender, Graminae grasses and others, while in shallow and narrow flood plains of the western rim valleys like Mulussa, Dwekhla and Ajrumiyat, grasses (Family Graminae) grow to feed galliform birds and sandgrouses. On some plateau like Tel Al-Na'aja, the soil is immature calcic with low thickness that help in growing *Plantago* spp. In the alluvial fan soil presents between large rocks, the thyme *Thymus vulgaris* and white wormwood (shieḥ)*Artmesiaherba-elba* are distributed.

Sand sheet soil is characterized by presence of some perinneal plants with deep roots and filiform leaves like *Haloxylonsalicornicum* (Compositae) which contribute to initiate microenvironment assist in shadowing restricted areas, reducing temperature and keeping humidity. The authors were able to recognize that temperature was going down by 2˚C under these plants that make it suitable for resting of quail *C. coturnix* and certain reptiles like *Acanthodactylus* spp. or *Ophisops* spp. This will lead also in preparing a sort of ecosystem encourages growing of some annual plants and insects.

Biodiversity: The biodiversity refers to the broadly diverse forms into which organisms have evolved and considered at three levels: genetic diversity, species diversity, and ecodiversity [20]. In regard to Ga'ara, depression biodiversity tentatively comprises 141 plants and vertebrates that could be identified by us including 31 plants, 17 reptiles, 71 birds and 22 mammals. Unknown number of different kinds of invertebrates, fungi and other macro- and submacroscopic organisms are in need to be studied and identified. The available systematic lists are as follows:

Plants:

1- *Alhagimourorum* (Fabaceae)
2-*Allium* sp. (Amaryllidaceae)
3- *Anabasis articulate* (Chenopodiaceae)
4-*Anthemis* spp. (Asteraceae) (Compositae)
5- *Artemisia herba-alba* (Asteraceae)
6- *Astragalusspinosus* (Fabaceae)
7- *Atriplex*spp. (Amaranthaceae)
8- *Calligonumcomosum* (Polygonaceae)
9- *Capparisspinosa* (Capparaceae)
10- *Carexstenophylla* (Cyperaceae)
11- *Cistanche*spp. (Orobanchaceae)
12-*Citrulluscolocynthis* (Cucurbitaceae)
13- *Convolvulus* sp. (Convolvulaceae)
14- *Cyperus conglomerates* (Cyperaceae)
15- *Ephedra alata* (Ephedraceae)
16- *Erodiumdeserti* (Geraniaceae)
17- *Haloxylonsalicornicum* (Amaranthaceae)
18- *Helianthemum*spp. (Cistaceae)
19- *Malvaparviflora* (Malvaceae)
20- *Orobanche*sp. (Orobanchaceae)
21- *Papaverglaucum* (Papaveraceae)
22- *Plantago*spp. (Plantaginaceae)
23- *Ranunculus* sp. (Ranunculaceae)
24- *Rhanteriumepapposum* (Asteraceae)
25- *Salsola*spp. (Amaranthaceae)
26- *Suaeda*sp. (Amaranthaceae)
27- *Tamarix*spp. (Tamaricaceae)
28- *Thymus vulgaris* (Lamiaceae)
29- *Trifolium* sp. (Fabaceae)
30- *Typhadomingensis* (Typhaceae)
31- *Zygophyllum*spp. (Zygophyllaceae)

Vertebrates:

Class Reptilia

1-*Acanthodactylus opheodurus*
2- *Acanthodactylus*sp.
3-*Eireniscoronella*
4- *Lytorhynchoskennedyi*
5-*Mesalinabrevirostris*
6-*Platycepsventromaculatus*
7- *Platycepsrhodorhachis*
8- *Psammophisshokari*
9- *Pseudocerastespersicusfieldi*
10- *Ptyodactylusgrandiceps*
11-*Trapelus pallidus*
12- *Trapeluspersicus*
13- *Trapelusruderata*
14- *Spalerosophisdiademacliffordi*
15-*Uromastyx aegypticus*
16-*Varanus griseus*
17-*Vipera lebetina*

Class Aves

1-*Accipiter nisus*
2-*Acrocephalus arundinaceus*
3-*Aegypius monachus*
4-*Alaemon alaudipes*
5-*Alauda arvensis*
6-*Alectoris chuckar*
7-*Ammomanes cinctus*
8-*Ammomanes deserti*
9-*Ammoperdix griseogularis*
10-*Aquila chrysaetos*
11-*Aquila nepalensis*
12-*Ardea cinerea*
13-*Athene noctua*
14-*Branta ruficollis*
15-*Bubo bubo*
16-*Bucanetesgithagineus*
17-*Burhinus oedicnemus*
18-*Buteo buteo*
19-*Buteo rufinus*
20-*Chlamydotis undulata*
21-*Charadrius asiaticus*
22-*Circaetus gallicus*
23-*Circus cyaneus*
24-*Circus macrorus*
25-*Circus pygargus*
26-*Caprimulgus aegyptius*
27-*Columba livia*
28-*Columba oenas*
29-*Corvus corax*
30-*Corvus corone*
31-*Coturnix coturnix*
32-*Cursorius cursor*
33-*Eremophila alpestris*
34-*Eremophila bilopha*
35-*Emberiza hortulana*
36-*Falco biarmicus*
37-*Falco columbarius*
38-*Falco naumanni*
39-*Falco tinnunculus*
40-*Galerida cristata*
41-*Grus grus*
42-*Hieraaetus fasciatus*
43-*Hirundo rustica*
44-*Irania guttularis*
45-*Lanius collurio*
46-*Lanius isabellinus*
47-*Melanocorypha calandra*
48-*Milvus migrans*
49-*Motacilla alba*
50-*Muscicapa striata*
51-*Nephron percnopterus*
52-*Podiceps cristatus*
53-*Pterocles alchata*
54-*Pterocles lichtenstienii*
55-*Pterocles senegallus*
56-*Oenanthe alboniger*
57-*Oenanthe deserti*
58-*Oenanthe finschii*
59-*Oenanthe lugens*
60-*Oenanthe oenanthe*
61-*Pandion haliaeetus*
62-*Passer domesticus*
63-*Passer hispaniolensis*
64- *Passer moabiticus*
65-*Phylloscopus collybita*
66-*Rhodospiza obsoleta*
67-*Streptopelia decaocto*
68-*Streptopelia senegalensis*
69-*Streptopelia turtur*
70-*Sylvia nana*
71-*Upupa epops*

Class Mammalia

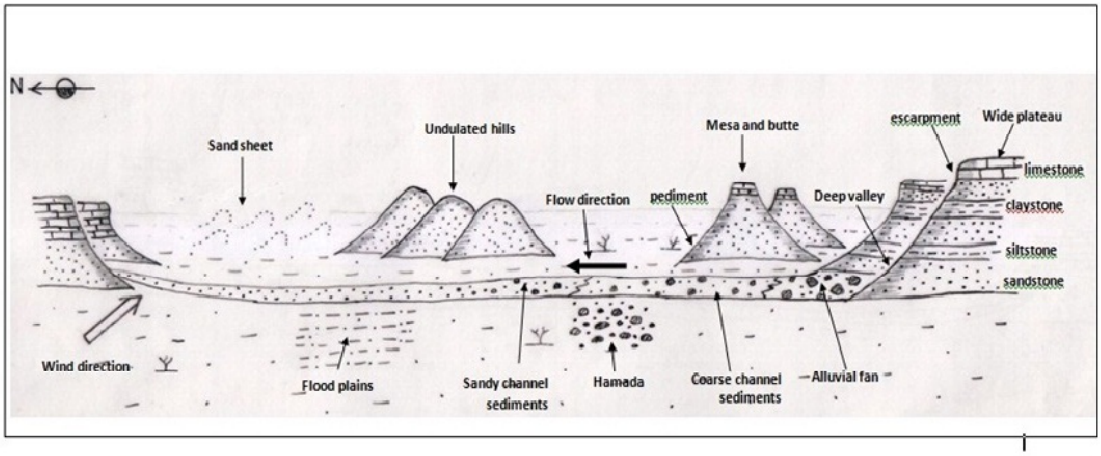
1- *Alactagaeuphratica*
2-*Asellia tridens*
3-*Canis lupus*
4-*Caracal caracal*
5- *Felismargaretta*
6*Felissilvestris*
7- *Gazelladorcas*
8- *Gazellasubguttorosa*
9- *Gerbillusdasyurusmesopotamiae*
10-*Hemiechinus auritus*
11-*Hyaena hyaena*
12-*Hystrix indica*
13-*Lepus capensisarabicus*

14- *Merioneslibycus*
15-*Mus musculus*
16- *Myotiscapaccini*
17-*Pipistrelluskuhlii*
18-*Rhinolophuseurayale*
19-*Rhinolophus ferrum-equinum*
20-*Taphozous nudiventrismagnus*
21-*Vulpes ruppellii*
22-*Vulpes vulpes*

More extensive surveys will certainly add more species of plants and animals to the present list.

CONCLUSIONS AND RECOMMENDATIONS

Four types of Geo-biodiversity complex habitats are recognized in the studied area, these are: 1- Plateaus, escarpments and pediments and deep valley flood plain complex such as Wadi Al-Mulussa, Wadi Al-Ajrumiyat, Wadi Al-Njeli, and WadiDwekhla is characterized with the presence of the snake *Pseudocerastespersicus* (FamilyViperidae), Chukar partridge *Alectorischukar*, Seesee partridge *Ammoperdixgriseogularis* (Family Phasianidae), rock dove, *Columba livia*, stock dove *C. oenas* (Family Columbidae), Trumpeter finch *Bucanetesgithagineus* (Family Ploceidae) and Gazelles *Gazelladorcas* (Family Bovidae), wheatears *Oenanthe* spp. (Family Turdidae) and the plant species Oxeye



(Fig. 2) shows land forms and soil (sediments) of Ga`ara Depression – Iraqi western desert

Asteriscuspygmaeus (Family Compositae). The latter species, the plant Oxeye is of special interest, in spring it is with broad thin leaves and relatively big flower/s but in summer it is not more than a "burned dark brown branched stick" lying beneath rocks with rather woody brown thick flower leaves lying accumulated concentrally on each other. On pouring few drops of water on it they will simultaneously opened in an effort to increase its surface area, probably to collect more drops of water. Studying the mechanism of the adaptation to xeric conditions in this plant is of interest.

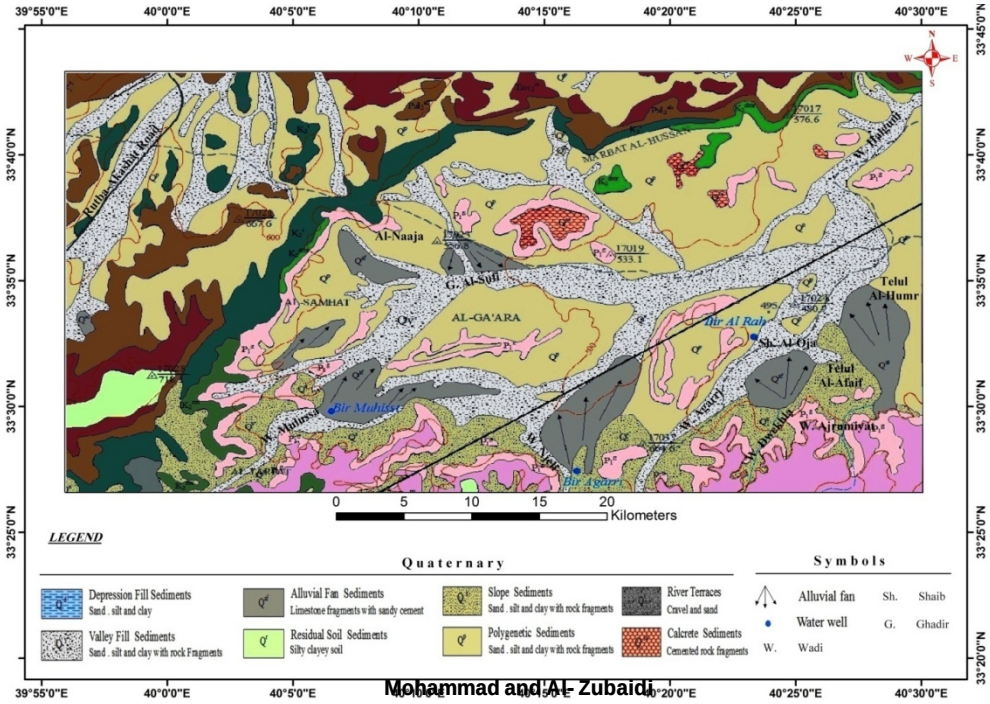
2- Caves in carbonates, marly carbonates and phosphatic limestone at rocky pediment of Ga'ara southern and northern rims are characterized with the presence of the wolf *Canis lupus*, foxes *Vulpesvulpes* and *V. ruppellii* (Family Canidae) and stripped hyaena*Hyaenahyaena* (Family Hyaenidae).

3- Flood plain habitats are adjacent to Ghadeer Al-Sufi, Shaib Al-Agharri and Shaib Al-Oja and characterized by presence of sandgrouses like spotted sandgrouse*Pteroclessenegallus*, pin-tailed sandgrouse*P. alchata* (Family Pteroclididae) and quail *Coturnixcoturnix* (Family Phasianidae), the plants *Plantago* spp. (Family Plantaginaceae), *Thymus vulgaris* and *Artmesiaherba-elba* (Compositae).

4- Sand sheet soil and sand dunes habitat at the eastern side of the depression in Al-Gar area (Kur Humor Eed) is characterized with presence of reptiles like *Acanthodactylus* spp. or *Ophisops* spp. (Family Lacertidae) and the plant *Haloxylonsalicornicum* (Compositae).

It could be also concluded that water is the most affecting limiting factor which draw the frontier lines of each geo-biodiversity complex, i.e. the more water collected, preserved and made available by each kind of habitat in the area in respond for the critical requirements of the biotic components, the more biodiversity present within the habitat leading into combination of biotic and abiotic elements and resulting into more ecodiversity. This conclusion coincides with the results of Thalen [5] who found that

only 13% of water samples taken from western desert wells had an amount of soluble salts exceeding 3000 ppm. However, desert animals carry their heritage of aquatic origin within their physical composition and all the metabolic processes occurring in their bodies take place in an internal environment in which the presence of a minimal constant amount of water is an absolute necessity [21].



Mohammad and Al- Zubaidi

Fig. 3: Local Sites Location of Gaara Depression- Iraqi Western Desert (GEOSURV,).

Fig. 4: Two inscriptions of the Nubian ibex, *Capra nubiana* on desert varnish at Tel l'Nisr (arrows).

From the above results about the biodiversity and geodiversity and their interactions in the Ga'ara depression, it can be concluded that there are some gaps in our knowledge about the flora of the depression and the need for more systematic studies and further surveys during different seasons. Al-Hassan [6] identified 270 plant species in the northern parts of the Kingdom of Saudi Arabia, the area that is continuous with the studied area. Another gap in our knowledge is the invertebrate fauna. Except for

identifying some invertebrates, e.g., scorpions like, *Androctonus crassicauda*, *Orthochirusscorbioculosus*, *Compsobuthusmathiesseni* and *C. werneri* (Buthidae), ticks infesting domestic as well as wild animals like *Haemaphysalisadleri, H. erinacei, Hyalommaanatolicum*, *H. excavatum*, *H. dromedarii, H. schulzei, Rhipicephalusleporis, R. s. sanguineus*,and *R. turanicus* (Family Ixodidae), *Argasconfusus*and *Ornithodoroserraticus* (Family Argasidae) [22], soli fungi *Galeodisarabs* (Galeolidae), insects like the ant*Messor* sp. (Formicidae), the termite *Anacanthotermesubachi*(Hodotermitidae) [23], the beetles *Scarabaeussacer* (Copridae), *Coccinellaseptempunctata* (Coccinellidae), *Juloidesdistincta* (Buperstidae), *Adesmiacancellata* (Tenebrionidae), *Ammocieonusaschabadensis* (Curculionidae), crustaceans like the wood lice *Hemilepistes* sp. and land snails like *Sphincterochylaboissierii* and *Ereminadesertotum,* practically there is no enough data about their specific identities as well as their prevalence or biology.

The rocks with desert varnish contribute to our knowledge of the ancient biodiversity of the Ga'ara depression shows one of two inscriptions of Nubian ibex, *Capra nubiana* which is extinct since relatively long time from the area.

Chemical analyses of different kinds of soil present in the depression for more understanding of their relation to plant groups that grow on them seem necessary.

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