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Species

Vegetation Survey for Vascular Plants of Protected Area of the University of Tripoli-Libya

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General Note
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ABSTRACT

The aim of the present study is to elucidate the floristic composition and to document the current plant diversity of protected area (Researches Station) of Agriculture Faculty, University of Tripoli. The current study revealed that (110) plant species belonging to (95) genera and (35) families (31 dicots and 4 monocots) were recorded from the study area. The most highly represented families are the Asteraceae (22 species), the Poaceae (16 species), and the Fabaceae (12 species). The dominance of Asteraceae and Poaceae families are an indication of the increased diversity of herbs in the area, as well as of the cosmopolitan nature of the families and they are dominated the Mediterranean climate conditions. To determine the floristic composition of plant species in the study area the following characters were studied: life forms, chorotypes and create a list of vascular plants species. According to Raunkiaer's method, the highest life form recorded were Therophytes (52.73 %), Hemicryptophytes (14.54%), and Chamaephytes (13.63%), while the least represented life forms were the Phanerophytes with five species (6.36%) and Nanophanerophytes with three species (2.72 %). The only halophytic plant we registered was *Scirpus holoschoenus*. The combination of the high percentage of Mediterranean species and the high percentage of therophytes reflects the Mediterranean character of the flora of the studied area. The dominance

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of Therophytes and Mediterranean chorotypes were expected because the study area is located within the Mediterranean region in which the Mediterranean Therophytes are dominating.

Keywords: Protected area, Vascular Plants, Floristic analysis, Life Forms, Chorotype.

1. INTRODUCTION

Protected areas are significant tools for the preservation of biodiversity by protecting species, habitats, and other biodiversity features within their frontiers (CBD, 2010). The protected area was identified as an area of land and/or sea, specially committed to the protection and upkeep of biological diversity, natural and associated cultural resources, and managed through legal or other effective means (IUCN, 1994). Protected areas are places where efforts are made to maintain not only wild species but also the ecosystems in which species live (Stolton et al., 2015). Throughout the world, protected areas could be the only natural or near-natural ecosystems remaining in large areas (Cardinale et al., 2012), they are the key to conserving biodiversity, and they provide food, also other ecosystem services essential for human sustenance (DeFries et al. 2007). The plants develop in communities; each community is characterized by species diversity, growth forms, and structures, dominance successional trends. Conversion of habitat leads to a simplification of natural communities, resulting in the promotion of species that are tolerant to altered environments (Dosso et al., 2012). The aim of the present study is to elucidate the floristic composition and to document the current plant diversity of protected area (Researches Station) of Agriculture Faculty, University of Tripoli.

2. MATERIALS AND METHODS

Study area

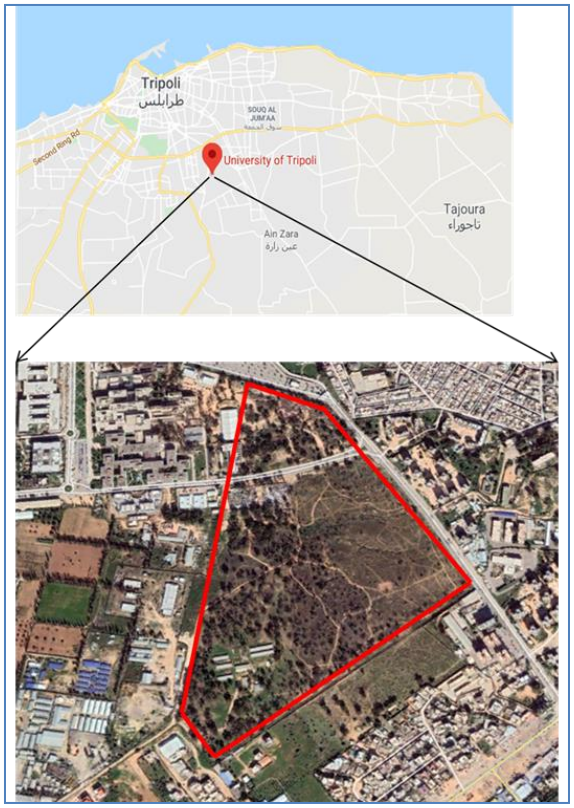

Figure 1. Location of Protected area in the University of Tripoli (Via https://www.Google Earth).

The study area is located within the University campus, between latitudes (32^0 50' 29.59" and 32^0 51' 02.51") North and longitude (13^0 13' 38.44" and 13^0 14' 05.99") East with a total area of 35 ha (Fig. 1). The area is characterized by the nature of a different flat land in the rise and it's about 8 Km from the sea, and it rises to about 11m above the sea level. The study area located within the

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influence of the Mediterranean climate, warm rain in the winter, and hot dry summers (Betelmal, 2010). Climate is one of the most important factors affecting biodiversity, vegetation distribution, and soil composition, and the high temperature affects vegetation and the dominant species.

Data collection

This research has been carried out during April and May 2019 and February to April 2020 in the experimental the protected area (Researches Station of Agriculture Faculty) University of Tripoli. To determine the floristic composition of plant species in the study area the following characters were studied: life forms, chorotypes and create a list of vascular plants species. The collected plant species were classified according to their life form (Rankiaer, 1934). Nomenclature and identification of plants followed the flora of Libya. The chorotypes of the recorded species were determined from the flora of Libya (El-Gadi, A. (Eds) 1977-1989).

3. RESULTS

Floristic analysis

The current study revealed that (110) plant species belonging to (95) genera and (35) families were recorded from the study area, of which 22 species and 20 genera belong to 4 monoctyledones families (arranged according to their families), life-form and chorotypes, were outlined in the table (1) while 88 species and 75 genera belonging to 31 dicotyledones families (Table 2). The most represented families are the Asteraceae (22 species), the Poaceae (16 species), and the Fabaceae (12 species), followed by Boraginaceae (6 species), then Apiaceae, Lamiaceae, Plantaginaceae (each with 4 species), and Brassicaceae, Caryophyllaceae, Liliaceae, Polygonaceae (3 species). The remaining families were represented by two or less than two species in the table (3).

Table 1: Shows list of Monocots species recorded in the study area with their families, life form, Chorotypes. (T= Therophytes, H= Hemicryptophytes, G= Geophytes, Ch= Chaemephytes, NP= Nanophanerophytes, P= Phanerophytes, Ha= Halophtyes), (Med= Mediterranean, SaAr = Saharo-Arabain, IrTu = Irano-Turanian, EuSi = European Siberia, Plu = Pluri-regional, T=Tropical)

Family	Species	Life Form	Chroptype
Alliaceae	*Allium leucanthum* C. Koch.	G	Med
	Allium roseum L.	G	Sa-Ar
Cyperaceae	*Scirpus holoschoenus* L.	Ha	Med/Ir-Tu
Liliaceae	*Asphodellus festulosus* L.	G	Med
	Muscari conmosa (L.) Mill.	G	Med/ Ir-Tu
	Scilla peruviana L.	G	Med
Poaceae	*Aegilops kotschyi* Bioss.	T	Ir-Tu/ Sa-Ar
	Avena barbata Pott ex Link	T	Med
	Avellinia michelii (Savi) Parl.	T	Med
	Bromus diandrus Roth.	T	Med
	Cenchrus ciliaris (L.) Link	H	Sa-Ar
	Catapodium marinum (L.) C.E.Hubb.	T	Med
	Cynodon dactylon (L.) Pers.	G	Plu-trop
	Eragrostis cilianensis	T	Plu-trop
	Hordeum murinum Huds.	T	Med/Ir-Tu
	Hyparrhernnia hirta (L.) Stapf.	H	Med/Ir-Tu/ Sa-Ar
	Imperata cylindrica (Linn.) Raeuschel.	H	Med/Ir-Tu/ Sa-Ar
	Lamarkia eurea (L.) Moench.	T	Med/Ir-Tu
	Lophochloa salzamnnii (Boiss.) H. Scholz.	T	Med
	Piptatherum miliaceum (L.) Cosson.	H	Med
	Stipa barbata Desf.	G	Ir-Tu/ Sa-Ar
	Stipa capensis Thumb.	T	Ir-Tu/ Sa-Ar

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Table 2: Shows list of Dicots species recorded in the study area with their families, life form, Chorotypes.

Family	Species	Life Form	Chroptype
Aizoaceae	*Mesembryanthemum crystallinum* L.	T	Med/Eu-Si/
Apiaceae	*Bupleurum semicompositum* L.	T	Med - Ir-Tu - Sa-Ar
	Daucus capillifolius Gilli.	T	Med
	Daucus syrticus Murb.	T	Med
	Pituranthos tortuousus (Desf.) Asch.	Ch	Sa-Ar
Asteraceae	*Achillea santolina* L.	Ch	Med_IrTh/Tu
	Artemisia campestris L.	Ch	Eu-Sib/Med
	Atracylis serratuloides Sieb. ex Cass	H	Sa-Ar
	Calendula arvensis L.	T	Med./Ir-Tu/ Sa-ar
	Carduncellus eriocephalus Boiss.	H	Sa-Ar
Asteraceae	*Carduus argentatus* L.	T	E.Med/ W.Ir-Tu
	Centauria dimorpha Viv.	H	Med/Ir-Tu
	Chrysanthemum coronarium L.	T	Med
	Echinops spinosissimum Turra.	T	Med
	Filago desertorum Pomel.	T	Sa-Ar/Ir-Tu
	Filago pyramidata L.	T	Med/Ir-Tu
	Hedypnois cretica (L.) Dum	T	Med
	Ifloga spicata (Fork.) Schultz-Bip.	T	Med/Sa-Ar
	Launaea resedifolia (L.) O. Kuntze	T/H	Sa-SindiTh
	Leontodon simplex (Viv.) Widder	T	Med
	Nollitia crysocomoides (Desf.) Cass.	H	Med
	Phagnalon rupestre (L.) DC.	Ch	Med/ Ir-Tu
	Reichardia tingitana (L.) Roth	T/H	Ir-Tu/Sa-ar
	Rhantherium suareolens Desf.	H	Steppe /Sa-ar
	Senecio gallicus Chiax	T	Med
	Sonchus oleraceus L.	T	Eu-Si./Med./Ir-Tu
	Tragopogon porrifolius L.	T/H	Med
Boraginaceae	*Alkanna tinctoria* Tausch	Ch	Med
	Cirenthe major L.	T	Eu-Si./Med
	Elizaldia calycina (Roem & Schultes.) Mair.	T	Med
	Echiochilon fruticosum Desf.	Ch	Sa-Ar
	Echium Thgustafolium Mill.	Ch	Med
	Hormuzakia aggregate (Lehm.) Gusul.	T	E.Med/ E.Sa-Ar
Brassicaceae	*Brassica tournefortii* Gouan	T	Med/Sa-Ar
	Hussonia pinnata (Viv.) Jafri	T	Sa-Ar
	Sisymbrium orientale L.	T	M/Ir-Tu./Eu-Sib.
Caryophyllaceae	*Arenaria serpylliofolia* L.	T	Eu-Si/Med
	Silene galiica L.	T	Med/Eu-Si
	Silene conoidea L	T	W. Ir- Tu/ E. Med
	Chenopodium murale L	T	Plu-trop
Cistaceae	*Helianthemum lippii* (L.) Dum.Cours	Ch	Sa-Ar - Su
Cuscutaceae	*Cuscuta planiflora* Ten.	T	Med/ Sa-Ar
Dipsacaceae	*Scabiosa arenaria* Forssk	T	Sa-Ar
Euphorbiaceae	*Euphorbia terracina* L	T	Med./ Er-Si.
Fabaceae	*Argyrolobium uniflorum* (Decne.)Jaub	Ch	Sa-Ar
	Astragalus peregrinus Vahl.	T	Sa-Ar
	Astragalus serrtuloides L.	T	Med

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	Calicotom villosa (Poir.) Link	NP	Med
Fabaceae	*Hedysarum spinosissimum* L.	T	Med
	Hippocrepis bicontorta Lois	T	Med/Sa-Ar
	Lotus edulis L.	T	Med
	Lotus halophilus Boiss.et Spruner	T	Med
	Medicago polymorpha L.	T	Eu-Si/Med/Ir-Tu
	Ononis natrix L.	Ch	Med
	Ononis serrata Forsk.	T	Med/Sa-Ar
	Retama raetam (forsk)we	NP	Sa-Ar
Gentianaceae	*Centaurium pulchellum* (Swartz) Druce	T	Med/Ir-Tu
Geraniaceae	*Erodium arborescens* (Desf.) Willd.	H	Sa-Ar
	Erodium laciniatum (Cav.) Willd.	T	Med
Illecebraceae	*Paronychia argentea* Lam.	H	Med
	Paronychia arabica (L.) DC	T/H	Sa-Ar
Lamiaceae	*Ajuga iva* (L.) Schreb.	Ch	Med
Lamiaceae	*Salvia lanigera* Poir.	Ch	Med/ Sa-Ar
	Teucrium davaeanum Coss	Ch	Sa-Ar
	Teucrium polium L.	Ch	Med/ Ir-Tu
Linaceae	*Linum strictum* L.	T	Med
Malvaceae	*Malva parviflora* L	T	Med/ Ir-Tu
Mimosaceae	*Acacia cyanophylla* Lindley	P	Australian
Myrtaceae	*Eucalyptus camaldunensis* Denhardi	P	Australian
	Eucalyptus gomphocephala DC.	P	Australian
Neuradaceae	*Neurada procumbens*L.	T	Sa-Ar
Oxalidaceae	*Oxalis pes-caprae* L.	H	Plu-trop
Oleaceae	*Olea europea* L.	P	Med
Pinaceae	*Pinus* sp L	P	Med
Plantaginaceae	*Plantago albicans* L.	H	Med/ Sa-Ar
	Plantago coronopus L.	T/H	Eu-Si/Med/Ir-Tu
	Plantago phaeostoma Bioss & Heldr.	T	Sa-Ar
	Plantgo lagopus L.	T	Med
Polygonaceae	*Emex spinosa* (L.) Campd.	T	Med
	Polygonum equisetiforme Sm.	H	Med/Ir-Tu
	Rumex tingitanus L.	H	Ir-Tu
Primulaceae	*Thagallis arvensis* L	T	Eu-Si/Med/Ir-Tu
	Asterolinon linum-stellatum (L.) Duby.	T	Med/Ir-Tu
Ranunculaceae	*Nigella arvensis* L.	T	W.Med/Ir-Tu
Scophulariaceae	*Linaria tenius* (Viv.) Spreng	T	Sa-Ar
	Kickxia aegyptiaca (L.) Nabelek	Ch	Med/Sa-Ar
Solanaceae	*Nicotiana glauca* Graham	NP	Plu-trop
Thymeleaceae	*Thymelea microphylla* Coss. et Dur.	H	Sa-Ar

Table 3. Shows the number of species depending on family of collected species.

Family	Number of species
Asteraceae	22
Poaceae	16
Fabaceae	12
Boraginaceae	6
Apiaceae	4

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Lamiaceae	4
Plantaginaceae	4
Brassicaceae	3
Caryophyllaceae	3
Lilliaceae	3
Polygonaceae	3
Alliaceae	2
Geraniaceae	2
Illecebraceae	2
Myrtaceae	2
Primulaceae	2
Scophulariaceae	2
Other 18 family	1

Life forms

The dominant life form in the study area reflects the characteristics of the environmental region (Hayat et al. 2019). It is in an ecosystem that indicates the adaptations of plant species' physiognomy to the surrounding climate (Archibold, 1995 & Alsherif et al., 2013). According to Raunkiaer's method (1934), the plant life form classes along the protect area indicated a high proportion of herbs (annuals then perennials) (Table 4). Figure 2 shows that the highest life form recorded was for the Therophytes (52.73 %), followed by Hemicryptophytes (14.54%), and Chamaephytes (13.63%). The least represented life forms were the Phanerophytes with five species (6.36%) and Nanophanerophytes with three species (2.72 %). *Scirpus holoschoenus* was the only halophytic plant we registered.

Table 4. Life forms of study species.

Life forms	No. of species	% of total species
Therophytes (T)	58	52.7
Hemicryptophytes (H)	16	14.5
Therophytes / Hemicryptophytes (T/H)	5	4.5
Geophytes (G)	7	6.4
Chaemephytes (Ch)	15	13.6
Nanophanerophytes (NP)	3	2.7
Phanerophytes (P)	5	4.5
Halophtyes (Ha)	1	0.91

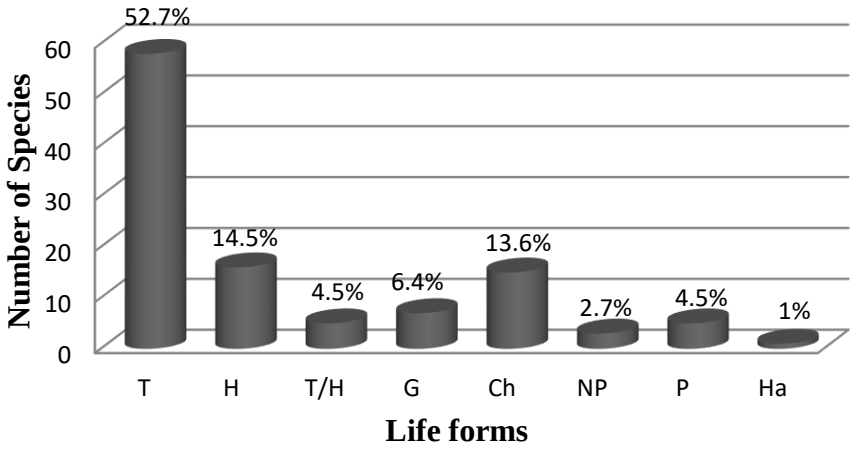

Figure 2. Shows the number of species and percentage of Life forms in the Study area.

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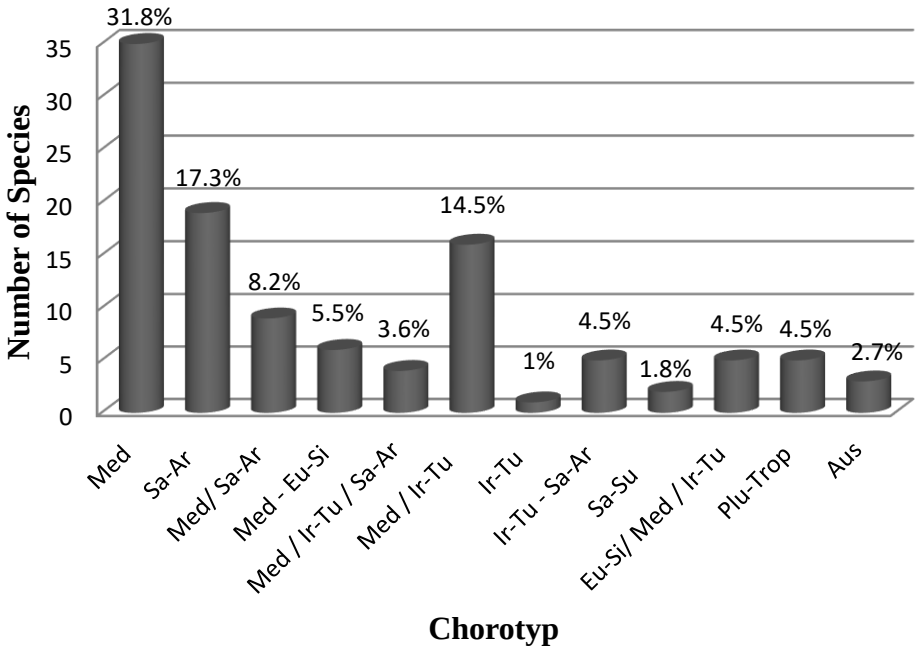
Geographical Elements of Species Level (Chorotype)

Chorological characteristic of the recorded species showed that 35 species (31.8%) are dominated in the Mediterranean region (Figure 3). A ratio of 17.3% (19 species out of the total) belongs to Saharo-Arabain region, 14.5% (16 species) belong to Mediterranean /Irano-Turanian regions, 8.2% (9 species) belong to Mediterranean / Saharo-Arabain regions, 5.5% (6 species) belong to Mediterranean / Euro - Siberian / regions, 5 species with a ratio of 4.5% belong to Irano-Turanian/ Saharo-Arabain, Euro - Siberian / Mediterranean / Irano –Turanian and Cosmopolitan- Tropical regions, 3.6% (4 species) belong to Mediterranean/ Irano-Turanian/ Saharo-Arabain regions.



Abbreviations: Med = Mediterranean, SaAr = Saharo-Arabain, IrTu = Irano-Turanian, EuSi = European Siberia, Plu = Pluri-regional, Torp=Tropical, Su=Sudanain, Aus= Australian.

Figure3. Geographical distribution of species showing number & percentage of species in each Chorotype in the study area.

4. DISCUSSION

This study documents the occurrence of 110 species, 95 genera, and 35 families of vascular plants reflecting the high plant diversity within a limited area, and the floristic composition of the area shows the dominance of Angiosperms and a 4:1 ratio of Dicots (80%) to Monocots (20%).

The dominance of Asteraceae and Poaceae families are an indication of the increased diversity of herbs in the area, as well as of the cosmopolitan nature of the families and they are dominated the Mediterranean climate conditions. Our findings regarding the dominant families are Asteraceae and Poaceae of the study area. Mahklouf and Al-Sghair (2016) reported Asteraceae and Poaceae as the dominant families at Al-Hadaba treatment plant (same region of the study area). Furthermore, Mahklouf and Al-Sghair (2016) stated that Poaceae and Asteraceae were the leading families in the Mallaha Wetland.

The present study findings showed that most plant species belong to Mediterranean species with 35 species (31.8%), followed by Saharo-Arabain species with 19 species (17.3%), then Mediterranean / Irano-Turanean species with 16 species (14.5%), therefore, the plant species belong to these three phytogeographical regions constituted almost 63.6% compared to other chorotypes. The species of the families Asteraceae and Poaceae showed that the most common life-forms were the Therophytes, also the geographical distribution of the species showed that most plant species belong to the Mediterranean region (Al-Sghair and Mahklouf, 2017, Al- Sghair *et al*., 2019).

General physiognomy of flora and vegetation are reflected in life form from effected by the particular set of environmental conditions (Badshah *et al*., 2016).

The life form spectra of the vegetation in the study area indicated the dominance of therophytes (52.7% of the total recorded species), followed by Hemicryptophytes (14.5%) and chamaephytes (13.6%). Due to the long dry periods during the year in Libya the Therophytes is dominated (El-Mokasabi, 2017). The combination of the high percentage of Mediterranean species and the high

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percentage of therophytes reflects the Mediterranean character of the flora of the studied area. It seems the better strategy in the temperate desert of Libya is annual and perennial life forms (AL Sghair *et al*., 2019).

5. CONCLUSION

This study set out to present the first vegetation survey for vascular plants of the protected area. The current study listed 110 species, belonging to 95 genera and 35 families from the study area. 22 species are belonging to 4 Monocot families and 88 species belonging to 31 Dicot families. The family Asteraceae (22 species) was the most dominant followed by Poaceae (16 species), it is expected because these families are dominated the Mediterranean climate conditions. The life form spectra of the vegetation in the study area indicated the dominance of therophytes (52.7% of the total recorded species), followed by Hemicryptophytes (14.5%). However, in the phytogeographical analysis, most of the collected species belong mainly to three chorotypes; Mediterranean, Saharo-Arabain, and Mediterranean /Irano-Turanian. The dominance of Therophytes and Mediterranean chorotypes were expected because the study area is located within the Mediterranean region in which the Mediterranean Therophytes are dominating.

Conflict of interest

The author has no conflict of interest to declare that are relevant to the content of this article.

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Data and materials availability:

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Ali, S. I., Jafri, S. M. H. & El-Gadi, A. (Eds), 1977-1989: Flora of Libya, 1-147. Tripoli.
2. Alsherif EA, Ayesh AM, Rawi SM. (2013) Floristic composition, life form and chorology of plant life at Khulais region, Western Saudi Arabia Pak. J Bot;45:29-38.
3. Al Sghair, F. G., and Mahklouf, M. H., (2017) Floristic Analysis of the Family Asteraceae in Libya depending on Flora of Libya. American Journal of Life Science Researches. 5(4): 170-183. ISSN: 2375-7485 (Print); ISSN: 2332-0206 (Online).
4. Al-Sghair, FG, Mahklouf, MH, Abudaya, EA. (2019) Species Diversity and Floristic Analysis of the Family Poaceae in Libya Depending on the Flora of Libya. Advances in Bioscience and Bioengineering 7(2) 13-21. doi: 10.11648/j.abb.20190702.11
5. Archibold OW. (1995) Ecology of world vegetation. Chapman & Hall, London.
6. Badshah, L., Hussain, F., Sher, Z. (2016) Floristic inventory, ecological characteristics and biological spectrum of plants of Parachinar, Kurram Agency. Pakistan Journal of Botany, 48 (4), 1547-1558.
7. Betelmal, AG. (2010) Classification of the Vegetation cover in the Pasture of Faculty of Agriculture Al Fateh University, Libya. Ass. Univ. Bull. Environ. Res. 13:2.
8. Cardinale, B. J., Duffy, J. E., Gonzalez, A., Hooper, D. U., Perrings, C., Venail, P., Narwani, A., Mace, G. M., Tilman, D., Wardle, D. A., Kinzig, A. P., Daily, G. C., Loreau, M., Grace, J. B., Larigauderie, A., Srivastava, D. S. and Naeem, S. (2012) 'Biodiversity loss and its impact on humanity', Nature 486:59–67.
9. CBD Secretariat (2010) The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. Document UNEP/CBD/COP/DEC/X/2. Secretariat of the Convention on Biological Diversity, Nagoya, Japan.
10. DeFries, R., Hansen, A., Turner, BL., Reid, F., & Liu J. (2007). Land use change around protected areas: management to balance human needs and ecological function. Ecological Applications, 17(4),1031–1038.
11. Dosso K, Yéo K, Konaté S, Linsenmair KE. (2012) Importance of protected areas for biodiversity conservation in central Côte d'Ivoire: Comparison of termite assemblages between two neighboring areas under differing levels of disturbance. Journal of Insect Science 12:131. Available online: http://www.insectscience.org/12.131.
12. El-Mokasabi, F. M. (2017) Studies on the Flora of Libya [Version 1; awaiting peer review]. ContROL 1: 08. doi:10.28915/control.0008.1.
13. Hayat, S.A., Hussain, F., Zhu, H., Asad, F. (2019) Floristic Composition and Ecological Characteristics of Plants of Tehsil Zazar, Swabi District, Pakistan. Silva Balcanica, 20:2. DOI: 10.6084/m9.figshare.9929138.

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14. IUCN. (1994) Guidelines for Protected Area Management Categories. IUCN, Gland, Switzerland and Cambridge, UK.
15. Mahklouf, M. H., and Al Sghair, F. G., (2016) Biodiversity and Floristic Study of Al- Hdaba Treatment Plant Tripoli– Libya.American Journal of Life Science Researches 4 :(3)16-18 DOI: 10.20286/ajlsr-040307.
16. Mahklouf, M. H., and Al Sghair, F. G., (2016) Floristic and Inventory Study of Mallaha Wetland, Tripoli – Libya. American Journal of Life Science Researches, 4:(4) 119- 123; DOI: 10.21859/ajlsr-040401.
17. Raunkiaer C (1934) Life forms of plants and statistical geography, Oxford, 632 P.
18. Stolton, S., Dudley, N., Avcıoğlu Çokçalışkan, B., Hunter, D., Ivanić, K.-Z., Kanga, E., Kettunen, M., Kumagai, Y., Maxted, N., Senior, J., Wong, M., Keenleyside, K., Mulrooney, D., Waithaka, J. (2015) 'Values and benefits of protected areas', in G. L. Worboys, M. Lockwood, A. Kothari, S. Feary and I. Pulsford (eds) Protected Area Governance and Management, pp. 145–168, ANU Press, Canberra, Australia.

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