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GEOGRAPHIC DISTRIBUTION OF ENDANGERED ENDEMIC SPECIES *ALOE SHADENSIS* LAVRANOS & COLLEN. (ASPHODELACEAE) IN SAUDI ARABIA

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Abstract

The geographical distribution of the *Aloe shadensis* Lavranos & Collen. in the Al-Baha region, Saudi Arabia was investigated. Areas around Shada Mountain and Qilwa area (Qilwa and Al-Mukhwah governorates) were visited. Number of individual plants and their location were recorded. *A. shadensis* occupies a very narrow regional and local geographic area, with an Area of Occupancy (AOO) of 20 and Extent of Occurrence (EOO) of 188 square kilometers.

Key words: *Aloe*, AOO, EOO, GIS, IUCN.

Introduction

The anthropogenic activities in Saudi Arabia have reduced the natural habitat of plants and many are becoming rare and endangered. About 20% of the Saudi flora, including fourteen endangered plants, 11 vulnerable, 23 critically endangered, and 14 extinct are reported (First Saudi Arabian National Report on the Convention on Biological Diversity, 2005).

In comparison to other Middle Eastern countries, Saudi Arabia has a high percentage of rare and endangered species, there are approximately six hundred endangered plants are in their natural habitat (Collenette, 1986; Al-Qurainy *et al*., 2013). However, a recent study on rare plants in Albaha region (Al-Khulaidi *et al*., 2018) has documented number of rare and endangered plant species in Albaha region including *Aloe shadensis* with a Frequency percentage of less than 1. The area of terrestrial protected lands in Saudi Arabia is a small proportion (less than 5%) of the total land area (Anon., 2022).

Aloe species (ASPHODELACEAE) are world-famous for their medicinal and cosmetic importance. According to estimates by some studies (Anon., 2016; Carter, 2001; Grace *et al*., 2011), there are about 600 *Aloe* taxa including subspecies and varieties in the world.

The genus *Aloe* naturally occurs in Africa, the Arabian Peninsula, Socotra, Madagascar and Mascarene Islands. The highest species density of aloes is found in southern, eastern and northeastern Africa, Arabia and Madagascar, with only very few species in the West African countries (Klopper & Smith, 2013).

Some *Aloe* species in the Arabian Peninsula have become endangered as a result of human activities such as urbanization, road construction, gathering, grazing, and other activities that are becoming more common (Al-Khulaidi *et al*., 2018; Al-Khulaidi, 2021).

About 50 *Aloe* species have been recorded in the Arabian Peninsula (Collenette, 1986; Wood, 1997; Al-Khulaidi, 2013; McCoy, 2019) all of which are endemic except for a few such as *A. vera*, (Baker,1898) *A. inermis* and *A. luntii* (Thulin, 2008), 35 species and 2 varieties of *Aloe* are endemics to the Arabian Peninsula (Collenette, 1986; Wood, 1997; Al-Khulaidi, 2013; Miller & Morris, 2004; Carter *et al*., 2011; McCoy, 2019). There are 23 taxa of the *Aloe* species with two natural hybrids occurring in the flora of Saudi Arabia, of which 13 are endemics (AI-Hemaid, 2002; McCoy, 2019).

A. shadensis is an endemic species to Saudi Arabia (Collenette, 1986). This species like many *Aloes* is under threat and increasing pressure from people. The species name shadensis refers to the mountain located in the Al-Mhkawa governorate, west of Albaha region called Jabal Shada (McCoy, 2019).

The geographic distribution data for endangered species in Saudi Arabia can be used to locate and assess the status of rare, endangered, and threatened plant species. This study aims at knowing the geographical spread and evaluating the endemic *A. shadensis* Lavranos & Collen. In Saudi Arabia, it grows in a very narrow geographical range, in Albaha region SW Saudi Arabia.

Rare and *endangered* plant *species* have been investigated covering all ecological zones in Albaha region, *Saudi Arabia* (Al-Khulaidi *et al*., 2018), in which *A. shadensis* Lavranos & Collen is considered to be an endangered species with a frequency percentage of 0.63.

Materials and Methods

The study area: The survey area is located between *19.889021* N and *20.028833*N and between 41.233326 E and *41.446768E,* in Qilwa and Al- Mukhwah governorates of Albaha region. The areas are characterized by mountains facing mainly W and SW traversed by numerous drainage lines and big wadis (Fig. 1).

The areas around Shada Mountain and Qilwa (Qilwa and Al-Mukhwah governorates) in Saudi Arabia were botanized for *A. shadensis* between January and September 2022. The number of individuals and the location of the *A. shadensis*, as well as the individuals of associated plant species, were recorded in an area of 400 square meters in the sites where the *A. shadensis* was seen. The topography and geographical location of each site were also recorded. GIS software was used to create maps depicting the geographical distribution and density of *A. shadensis*.

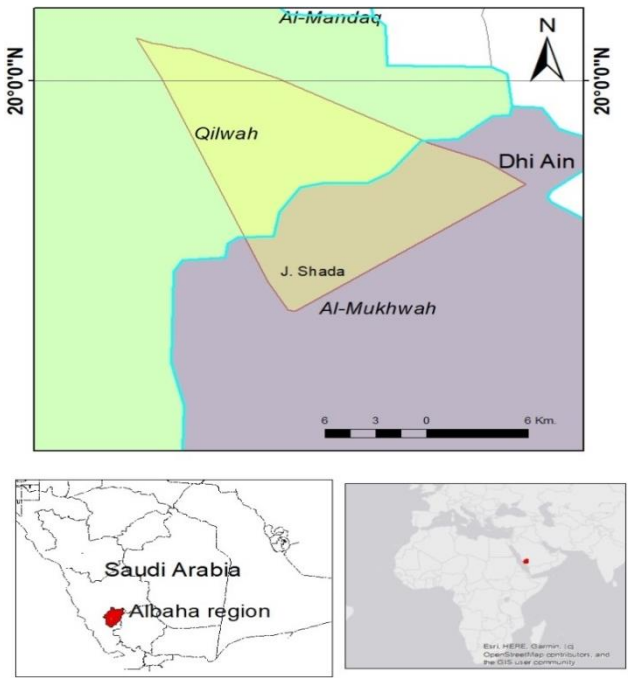

Fig. 1. The location of the study area, showing the extent of Occurrence (EOO) of the plant (188 square km.), red line on Google earth and polygon on the map.

The species: *Aloe shadensis* Lavranos & Collen. (Asphodelaceae, Xanthorrhoeaceae).

Climate: The amount of monthly rainfall in the governorates of Al-Mukhwah and Qilwa, Albaha region, was recorded for 43 to 45 years (Anon., 2017). Monthly rainfall in the two governorates where the plant is grown ranges from 21 mm to 50 mm in Al-Mukhwah, with an annual average of 40 mm, and from 5 mm to 48 mm in Qilwa, with an annual average of about 22 mm (Fig. 2 and Table 1).

Result and Discussion

Aloe shadensis Lavranos & Collen. in: Cact. Succ. J. (Los Angeles) 72: 82. (2000).

Type specimen: Saudi Arabia, Jabal Shada, 22.4.1988, Collenette 6718, 1500m (holotype: K)

Description

A Solitary succulent plant, stemless or with short stem. Leaves, smooth, lanceolate, Young Leaves are spotted, but the spots disappear at maturity, gray to greyish green, smooth, leaf blade 80 cm long and 16 cm wide towards the base, leaf margins with brown teeth, widely spaced 10 to 30 mm apart. Inflorescence erect, 120-170 cm long with 2-5 branches, flower pinkish red Bracts small, with brown nerves, 5-6 mm (Fig. 3).

Habitat and Ecology: The plant was seen on rocky slopes and areas of rock outcrops located on the banks of the wadis in the Qilwa and Al-Mukhwah governorates of the Albaha region, at an elevation ranging from 850 and 1115 meters above sea level, with a number of individuals (1-3) with *Senegalia asak* community and 15 to 20 with *Euphorbia inarticulata* community at 578 m asl and with *Anisotes trisulcus-Blepharis edulis* community at 748m asl (Table 1). The geographical types of the locality were Quaternary alluvium, rocky Biotite-hornblende granite, and Monzogranite geologic with the soil of Entisols and Aridisols orders (Alzahrany & Alnafie, 2007; Anon., 2017).

The IUCN uses two statistics for their Red List of Threatened Species (Anon., 2022): Area of Occupancy (AOO) and Extent of Occurrence (EOO). Based on the values listed in the IUCN Categories and Criteria Version 3.1, the plant's Extent of Occurrence (EOO) was approximately 188 square kilometers (Fig. 1). AOO = the number of occupied cells multiplied by the area of the individual cell, which was 5*4=20. The plant's EOO and AOO ratings are both endangered (Anon., 2019; Al-Khulaidi, 2021).

In addition to the previous criteria that determined how vulnerable the plant is, the plant grows near settlements and remarkably collected for medicinal use by citizens, making the plant vulnerable to extinction in the short term.

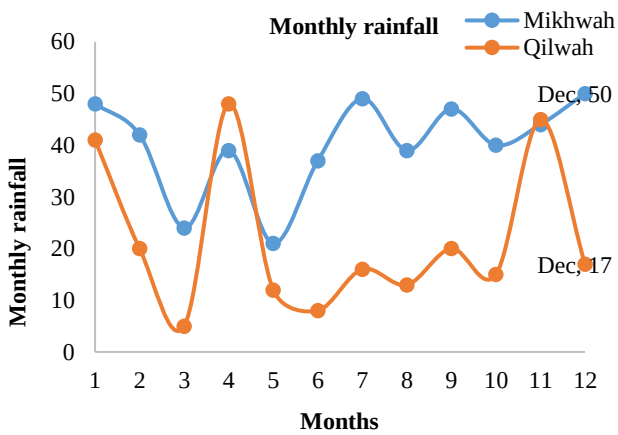

Fig. 2. Monthly rainfall in Qilwa and Al-Mukhwah Governorates.

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	
Al-Mukhwah	48	42	24	39	21	37	
Qilwa	41	20	5	48	12	8	
Location	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Average**
Al-Mukhwah	49	39	47	40	44	50	40.0
Qilwa	16	13	20	15	45	17	21.7

Discussion

The plant was found in greater number on rocky dry slopes facing wadis, such as wadi Dawqa (West of Qilwa), Dhi Ayn and wadi Al-Jawf (J. Shada) (Fig. 4), where additional humidity was available, indicating that it preferred dry slopes facing wadis with less than 40 mm of annual rainfall.

Intensive plant research in neighboring geographical areas may reveal additional numbers of this plant. As a result of its importance as an endemic and rare plant, we recommend looking for this plant in those geographical zones in the near future.

The plant is endemic to the Kingdom with a narrow geographical distribution, and it is vulnerable to extinction due to its low density and narrow geographic range, as well as its habitat often near residential area which is constantly expanding at the expense of this plant's habitats. As a result, we urge the appropriate authorities to quickly propagate the plant, replant it, and protect its unique habitats, particularly in the Jabal Shada protected area.

Table 1. Location sites of *Aloe shadensis* with their plant association and environmental data.

Latitude	Longitude	Name	No. individual	Area	Sample site	Altitude (m)	Trees %	Shrub %	Herb %
19.864866	41.303956	***Aloe shadensis***	3	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Capparis tomentosa*	1	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Crossandra johanninae*	2	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Ficus vasta*	1	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Flueggea virosa*	1	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Grewia tembensis*	2	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Grewia villosa*	2	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Ochna inermis*	1	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Ruellia patula*	4	J. Shada wadi AlJawf	57	1114	9	1	2
19.864866	41.303956	*Senegalia asak*	3	J. Shada wadi AlJawf	57	1114	9	1	2
19.864700	41.304080	*Abutilon* sp.	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Acalypha fruticosa*	10	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Acalypha indica*	3	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Achyranthes aspera*	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Adenium obesum*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	***Aloe shadensis***	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Barleria bispinosa*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Becium* sp.	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Capparis tomentosa*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Commelina forskalaei*	15	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Cordia monoica*	5	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Diospyros mespiliformis*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Euclea racemosa*	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Ficus ingens*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Grewia velutina*	3	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Grewia velutina*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Hyparrhenia hirta*	12	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Justicia flava*	5	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Kleinia odora*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Leucas glabrata*	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Maytenus* sp.	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Ochna inermis*	1	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Phyllanthus* sp.	2	J. Shada wadi AlJawf	233	1076	15	5	10
19.864700	41.304080	*Senegalia asak*	5	J. Shada wadi AlJawf	233	1076	15	5	10
19.957713	41.307899	*Abutilon* sp.	2	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	***Aloe shadensis***	20	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Anisotes trisulcus*	3	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Aristida* sp.	12	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Blepharis edulis*	60	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Caralluma retrospiciens*	1	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Cissus quadrangularis*	3	Qilwa, rocky dry slope	356	578	3	20	5

Table 1. (Cont'd.).

Latitude	Longitude	Name	No. individual	Area	Sample site	Altitude (m)	Trees %	Shrub %	Herb %
19.957713	41.307899	*Euphorbia inarticulata*	35	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Grewia tenax*	1	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Indigofera spinosa*	5	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Jatropha pelargoniifolia*	5	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Salvadora persica*	2	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Vachellia flava*	3	Qilwa, rocky dry slope	356	578	3	20	5
19.957713	41.307899	*Vachellia tortilis*	7	Qilwa, rocky dry slope	356	578	3	20	5
20.028191	41.234425	***Aloe shadensis***	1	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Anisotes trisulcus*	3	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Cadaba farinosa*	2	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Commelina albescens*	4	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Commelina forskalaei*	5	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Commiphora myrrha*	2	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Crossandra johanninae*	2	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Dobera glabra*	2	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Ecbolium viride*	2	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Ehretia obtusifolia*	1	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Evolvulus alsinoides*	5	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Ficus vasta*	1	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Hibiscus micranthus*	5	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Premna resinosa*	3	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Psydrax schimperiana*	3	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Ruellia patula*	4	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Senegalia asak*	15	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Vachellia johnwoodii*	3	Wadi Reem	379	851	50	30	40
20.028191	41.234425	*Ziziphus spina-christi*	2	Wadi Reem	379	851	50	30	40
19.930407	41.440038	***Aloe shadensis***	25	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Anisotes trisulcus*	9	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Blepharis edulis*	40	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Jatropha glauca*	2	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Vachellia tortilis*	4	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Seddera* sp.	7	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Cissus quadrangularis*	3	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Grewia tenax*	5	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Grewia erythrea*	1	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Stipagrostis* sp.	7	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Salvadora persica*	2	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Caralluma russiliana*	3	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Commiphora myrrha*	1	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Cenchrus ciliaris*	50	Dhi Ayn		748	1	7	35
19.930407	41.440038	*Malva pannosum*	3	Dhi Ayn		748	1	7	35

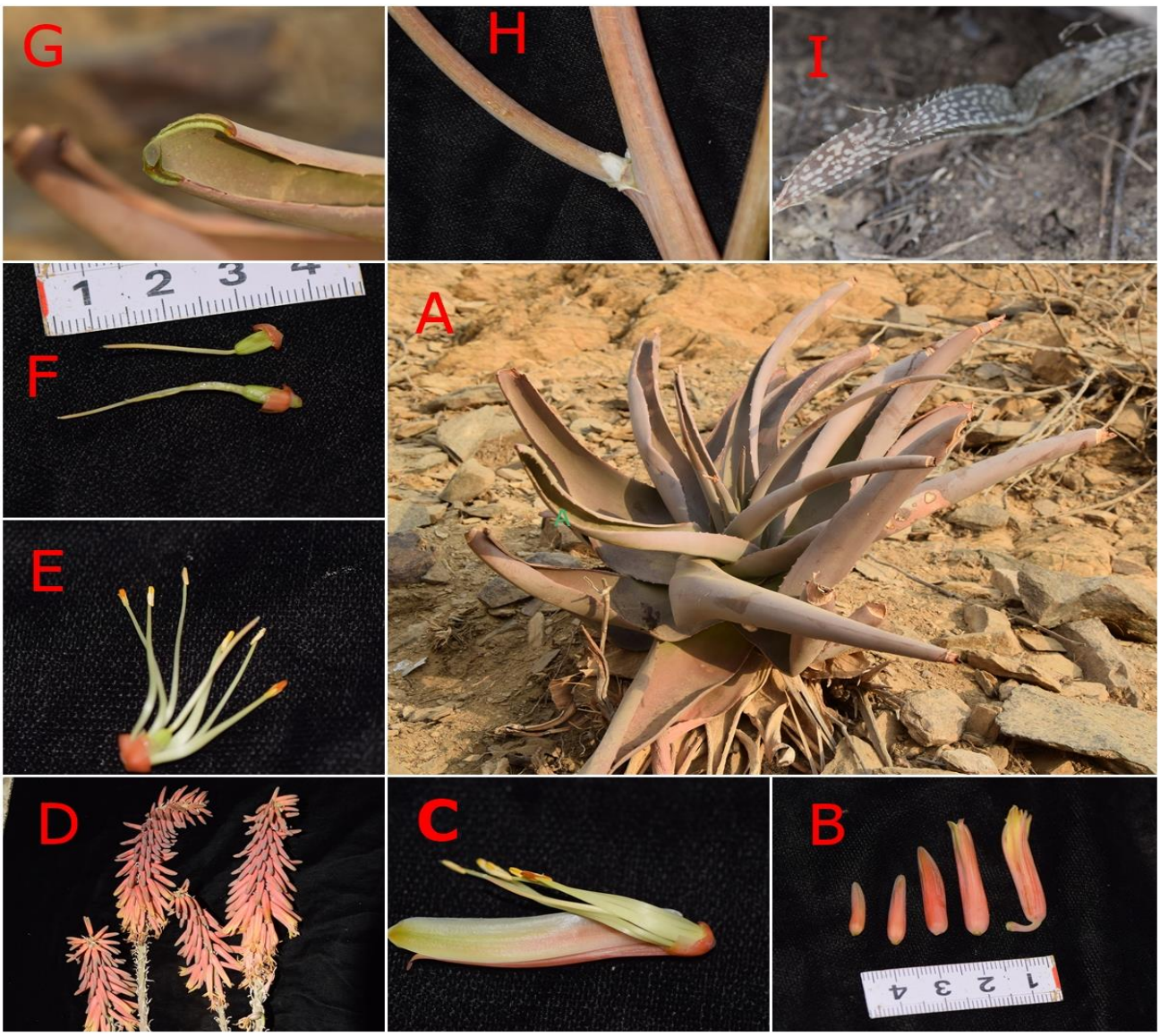

Fig. 3. *Aloe shadensis* Lavranos & Collen.: A, Habit; B, Flower development stages; C, The perianth; D, Inflorescence; E, Stamens; F, Pistil; G, The sap; H, Floral bract; I, White spots in young leaves.

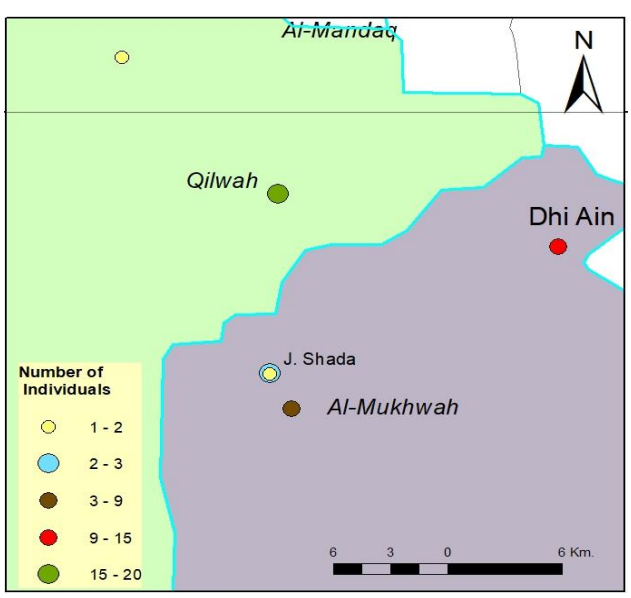

Fig. 4. Number of Individuals of *Aloe shadensis.*

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References

AI-Hemaid, F.M. 2002. Revision of the Genus Aloe L. in Saudi Arabia. *Arab Gulf J. Sci. Res*., 20(3): 123-132.

Al-Khulaidi, A.W, N.A. Al-Sagheer, T.U. Al-Turki and F. Filimban. 2018. Inventory of most rare and endangered plant species in Albaha region Saudi Arabia. *International Journal of Biology, Pharmacy and Allied Sciences* (*IJBPAS)*, 7(4): 443-460.

Al-Khulaidi, A.W. 2013. Flora of Yemen. The Sustainable Natural Resource, Management Project (SNRMP II), EPA and UNDP, Republic of Yemen, Sana'a. Publisher Obadi Centre for publishing and studies, Sana'a, 266 page

Al-Khulaidi, A.W. 2021. Preliminary evaluation of the status of *Aloe dhufarensis* Lavranos (*Asphodelaceae juss*.) in the Arabian Peninsula. *EJUA-BA*., 2(1):

Al-Qurainy, F.S., M. Nadeem, A. Tarroum and A. Alaklabi. 2013. Assessment of phylogenetic relationship of rare plant species collected from Saudi Arabia using internal transcribed spacer sequences of nuclear ribosomal. *Gen. Mol. Res*., 12 (1): 723-730.

Alzahrany, F.A. and A.H. Alnafie. 2007. Types of natural woody plants and firewood gathering in Al-Baha region, Saudi Arabia. (A study in biogeography). MSc study.

Anonymous. 2016. *Royal Botanic Gardens, Kew*, UK.

Anonymous. 2017. Geologic map of Albaha, Annual report,

Anonymous. 2019. Standards and Petitions Committee, Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Downloadable from http:// www.iucnredlist.org/documents/RedListGuidelines.pdf

Anonymous. 2022. National Center for Wildlife. Protected areas in Saudi Arabia, https://www.ncw.gov.sa/en/wildlife/ protectedareas

Anonymous. 2022. The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org.

Baker, J.B. 1898. Flora of Tropical Africa, Vol. 7, page 421,

Cact. Succ. J. (Los Angeles). 2000. *Aloe shadensis* Lavranos & Collen.

Carter, S. 2001. Aloaceae. In: (Ed.): Pope, G.V. *Flora Zambesiaca*, 12(3): 48-98. Royal Botanic Gardens, Kew.

Carter, S., J.J. Lavranos, L.E. Newton and C.C. Walker. 2011. Aloes. The definitive guide: 1-720. Kew Publishing, Royal Botanic Gardens, Kew.

Collenette, S. 1986. An Illustrated Guide to the Flowers of Saudi Arabia. Interlink Pub Group, London. 514 pages.

First Saudi Arabian National Report on the Convention on Biological Diversity. 2005. The National Commission for Wildlife Conservation and Development.

Grace, O.M., R.R. Klopper, E. Figueiredo and G.F. Smith. 2011. The Aloe Names Book. Strelitzia 28. South African National Biodiversity Institute, Pretoria; and the Royal Botanic Gardens, Kew, London.

Klopper, R.R. and G.F. Smith. 2013. Aloes of the world: When, where and who? *ALOE*, 50:1-2.

McCoy, T. 2019. The Aloes of Arabia. McCoy Publishing. 441 pages

Miller, A.G. and M. Morris. 2004. Ethnoflora of the Soqotra Archipelago. *Royal Botanic Garden Edinburgh*: UK, 759 pp.

Thulin, M. 2008. Flora Somalia, Vol 4. Royal Botanic Gardens, Kew (K). 312 pages.

Wood, J.R.I. 1997. Handbook of the Yemen Flora. *Royal Botanic Gardens*, *Kew*, UK, 434p.

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