Research Article

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The Age Structure Of Acacia: Insights Into Conservation Strategies In Arid Landscapes, South Sinai, Egypt.

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ABSTRACT

Over the past two decades, wild vegetation in the Egyptian desert has faced significant threats, including the loss of palatable species, a decline in tree populations, and shifts in vegetation composition. The main drivers of these changes include deforestation for fuelwood, overharvesting of medicinal plants, large-scale development projects, and overgrazing. Addressing these threats requires immediate implementation of sustainable development and conservation policies to safeguard critical biodiversity components. Acacia trees, vital to the Bedouin communities for their multiple uses, are particularly at risk due to pressures such as illegal logging, overgrazing, seed infestation by insects and fungi, and encroaching construction. This study examines the demographic status of Acacia populations across three key regions in South Sinai: Wadi Mandar, Wadi Lithi, and Wadi Feiran. A total of 615 trees were surveyed, with 202 trees at Wadi Mandar, 281 at Wadi Lithi, and 132 at Wadi Feiran. Additionally, 38 cuttings from dead Acacia trunks were collected across these sites. Tree age was determined by counting the annual growth rings, and the relationship between tree diameter and growth rings was analyzed through linear regression. This research highlights the importance of understanding the age structure of Acacia populations, which provides insights into their demographic status and resilience to environmental stressors. By identifying older, more mature trees, conservation efforts can prioritize the protection of genetically diverse, reproductively mature trees, which are crucial for the long-term survival of the species. Furthermore, factors such as climate variability, soil conditions, and human intervention especially land-use changes and overharvesting were considered in the analysis to assess their impact on Acacia tree health and distribution. These findings aim to inform conservation strategies within the St. Catherine Protectorate and, ultimately, across the South Sinai Protectorates.

Keywords : *Acacia; Age structure; Conservation; South Sinai.*

INTRODUCTION

Acacia species (Leguminosae: Mimosoideae) are of immense ecological and economic importance, particularly in arid and semi-arid regions. These trees provide a wide range of essential resources, including high-quality animal fodder, timber, fuelwood, charcoal, gums, and medicinal products. Beyond their direct economic value, Acacia species contribute to soil stabilization and improvement through nitrogen fixation, enhancing soil fertility in degraded ecosystems. In addition, they are keys to preventing soil erosion in areas prone to desertification. The resilience of Acacia species to extreme conditions such as drought, heat, salinity, alkalinity, and overgrazing makes them essential for sustainable land management in arid zones. However, while Acacia species offer substantial ecological and economic benefits, their expansion into new areas and their role in land rehabilitation must be carefully managed, as some species can become invasive and pose a threat to native flora and crops (Kaul and Nambiar, 1966).

Dendrochronology, the science of dating annual growth rings in trees, provides valuable chronological and environmental data. This method has been widely used to reconstruct past climate conditions (Fritts, 1976; Scheingruber et al., 1978) and to study the growth patterns of trees under varying environmental stresses. For Acacia species, particularly in arid regions, dendrochronological methods have proved useful in understanding the historical responses of these trees to environmental changes, such as droughts, floods, and

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temperature fluctuations. Despite its successful application in temperate regions, fewer studies have focused on tropical and arid-zone species, including Acacia species in the Middle East (Schweingruber, 1988). The challenge of applying dendrochronology to these regions arises from the irregular growth patterns of trees in harsh climates and the lack of long-term, well-dated tree-ring data.

The genus Acacia includes approximately 1,511 species, ranging from small shrubs to large trees, and is distributed across Africa, Asia, Australia, and the Americas. In arid regions, Acacia species are particularly valuable, not only for their direct use in various industries (such as fodder and charcoal) but also for their ecological roles in land rehabilitation and combating desertification. In the Middle East, about 25 species of Acacia are found in arid and semi-arid zones, with *Acacia tortilis* being the most widespread and best known for its remarkable drought and heat tolerance. *Acacia tortilis* occurs in various forms, from small, multi-stemmed shrubs to tall trees with wide, flat crowns. In Egypt, this species is particularly prevalent in the Sinai Peninsula, where it thrives in wadi beds and other areas with occasional runoff. It is well adapted to harsh conditions, able to withstand high temperatures, strong winds, and limited water availability (Halevy and Orshan, 1972; Zohary, 1973).

Acacia tortilis is represented by two subspecies in Sinai: A. tortilis subspecies raddiana and *A. tortilis* subspecies tortilis. The subspecies raddiana is the dominant form, particularly in the southern and central regions of Sinai, and is found primarily in low-elevation areas and wadi beds. Subspecies tortilis, on the other hand, occurs at slightly higher elevations and is restricted to areas with specific soil and hydrological conditions (Halevy and Orshan, 1972). The distribution of these subspecies is highly dependent on factors such as water availability, soil type, and the frequency of grazing, which can significantly affect their growth and regeneration. In Sinai, *Acacia tortilis* is not only an important ecological species but also a key component of the local economy, providing fodder for livestock and materials for construction and charcoal production.

However, *Acacia tortilis* populations in Sinai face numerous threats, primarily driven by human activities. Overgrazing by livestock, particularly goats and camels, has led to significant degradation of Acacia habitats. Excessive tree cutting for fuelwood and charcoal production, along with the encroachment of agricultural activities, have further stressed Acacia populations. Additionally, seed predation by bruchid beetles has been shown to reduce seedling recruitment, limiting the species' ability to regenerate naturally (Rohner and Ward, 1999; Moustafa et al., 2000). These human-induced pressures are compounded by the effects of climate change, including increasing drought frequency, shifting rainfall patterns, and rising temperatures, which may further exacerbate the vulnerability of *Acacia tortilis* populations in the region.

The demographic structure of *Acacia tortilis* populations is critical for understanding the long-term survival and sustainability of the species. Tree aging, recruitment rates, and the impacts of environmental stressors are key factors influencing the health of these populations. While *Acacia tortilis* has been shown to be resilient to some environmental stresses, the high mortality rate of adult trees and the scarcity of juveniles suggest that natural regeneration is insufficient to maintain population stability (Ward and Rohner, 1997). Therefore, a detailed understanding of the age structure and recruitment patterns of Acacia populations is essential for devising effective conservation strategies.

Recent studies have highlighted the need for a more comprehensive approach to managing Acacia populations in arid and semi-arid regions, focusing on both ecological factors and human interventions. Mohamed et al. (2023) investigated the demographic status of *Acacia tortilis* in various regions of Sinai, noting that anthropogenic activities, such as overgrazing and deforestation, have exacerbated the decline of Acacia populations. This research emphasizes the importance of monitoring the age structure, recruitment success, and environmental conditions that influence the survival of Acacia species in desert ecosystems.

This study aims to assess the demographic status of *Acacia tortilis* populations in the St. Catherine Protectorate, with the objective of extending the research to other regions within the South Sinai Protectorates. The study will examine the age structure of *Acacia* populations, focusing on the distribution of mature trees, the recruitment of seedlings, and the impacts of environmental factors such as grazing, soil erosion, and flooding. In addition, this research will investigate the role of the soil seed bank in maintaining Acacia populations and explore how the combination of environmental and anthropogenic factors influences the species' regeneration capacity. By integrating tree-ring data, environmental assessments, and seed bank studies, this research will provide critical insights into the conservation needs of *Acacia tortilis* and inform future management strategies for maintaining this key species in Sinai's desert ecosystems.

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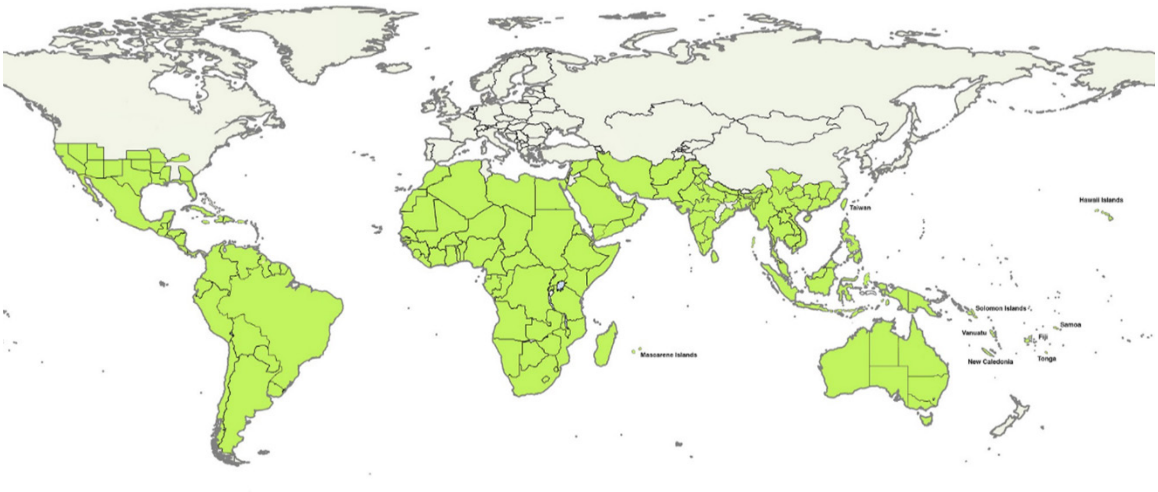
Figure 1: Distribution of Acacia sens. lat. globally (1511 species).



MATERIALS AND METHODS

Study area

The Wadi Mandar, Wadi Feiran and Wadi Lithi basins are notable wadi systems in Southeastern Sinai (Figure 2). The Wadi Mandar basin has a series of plains and rivers encircled by moderately elevated granitic hills (75-100m). The soil surface consists of a combination of gravel and cobbles, except near the wadi entry and the termini of rivers, where it is sandy. Total plant cover ranges from 3-5% on the slopes and at the terminus of streams, and is less than 1% in other areas. The sole dominating species is *A. tortilis*, with a height varying from 70 cm to 2 m near the wadi's center and entrance, and reaching 3-4 m or greater on the slopes and upstream. Scattered individuals of *Zilla spinosa, Fagonia mollis, Lycium shawii*, and *Artemisia judaica* are present in the wadi. *Acacia tortilis* at Wadi Mandar has significant human disturbance because to the presence of around 68 Bedouin households residing at the wadi's entrance. Wadi Feiran is an important drainage basin in southern Sinai Peninsula covering an area of about 1785, its streams drain into the Gulf of Suez crossing variety of rocks and sedimentary units varied in age from Precambrian to Quaternary.

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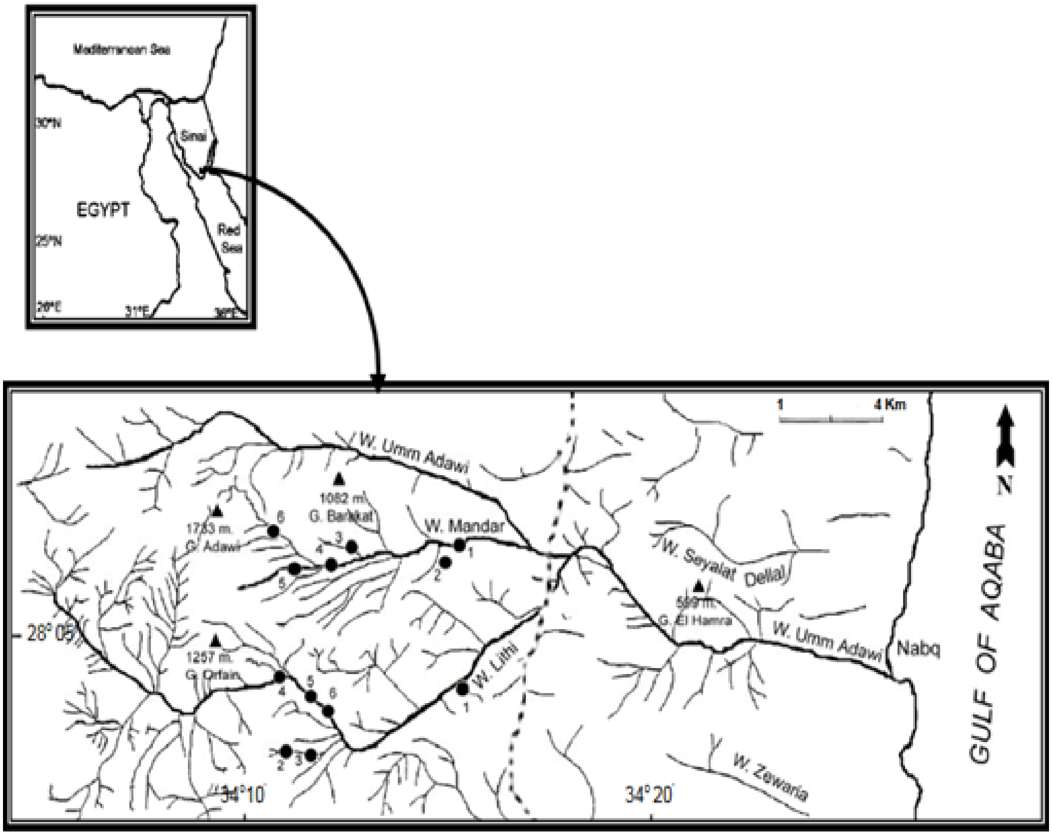
Figure 2: Location map for the study area.



Sampling

To assess the demography and age structure of Acacia populations in South Sinai, three main wadis were selected as suitable field sites based on various ecological parameters: Wadi Mandar, Wadi Lithi, and Wadi Feiran. A population-based sampling approach was applied to ensure comprehensive coverage of Acacia populations across these sites. Specifically, eight populations were chosen at Wadi Mandar, fifteen at Wadi Lithi, and nine at Wadi Feiran. This strategy aimed to accurately capture the demographic distribution and age structure of Acacia populations in the region.

Field data were collected using a dendrochronological sampling approach, where each individual tree was thoroughly recorded on a site and specimen sheet. Traditionally, dendrochronological studies have relied on tree samples taken from dead trees or dead tree branches, as this method allows for the preservation of tree-ring data that may not be accessible in live specimens (Ferguson, 1970; Zoltai, 1975; Stokes and Smiley, 1978). In this study, cross-sections of dead trees and branches were taken and cut into thin sections. These sections were then smoothed with sandpaper to enhance the visibility of the growth rings and improve the resolution of the data. Each specimen was carefully labeled to maintain accurate records of its original position within the tree, ensuring that no critical data about the tree's age and growth history was lost during preparation (Lawrence, 1950; Schweingruber et al., 1978).

In addition to sampling from dead trees, we also employed the core sampling method to obtain data from live Acacia trees. Using increment borers, core samples were taken from living trees without causing significant harm. This method allowed us to capture growth rings from live specimens, providing real-time insights into the ongoing growth and age structure of the population. By sampling from both dead trees (through cross-sections) and live trees (via increment cores), we were able to combine historical data with current growth patterns, offering a more comprehensive understanding of the age structure and demographic trends in the Acacia populations. While the use of dead trees has been a common method in dendrochronological studies, sampling from live trees through increment boring adds a valuable dimension to the data collection process. Increment borers enable the study of tree growth in real time, offering continuous data on the tree's age and growth dynamics. However, due to logistical constraints and the specific ecological conditions of the study area—such as the scarcity of suitable live trees for sampling—the primary reliance on dead trees was deemed the most feasible approach for this study. Despite this, both methods are scientifically valid and complement each other, as tree-ring patterns in dead trees provide reliable chronological data, particularly when considering environmental factors such as climate and anthropogenic stressors that have influenced tree growth over time.

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Vegetation parameters and geographical settings

A total of thirty-three *Acacia* populations were randomly selected to represent the main variations in the selected three main wadis (eight at W. Mandar, fifteen at W. Lithi, and ten at W. Feiran). In each population, the basic information included the precise GPS location; altitude, number of trees, tree height, diameter and age were recorded (Tables 2, 3, 4). Six hundreds and fifteen tree were surveyed (202 trees at Wadi Mandar, 281 trees at Wadi Lithi, and 132 trees at Wadi Feiran).

W. Mander's population were located at three main areas (Barakat, Maghwela, and Hebeila) (Table 1), while populations of W. Lithi were located at ten main sites (e.g. Hamer El-Atshan, Hamer El-Rayan, Roknet Amera, Um Ormot, Tala'et Rashid, Um Ghrat, Um Merkha'a, El-Beida'a, Um Zaraba, Abu-Ntishat, and El-Menaizla) (Table 2). On the other hand, ten populations and spots of Wadi Feiran were located at W. Alliat, W. Nakhla, Rei'a Safia, W. Reim, W. Nisreen, W. Gohaier, Elsheikh Abu-shabib, Wadi Agla, El-Sheikh Hamad, and El-Haswa (Table 3).

Data treatment

Generally, the age of some organisms can be determined fairly accurately because they possess some character, which leaves a regular pattern in their structure representing some fixed time interval such as year, lunar month or day. Annual growth rings are the best method to determining the exact age of trees. Each year as the sap arises in the tree in spring for the growth of new leaves, the tree grows a new layer of wood in a ring just beneath the bark. This spring- wood has wide transport cells of tracheids or vessels. The diameter of new cells decreases during the following months until growth of wood stops in late summer. This produces a distinct tree ring for each year of growth and the rings can be counted, either in a felled stump or from a core of wood bored out of the living. Cutting cross sections of dead trunk applied during the present assessment. Thirty-eight cuttings of dead trunk of *Acacia* trees were collected from the three wadis. The age of each sample was obtained directly by counting the annual rings. The data were treated as linear regression relationship between the tree diameter and the number of counted growth rings. Simple Linear Regression analysis is applied to calculate the equation and figure out the relationship between the diameter of cross-cut sections and the number the number of annual rings. The data of diameter and number of growth rings have been analyzed through regression analysis (No. of rings = -0.91 + 6.96 Diameter) to draw the regression line.

RESULTS

A total of thirty-three *Acacia* populations were randomly selected to represent the main variations in the selected three main wadis (eight at W. Mandar, fifteen at W. Lithi, and ten at W. Feiran). In each population, the basic information included the precise GPS location; altitude, number of trees, tree height, diameter and age were recorded (**Tables 1, 2, 3**). Six hundreds and fifteen tree were surveyed (202 trees at Wadi Mandar, 281 trees at Wadi Lithi, and 132 trees at Wadi Feiran).

W. Mander's population were located at three main areas (Barakat, Maghwela, and Hebeila) (**Table 2**), while populations of W. Lithi were located at ten main sites (e.g. Hamer El-Atshan, Hamer El-Rayan, Roknet Amera, Um Ormot, Tala'et Rashid, Um Ghrat, Um Merkha'a, El-Beida'a, Um Zaraba, Abu-Ntishat, and El-Menaizla) (**Table 3**). On the other hand, ten populations and spots of Wadi Feiran were located at W. Alliat, W. Nakhla, Rei'a Safia, W. Reim, W. Nisreen, W. Gohaier, Elsheikh Abu-shabib, Wadi Agla, El-Sheikh Hamad, and El-Haswa (**Table 4**). The following is a general description of the all *Acacia* populations that are sampled in each wadi including the most important associated species.

Table 1. Site description of the main localities of Acacia populations in three main wadis (Mandar, Lithi and Feiran) at South Sinai.

Location	Site	Population no.	GPS		Altitude	No. of individual tree
			N	E		
Wadi Mandar	Wadi Mandar	1	28.12526	34.17536	577	29
	Wadi Barakat	2	28.10722	34.21998	376	29
	Wadi Mandar	3	28.12359	34.17635	533	24
	Wadi Mandar	4	28.11718	34.17463	549	16
	Hebeila	5	28.10453	34.1883	485	36
	Wadi Mandar	6	28.06444	34.15104	460	22
	Wadi Mandar	7	28.06499	34.13554	460	18
	Wadi Mandar	8	28.06229	34.11363	470	25

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Wadi Lithi	Hamer El-Atshan	1	28.42162	34.20898	383	26
	Hamer El-Rayan	2	28.04448	34.19604	493	14
	Hamer El-Rayan	3	28.04764	34.20085	478	24
	at the end of W. Lithi	4	28.05682	34.16458	576	19
	Roket Amra	5	28.06891	34.10675	767	27
	Um-Ormot, and Um-Tush	6	28.06882	34.22833	388	34
	Um-Ormot	7	28.06787	34.21354	379	21
	Talae'et Rashid	8	28.07868	34.21331	442	24
	Umm-Ghrat	9	28.06918	34.12641	729	17
	Umm-Merkha'a	10	28.06984	34.18049	611	12
Wadi Feiran	Wadi Alliat	1	28.68782	33.64839	766	17
	Wadi Alliat	2	28.68876	33.64718	760	11
	Wadi Alliat	3	28.67621	33.65325	878	14
	Wadi Nakhla branched from W. Alliat	4	28.69083	33.63737	763	20

Table 2. Basic information and summary statistics of Acacia populations at Wadi Mandar, South Sinai.

Population no.	Site	GPS		Altitude (m)	No. of trees	Tree Height (m)		Tree Diameter (cm)				Age of trees (Year)		
								DBH		DAB				
		N	E			Mean	St.dev.	Mean	St. dev.	Mean	St. dev.	Min.	Max.	Mean
1	Wadi Mandar	28.12526	34.17536	577	29	4.6	1.94	22.24	32.45	59.1	32.81	66.5	1063.3	533.6
2	Wadi Barakat	28.10722	34.21998	376	29	1.4	1.31	11.32	25.86	-	-	44.3	886.1	254.9
3	Wadi Mandar	28.12359	34.17635	533	24	4.5	2.58	36.94	61.59	32.2	77.79	125.5	1919.8	811.6
4	Wadi Mandar	28.11718	34.17463	549	19	6.3	0.94	34.61	26.87	31.4	32.51	406.1	1299.6	842.2
5	Hebeila	28.10453	34.1883	485	36	5.9	1.7	30.43	44.75	38.0	55.05	273.2	1993.7	895.3
6	Wadi Mandar	28.06444	34.15104	320	22	4.0	3.23	29	78.92	34.0	69.44	73.8	2362.8	802.0
7	Wadi Mandar	28.06499	34.13554	346	18	5.1	2.39	25	31.49	31.0	41.12	413.5	1218.3	739.2
8	Wadi Mandar	28.06229	34.11363	261	25	5.0	1.7	22	53.03	24.0	44.94	162.4	1690.9	674.4
Total					202.0	36.7	15.8	211.54	354.96	249.67	353.66	44.3	2362.8	694.1

Table 3. Basic information of Acacia populations at Wadi Lithi, South Sinai.

Population no.	Site	GPS		Altitude (m)	No. of trees	Tree Height (m)		Tree Diameter (cm)				Age of trees (Year)		
								DBH		DAB				
		N	E			Mean	St. dev	Mean	St. dev	Mean	St. dev	Min.	Max.	Mean
1	Hamer El-Atshan	28.42162	34.20898	383	26	4.21	2	24.36	49.29	13.68	57.5	147.7	1772.1	576.2
2	Hamer El-Rayan	28.04448	34.19604	493	14	5.96	1.59	31.07	45.48	5.25	14.2	169.8	1277.4	720.5
3	Hamer El-Rayan	28.04764	34.20085	478	24	5.73	2.73	35.61	65.23	10.27	28.5	14.8	1846.0	825.8
4	End of W. Lithi	28.05682	34.16458	576	19	6.53	1.17	34.99	28.95	25.33	33.6	406.1	1218.3	814.6
5	Roket Amra	28.06891	34.10675	767	27	5.21	2.29	26.55	44.43	16.5	41.6	22.2	1255.3	616.1
6	Um-Ormot,	28.06882	34.22833	388	34	2.24	2.7	24.58	50.11	12.58	44.9	14.8	1476.8	572.1
7	Um-Ormot	28.06787	34.21354	379	21	4.67	2.07	27.83	56.62	13.6	44.3	132.9	1572.8	645.2

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8	Talae'et Rashid	28.07868	34.21331	442	24	4.91	1.96	28.19	47.99	16.99	51.3	73.8	1572.8	653.8
9	Umm-Ghrat	28.06918	34.12641	729	17	6.71	1.68	51.42	62.56	41.35	80.6	258.4	1927.2	1192.3
10	Umm-Merkha'a	28.06984	34.18049	611	12	5.04	1.18	40.15	47.08	6.42	39.0	354.4	1402.9	931.0
11	El-Baida'a	28.04130	34.15700	-	7	5.68	0.71	23.5	27.61	34.39	19.8	561.2	1181.4	797.5
12	Um-Zaraba	28.04200	34.12530	-	26	2.98	1.81	10.53	20.23	15.15	14.8	110.8	568.6	347.9
13	Abu-Ntishat	28.03230	34.13200	-	7	5.71	0.29	20.54	38.35	36.67	9.8	590.7	1366.0	850.2
14	El-Menaizla	28.03160	34.11452	-	13	5.24	2.53	34.16	46	42.33	48.8	553.8	1772.1	999.1
15	El-Menaizla	28.03226	34.11251	-	10	5.00	1.64	18.15	41.82	28.15	31.7	295.4	1181.4	641.7
Total		-	-	-	281	75.8	26.4	431.63	671.75	318.66	560.29	14.8	1927.2	745.6

Table 4. Basic information of Acacia populations and spot samples at Wadi Feiran, South Sinai.

Population no.	Site	GPS		Altitude (m)	No. of trees	Tree Height (m)		Tree Diameter (cm)				Age of trees (Year)		
								DBH		DAB				
		N	E			Mean	st. dev	Mean	st. dev	Mean	st. dev	Min.	Max.	Mean
1	Wadi Alliat	28.68782	33.64839	766	17	6.1	1.79	36.94	64.34	26.85	48.8	169.8	2074.9	863.9
2	Wadi Alliat	28.68876	33.64718	760	11	6.8	1.29	45.98	52.54	30.86	50.9	605.5	1750.0	1067.3
3	Wadi Alliat	28.67621	33.65325	878	14	6.8	1.19	51.07	50.83	39.58	48.8	428.3	1631.8	1159.8
4	Wadi Nakhla	28.69083	33.63737	763	20	7.4	2.83	38.39	50.33	29.98	42.6	413.5	1668.8	963.2
5	Rei'h Safia	28.70451	33.65956	639	18	11.1	4.65	57.15	89.73	51.95	83.4	465.2	2732.0	1325.8
6	Wadi Feiran	28.69874	33.64724	642	7	14.2	2.28	77.53	77.89	69.65	71.4	1122.4	2547.4	1797.5
7	Wadi Reim	28.6685	33.68911	904	11	8.0	2.65	41.67	58.64	50.26	45.0	679.3	2104.4	1205.6
8	Wadi Ferian	28.71185	33.61104	689	8	15.0	1.85	90.13	85.69	102.35	100.9	1439.9	3559.0	2478.5
9	Wadi Nisreen	28.8481	33.52169	591	9	3.3	0.87	-	-	104.53	87.2	1351.3	3330.1	2430.9
10	El-Sheikh Abu-Shabib	28.71325	33.6189	608	17	0.1	0.04	54.4	64.97	46.56	59.0	553.5	2140.2	1253.9
Total					132	78.7	19.4	493.26	594.96	552.57	637.91	169.8	3559.0	1477.0

a. Wadi Mandar (Populations from 1-8)

Population no. 1

This population is located at the end of Wadi Mandar. About twenty-nine trees of this population were marked and numbered. The trees in this population are mainly of smooth bark type. Height ranges from 130 to 800 cm. A few numbers of individuals of various associated species were recorded in the site which are; *Aerva javanica, Ballota undulata, Blepharis ciliaris, Cleome dorserifolia, Crotalaria aegyptiaca, Iphiona scabra, Lavandula pubescens*, and *Zilla spinosa*.

Population no. 2

This area is very disturbed in the past and was exposed to numerous cutting activities by bedouins. All trees in this area are totally cut and only a small part of the main trunk still present (from which we took a small sample). Associated species recorded are mainly; *Globularia arabica, Fagonia mollis, Zilla spinosa*, and *Crotalaria aegyptiaca*. This site is characterized mainly by the presence of a high number of dead Acacia trees, which gave us the chance to collect about six cuttings from the main trunks and the branches as dead samples.

Population no. 3

This site is represented as population no. 3. As noted, before it is located at the end of Wadi Mandar and near to population no. 1. The area is a part of the main wadi located between two protruding ridges of east and west. The main wadi is made of two channels cutting a low terrace. The number of individuals is very high, and this area is characterized by the presence of both small and big trees (e.g. young and old trees). Also, some *Acacia* trees are very green and young, others are very dry. Two associated species were recorded *Lycium shawii and Fagonia mollis*. *Lycium shawii* is severely grazed, and attains one-meter height. *Fagonia mollis* is represented by many individuals nearly 50-70 individuals in the whole population. In this population we had to sample cuttings from previously cut old tree or from the lateral branches. A soil sample is also collected near tree no. 62. We noticed that there are a lot of cut and dead trees in the population; a similar observation is also noticed in case of population no. 1 of Wadi Mandar.

Population no. 4

The site of this population is called Um-Ghwael. It is bounded by a ridge protruding into the main stream of Wadi Mandar from the eastern side of a nearby mountain. The area can be described as an elevated wide terrace amidst the main wadi. The total area of the site is estimated to be about 70 x 40 m. *Acacia* in this population is characterized by a high vitality and show vegetative leaves. Trees cut in the past are growing back again giving rise to a population of *Acacia* characterized by its low height. The soil surface is mainly coarse sand with a lot of human disturbance and grazing practices. Grazing in this area assumed to prevent the appearance of new individuals of *Acacia*, however, grazing by camel is much less than that of goats and sheep (Kayongo Male and Field, 1983).

Population no. 5

This population is located in a small tributary at the end of Wadi Mandar next to foothill. Many different landform habitats were recognized such as; gorges, and foothill slopes. The soil surface is mainly coarse sand, which is suitable to vegetation. The area is very disturbed and is considered as a rest place for bedouins' animals, camels, sheep and goats. There are no creeping branches (procumbent) of all trees as in the case of population no. 2 of Wadi Mandar. It appears that cuttings were mainly from lateral branches, which have greatly affected the morphology of all trees in, as the cutting of lateral branches tends to stimulate vertical plant growth, i.e. through the apical buds. Most cuttings are very old. As most of the cuttings are old, it is mostly to mention that not all of them are man-made. One of the trees is characterized by its short green branches is apparently broken by strong winds. During rainy season this area is considered as a habitat of local bedouins searching for herbaceous land for grazing. In general, this population is growing at a depression surrounded by a foothill that is protecting all trees of the population. Trees usually grow at alluvial fans. The wadi is covered with red soil. The estimated area of this population is about 1000 m2, whereas the total area is about 2800 m2. Few numbers of individuals of limited number of associated species observed. In this site the associated species are; *Zilla spinosa, Fagonia mollis*, and *Crotalaria aegyptiaca*.

Population no. 6

The tree of this population possesses a high growth rate specially those of low height. Leaves are mainly green and new branches appear in all trees. The pod seeds are brown in color. There is remark of flash or flood happened recently in the area, so the plants are all in good shape also, the trees of Acacia (Aly et al., 2022). Associated species that recorded in the enclosure can be listed as follows: *Citrullus colocynthis, Cleome droserifolia, Crotalaria aegyptiaca, Fagonia mollis, Fagonia scabra, Heliotropium aegyptiacum, Iphiona scabra, Lotononis platecarpa, Tephrosia purpurea, Teucrium polium, Zilla spinosa, Ochradenus baccatus, Chrozophora pilicata*.

Population no. 7

This population comprises eighteen trees. Associated species with these trees are *Zilla spinosa, Fagonia mollis*, and *Chrozophora pilicata*. The tree height in that population ranged between .77 - 9.5 m with an average tree height of 5.12 m. The tree diameter ranged from 22 to 229 cm with average tree diameter of 91.3 cm.

Population no. 8

This site is a part of the main wadi. Its soil type is characterized by a fine sand texture. Trees of this population are mainly affected by currents of sand-laden wins due to its position in the wide-open part of Wadi Mandar. All trees are vegetative and green. A small number of pods occur under trees due to the effect of wind, which take the pods away from their trees. Tree no. 6 is in a terrible condition as no pods are fallen down in the circle. The main big tree covers the canopy area with many brown non-seeded pods. The list of associated species include: *Chrozophora plicata, Citrullus colocynthis, Crotalaria aegyptiaca, Fagonia moilis, Launaea spinosa*, and *Zilla spinosa*.

b. Wadi Lithi (Populations from 1- 15)

Population no. 1

This population is located in a gorge habitat (Hamer El-Atshan) that opens at Wadi Lithi mainstream. Its area around 260 X 50 m. Vegetation especially herbaceous plants is very rich and green and they are generally in a very good condition. Most of the trees are not old, it seems that all trees are young except with few exceptions. Most trees are in good shape (not so many cuttings). Many channels and alluvial fans dissected the area-giving rise to a diversity of microhabitats that sustain the growth of many herbs. Associated species recorded at this site are; *Aerva javanica, Blepharis ciliaris, Iphiona scabra, Launaea spinosa, Lavandula pubescens, Lindenbergia sinaica, Solenostemma arghel*, and *Zilla spinosa. Iphiona scabra* is the most common species around Acacia trees in this population. It is flowering and the number estimated for it in a randomly oriented and selected 5 x 5 m quadrates are 7, 8, and 8 individuals.

Populations no. 2 & 3

These two populations are located at Hamer El-Rayan next to population number one; they are very close to the main stream of Wadi Lithi drainage. The whole area of this population has a lot of disturbance in the area by camels and intense grazing. Many trees have bent down trunks, which is probably caused by the prevailing winds in the area.

A lot of associated species mainly represented by *Citrullus colocynthis, Eruca sativa, Zilla spinosa*, and *Astragallus sieberi*. Soil surface is composed mainly of coarse- sand and fine sand with gravel. Heavily grazing stress and human disturbances are recorded in the area (Manniche, 1989).

Population no. 4

This site is located at the end of Wadi Lithi. The area is 80 x 40 m, and is characterized by a surface covered with rock fragments of different sizes. In general, the site is affected by disturbance caused mainly by camels. The total plant cover of the area is estimated between 5 and 10 % of the area as herbaceous plants. The list of associated species includes; *Lycium shawii, Fagonia mollis, Pulicaria crispa, Blepharis ciliaris, Citrullus colocynthis, Aerva javanica, Crotalaria aegyptiaca*, and *Zilla spinosa*.

Population no. 5

This population is located at the end of Wadi Lithi (Roknet Amra) next to the previous population. The population area is mainly characterized by coarse sand and fine sand covering the surface and is moistened due to flood. The density of Acacia trees in the site is high than in any other population with total herbaceous plant cover ranging between 10-15 %. Acacia trees are markedly affected by cutting activities. Associated species in the site include: *Lycium shawii, Heliotropium arbainense, Ochradenus baccatus, Malva sp., Fagonia mollis, Zilla spinosa, Pulicaria crispa, Blepharis ciliaris, Aerva javanica*, and *Crotalaria aegyptiaca*.

Population no. 6

The population located at Umm-Ormot and Umm-Tush at Wadi Lithi. The population area (40 x 55 m) is a part of a fan-habitat covered with coarse sand. The site is heavily stressed with cuttings and high disturbances caused by camels, sheep and goats. Also, the area characterized by presence of many Acacia seedlings growing in good shape and plenty of associated species such as *Fagonia mollis, Aerva javanica* and *Crotalaria aegyptiaca*.

Population no. 7

This population located at Umm-Ormot and Umm-Tush (a tributary) of Wadi Lithi. The population area (80 x 18 m) is characterized by two types of growth form; they are the cushion-form (1-2 m high) and the fork-shaped (5-7 m high). Soil surface is made of loose coarse and fine sands with a numerous indication of grazing and human disturbances. The list of associated species include: *Solenostemma arghel, Fagonia mollis, Zilla spinosa, Crotalaria aegyptiaca*, and *Aerva javanica*.

Population no. 8

This population is located at Tala'et Rashid area (30x50m), which is a tributary of Wadi Lithi. The population is a part of a big fan habitat with a population size of twenty-four Acacia trees. The soil is mainly coarse sand caused with scattered blocks of rocks and shows indications of grazing remarks of sheep, goats and camels. Associated species in this site are not so many (e.g. *Citrullus colocynthis, Zilla spinosa, Fagonia mollis, Crotalaria aegyptiaca* and *Senna italica*).

Population no. 9

The population is located at Umm-Ghratt a tributary of Wadi Lithi. The site is a part gorge habitat (120x 30m) and is heavily affected by grazing caused by sheep and goats. Trees of this population are mainly assumed to be relatively young trees. The area is characterized by growing many Acacia seedlings and also a high number of associated species which can be listed as follows:

Aerva javanica, Astragallus sieberi, Blepharis ciliaris, Bufonia multices, Caylusea hexagyna, Centaurea aegyptiaca, Citrullus colocynthis, Cleome arabica, Crotalaria aegyptiaca, Fagonia arabica, Fagonia mollis, Galium sinaicum, Gypsophilla capillaris, Heliotropium, Launaea spinosa, Iphiona scabra, Kickxia macilenta, Lavandula pubescens, Lindenburgia sinaica, Lycium shawii, Ochradenus baccatus, Pituranthos triradiatus, Pterocephalus sanctus, Pulicaria crispa, Rumex sp., Salvia aegyptiaca, Senna italica and *Zilla spinosa*.

Population no. 10

This population is located at Umm-Merkha'a; a tributary of Wadi Lithi. The population size is very small represented by only twelve-trees, with an average height ranging between 2-6 m. The population area is a part of gorge landform type with coarse sand and fine sand covering the surface as well as small rock fragments. The list of associated species include: *Citrullus colocynthis, Crotalaria aegyptiaca, Fagonia mollis, Gallium sinaicum, Iphiona scabra, Launaea spinosa, Pituranthos triradiatus*, and *Zilla spinosa*. Grazing intensity is lesser than that in any other sites, due to the rigidity of the hard rocks, therefore the disturbances and human activities are quite less than in other populations.

Population no. 11

This site is located in the middle of Wadi El-Beida'a (a branch of Wadi Lithi). Only seven trees represent this population with a height ranging between 5 - 7.5 m. Four trees of them are in good shape with some brown pods down. The trees number 2 and 3 show numerous vegetative growths indicated by the appearance of large vegetative lateral branches. All area of the site has a lot pods covering the ground. Generally, this site shows a general increase in the vegetative growth of lateral branches. No associated species observed in this site.

Population no. 12

This population located at Wadi Umm-Zaraba a tributary of Wadi Lithi. The size of this population is quite large in comparison to other populations. It is represented by twenty-six trees with average height ranges between 1-6 m high. Most of trees in this site are in good shape (fruiting). The ground under the canopy of the tree appears as brown circle, due to the presence of numerous brown dry pods under canopy. Small or short trees are growing very good, especially the growth of new lateral branches. Brown pods occurred in the depression and some blown away by wind but still in the area around the site. Two new *Acacia* seedlings are in good shape with young branches very green and many lateral branches were recorded. Associated species include: *Zilla spinosa* and *Fagonia mollis*.

Population no. 13

This population located at Abu-Ntishat a tributary of Wadi Lithi. Also, only seven trees represent this population. These trees are showing a vegetative growth by the growth of new

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branches and new compound leaves. High growth of lateral branches of trees no. 2. The area under canopy is mainly covered by pods especially that of trees no. two and three. Accordingly, soil shows high seed content. The site is also marked with the appearance of two new Acacia seedlings (10-12cm cover). Associated species of this site are: *Fagonia moilis, Fagonia scabra, Iphiona scabra*, and *Heliotropium sp*.

Populations no.14 & 15

These two populations are located at El-Menzaizla (Wadi Lithi). All the trees in this site are in good shape. Trees are generally showing vegetative growth and brown circles of fallen pods are numerous, increasing, accordingly, the soil seed content under most these trees. A lot of associated species were recorded that can be listed as follow: *Fagonia moilis, Zilla spinosa, Pulicaria crispa*, and *Fagonia scabra*.

c. Wadi Feiran (Populations from 1-10)

W. Alliat

Wadi Alliat attains about 8 kilometers in length. Its width varies between 150-200m along its downstream and middle parts, and about 50 m or less along it's upstream. In general, the wadi is surrounded by metamorphic mountains up to 200m in height, and is filled with alluvial deposits mainly composed of large boulders mixed with coarse to fine grained fragments. Low terraces are present at both sides. Although, its basin collects a considerable amount of ground, but it is characterized by hot climate and scanty of rainfall (Moustafa and Ghowail, 2022 ;Moustafa et al., 2023).

The vegetation cover throughout this wadi ranges between 5-10%. The wadi supports about 40 plant species dominated mainly by *Acacia* that spread over the entire wadi due to climate and water conditions. Many gullies dissect the mountains of W. Alliat and drain the water into the main wadi. These gullies are a good habitat for Acacia sp. Wadi Alliat, however, is subjected to many human disturbances (such as grazing, cutting, uprooting and fire). Generally, W. Alliat is dominated by *Acacia sp*. particularly along its foothills and the openings of its distributaries. Furthermore, there is one representative gorge, near the middle of the wadi, where a community of *Moringa peregrina grows*. The density of *Acacia* trees in the main stream of the wadi is high; it is about 5-6 trees per 15 x 15 meter. On the other hand, a low density of *Acacia* trees is recorded at the downstream part.

Population no. 1

This population lies at the downstream of Wadi Alliat. The nature of soil surface is mainly boulders stones and rock fragments of different sizes. The site is characterized by its high grazing intensity as well as human disturbance. The area also suffers from cutting activities that is estimated to be very high. Associated species of the population are as follows: *Astragallus spinosus, Fagonia mollis, Citrullus colocynthis*, and *Forsskaolea tenacissima*.

Population no. 2

This population lies at the downstream part of Wadi Alliat, in the middle of the flood path. Floods create the chance for Acacia to grow on both sides. Associated species in the area are; *Achillea fragrantissima, Astragallus spinosus, Citrullus colocynthis, Citrullus colocynthis, Fagonia arabica, Fagonia mollis, Fagonia mollis, Forsskaolea tenacissima, Heliotropium sp., Launaea spinosa, Lycium shawii*, and *Senna italica*.

Population no. 3

This population is located at upstream part of W. Alliat (Wadi Gohaier). It is a short wadi (about 2 km), which is about 20-50m in width and characterized by high slope gradient. Ain Gohaier is a nice fissure spring issued from fractured granitic rocks. It has a very low rate of flow forming a stagnant water pond. This pond is surrounded by steep sides of low granitic hills (altitude 930m) and is characterized with a dense vegetation cover. The wadi is mainly dominated by *Acacia sp*. but they occur in less numbers compared to W. Alliat. The low percent of plant cover in this wadi (less than 5% cover) is attributed largely to aridity. There are about 25 plant species in relatively small area 10 x 20m. The area is mainly dominated by *Mentha longifolia* and *Juncus acutus*. *Hypericum sinaicum* covers the fissures of steep sided hills. Other species are present in few numbers as: *Alkanna orientalis, Stachys aegyptiaca, Ficus palmata, Retama raetam*, and *Capparis sinaica*. Although all plants are in good conditions, there are plenty of cuttings. This area shows a combination of endemic species in small area as: *Hypericum sinaicum, Anarrhinum pubescens*, and *Kickxia macilenta*.

Population no. 4

This population is located at wadi Nekhla (a tributary of W. Feiran). The site is mainly a gorge habitat that is dominated by *Artemisia herba-alba*. Slopes and terraces along this gorge are characterized by the growth of by *Helianthemum kahiricum*, in addition to *Ephedra aphylla, Echinops glaberrimus*, and *Globularia arabica*. All Acacia trees in the area are in bad shape due to aridity. All trees have a white rough and furrowed bark. The area is heavily disturbed with grazing activities.

Population no. 5

This population site lies at Rea'a Safia. The site is mainly a slope habitat located near to a cliff of a mountain of metamorphic rocks. The site shows different age classes. All trees are in good shape, strong vegetative and very green, this because the mountain cliffs make a sort of fencing to this population.

Population no. 6

This site is located in El-Menaizla, a tributary of Wadi Feiran. It is a small wadi where a few numbers of Bedouins settle in small huts. One of the Bedouins in this area told us that he estimated that the Acacia tree grows by about 5-10 cm every 8 years in one of its main branches.

Population no. 7

This site is located at Wadi Reim, a tributary of Wadi Feiran, it

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is a long Wadi (about 10 km long) surrounded by granitic mountains. Its altitude ranges from 1230 to 1140 m (a.s.I) Mean width of the wadi reaches about 50 to 75 m, with deep soil and very loose surface in the mainstream parts. The nature of soil surface is suitable for agriculture. This Wadi shows the lower number of associated species.
The most common communities are Palm trees (*Phoenix dactylifera*) with Labiatae species in depression habitats forming a sort of small Oases and few cultivated gardens at the middle part of the Wadi. This is followed by a number of communities dominated mainly by *Retama raetam* with *Anabasis articulata*, and *Artemisia judaica* in a good condition growing with high growth viability. This site is a good representative area for *Artemisia judaica*. The other companion species include *Fagonia mollis, Fagonia arabica, Artemisia herba-alba* and *Astragallus spinosa*. This wadi becomes drier and more sloped towards the east. It receives a good amount of water during floods, which can be useful to enrich the vegetation. This can be done easily by a system of watershed management through building of sandy or rocky dams at intervals to minimize the velocity of floods and maximize the amount of infiltration. The area is also highly disturbed with sheep, goats and camels.

Population no. 8

This population represents the spots samples that selected from the tributaries of Wadi Feiran. These wadis are; Wadi Agla, El-Sheikh Hamad, Etmara, Alliat, El-Sheikh Awad, El-Kosiar, and El-Haswa.

Population no. 9

This site lays at Wadi Nisreen a tributary of Wadi Feiran. The Acacia population in this area is in good condition. It is very dense attaining about 25 trees per one kilometer. The trees show high vegetation with less infected trees.

Population no. 10

This site located at a small tributary of Wadi Feiran called Elsheikh Abu-Shabib. The area of the population is a gorge habitat. The Acacia population in that area is in good shape. The size of population is represented by seventeen trees. Associated species in the area represented by *Reseda arabica, Fagonia mollis, Chrozophora plicata*, and *Capparis spinosa*.

Soil analyses

Twenty-Four soil samples from nineteen populations distributed over three main wadis were collected to determine the physical and chemical characteristics of each population (**Table 5**). In laboratory, soil samples were dried in air, and then passed manually through a 2 mm sieve to evaluate gravel percent. The organic matter content of soil samples was determined by loss on ignition method after oven drying at 600o C for 3 hours using muffle furnace. The degree of saturation for each sample were assessed. The pH was measured in 1:5 extract. Electric conductivity (EC) was measured in water extract 1:1.

Table 5. Soil analyses of the twenty-four collected soil samples.

No.	Location	Organic matter (%)	pH	Electric conductivity (μS)	Moisture (%)	Saturation
1	Wadi Mandar	1.56	7.55	160	0.095	9.50
2	Wadi Mandar	3.95	7.79	253	0.211	11.15
3	Wadi Mandar	2.34	7.42	697	0.131	11.75
4	Wadi Mandar	1.26	7.79	876	0.091	10.75
5	Wadi Lithi	2.01	7.03	440	0.102	12.50
6	Wadi Lithi	3.09	7.51	1375	0.952	9.75
7	Wadi Lithi	2.10	7.79	204	0.159	11.00
8	Wadi Lithi	1.99	7.78	248	0.148	10.95
9	Wadi Lithi	2.85	7.77	380	0.006	11.25
10	Wadi Lithi	2.76	7.69	504	2.947	11.50
11	Wadi Lithi	2.57	7.74	419	0.002	10.00
12	Wadi Lithi	5.03	7.51	847	0.005	10.50
13	Wadi Lithi	5.41	7.28	1306	0.035	15.50
14	Wadi Lithi	3.69	7.49	1026	0.009	12.75
15	Wadi Lithi	2.25	7.50	377	0.003	10.25
16	Wadi Lithi	6.71	7.77	1505	0.015	13.00
17	Wadi Lithi	4.71	7.42	1305	0.037	12.50
18	Wadi Lithi	2.50	7.67	641	0.015	10.25

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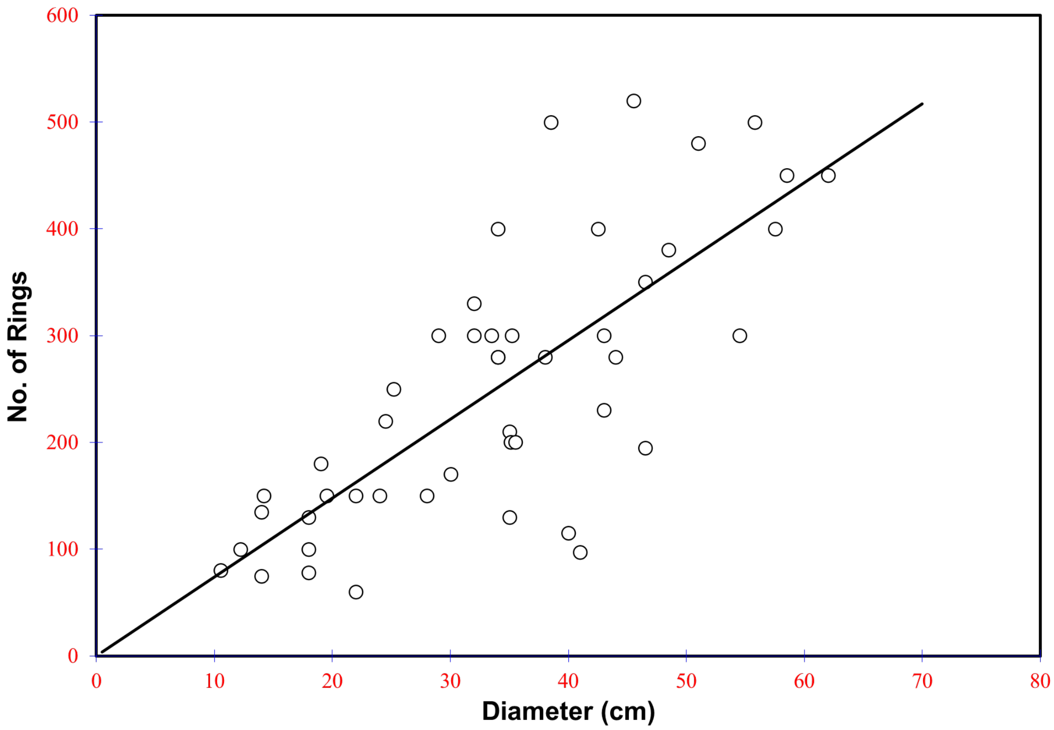
19	Wadi Lithi	4.17	7.89	631	0.025	11.00
20	Wadi Lithi	2.04	7.75	856	0.001	11.75
21	Wadi Lithi	1.37	7.77	371	0.024	12.00
22	Wadi Feiran	3.58	7.51	475	0.001	15.50
23	Wadi Feiran	7.64	6.74	273	0.284	26.00
24	Wadi Feiran	2.97	7.81	728	0.030	12.75

Age structure

A simple regression analysis is carried out to figure out the relationship between the number of growth rings and tree diameter (**Fig. 1**). Only, forty-seven sections were used as dead trees collected from thirty-three populations. The regression results confirmed the existence of linear relationship between diameter and number of growth rings. Table 6, shows the complete results of ANOVA analysis of the regression trendline that would be helpful to predict the age of the collected measurements of six hundred and fifteen trees.

Figure 3. Linear regression analysis between diameter of trees (cm) and number of annual rings.



Based on the regression line, oldest *Acacia* tree is about 3559 years old, which dates backs to the year 1558 B.C. Also, the second oldest tree is found at W. Feiran, it is 3330.1 years old, which means that it is established around the year 1329 B.C.The results of age structure of *Acacia sp*. through three main wadis (namely Wadi Mandar, Wadi Lithi, and Wadi Feiran) were grouped and presented after calculating the percentage of individuals in each group age (**Figs. 2, 3, 4 and 5**).

In the field of population ecology, researchers usually divided the age period of any population into three main ecological periods: *pre-reproductive, reproductive*, and *post-reproductive*. In plants, the *pre-reproductive* period is usually termed the juvenile period. The relative length of each period depends largely on the life history of the organism. In longer-lived plants (*Acacia*) and animals, the length of the pre-reproductive period has a pronounced effect on the population's rate of growth. In general, organisms with a long *pre-reproductive* period increase more slowly and have a long span of time between generations (**Figure 3**).

Fig 2: a, b, c, The age structure of Acacia sp. in the main three Wadis at South Sinai**.**

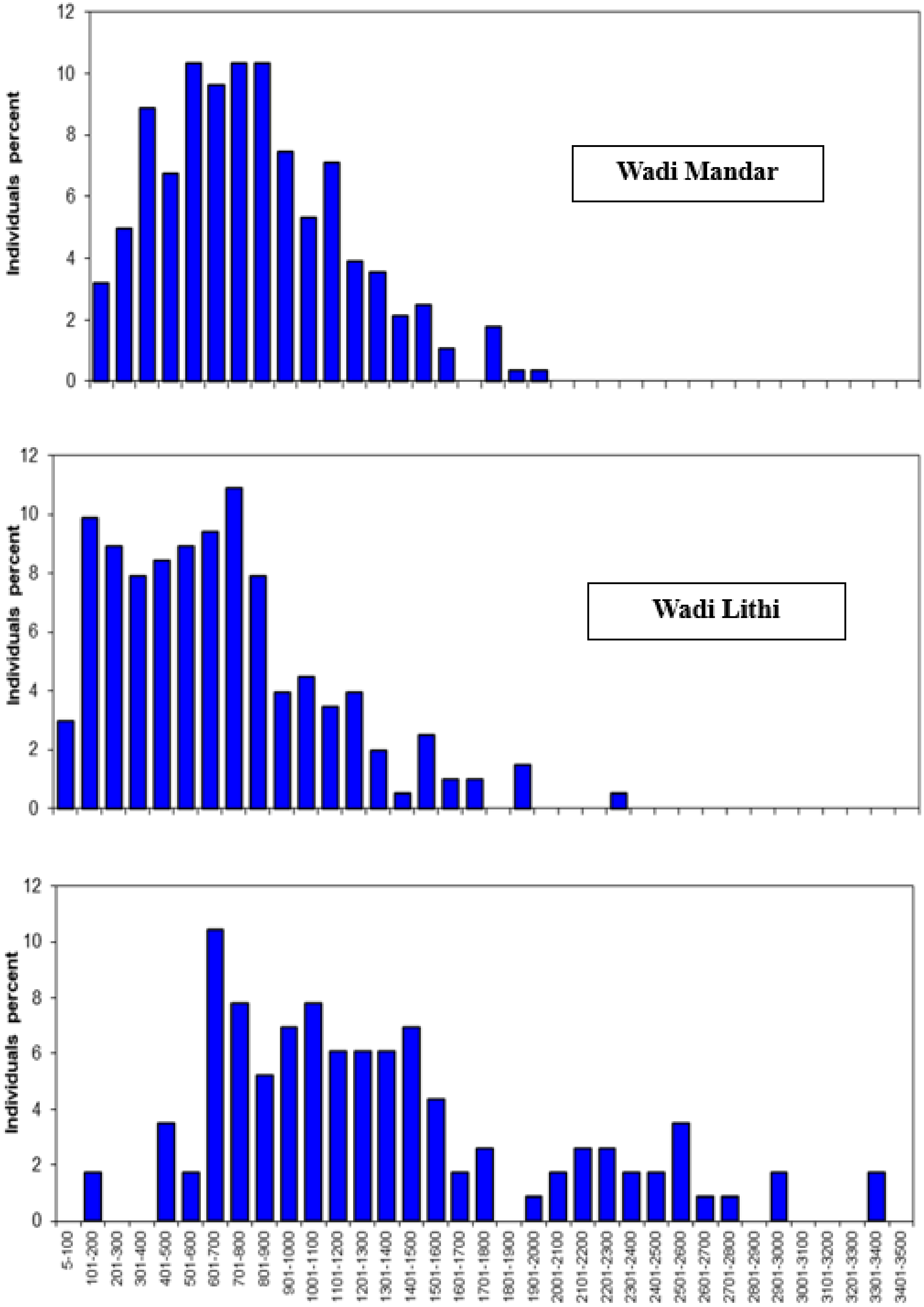


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Figure 3. Population pyramid of Acacia sp. at South Sinai. The two halves of the pyramid are symmetrical.

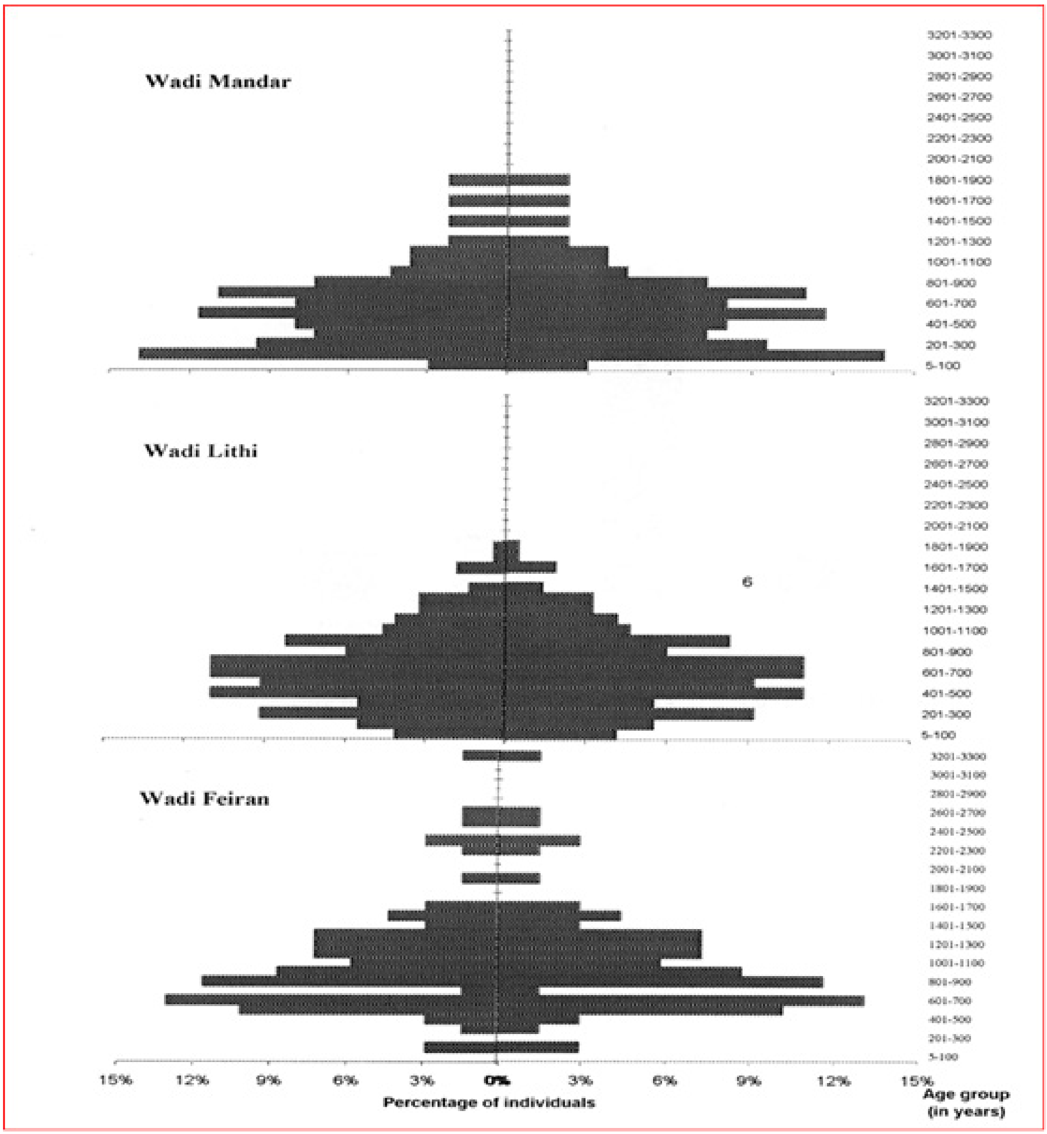


Figure 4. The age structure of Acacia sp. populations at South Sinai, Egypt.

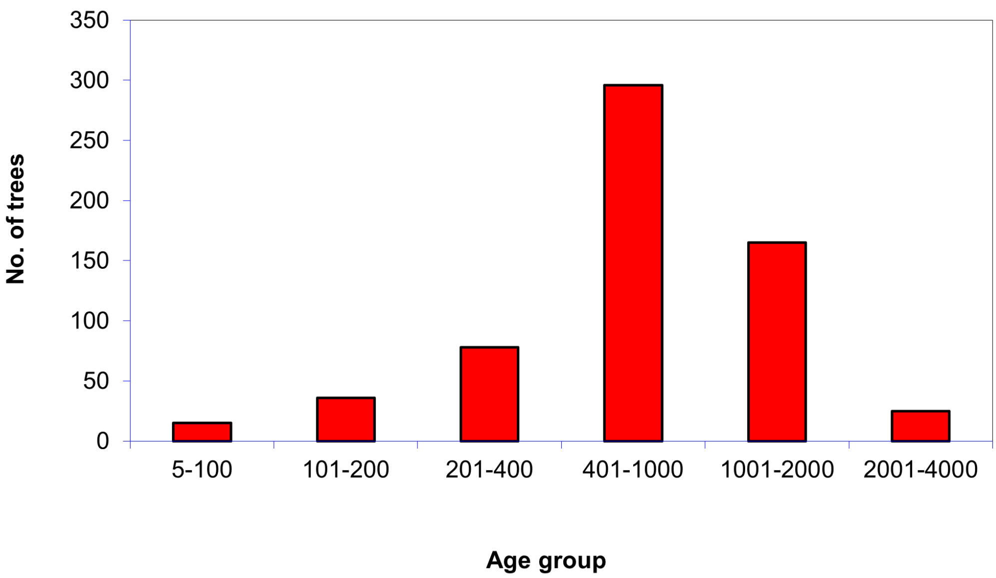
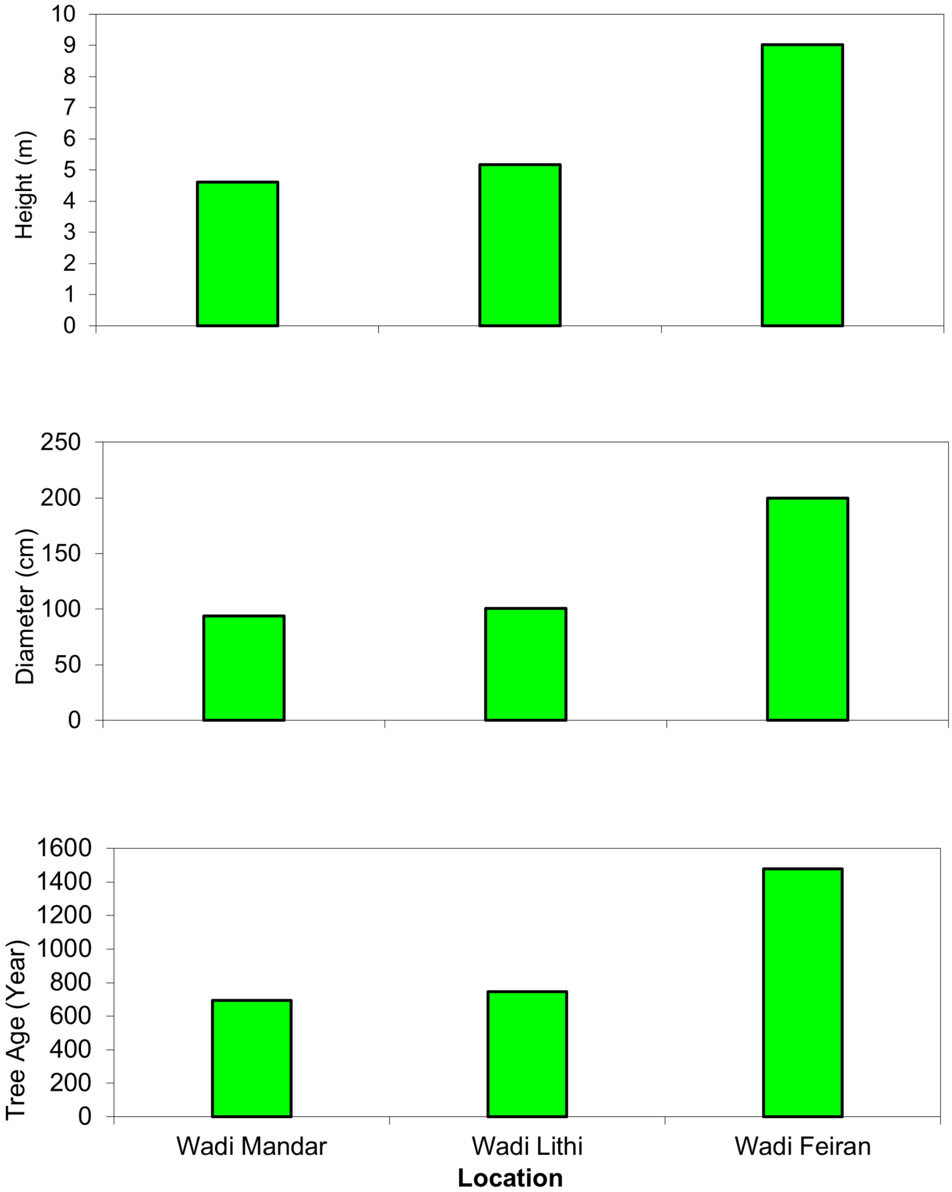
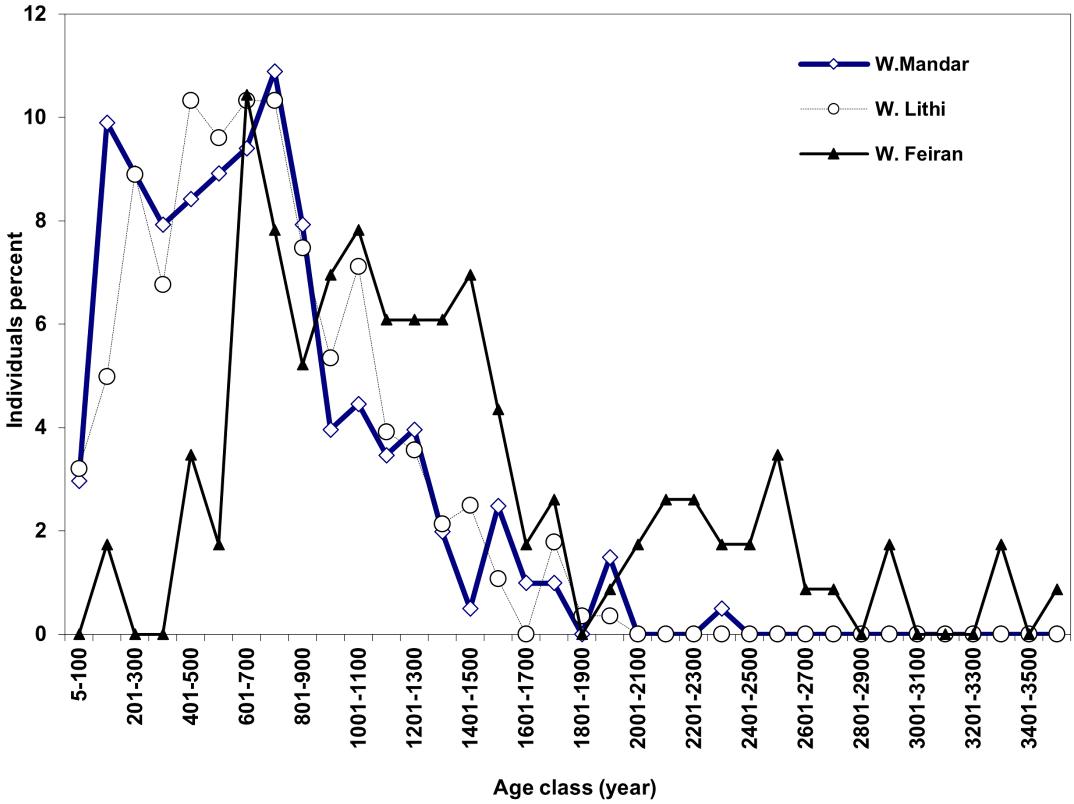


Figure 5. Shows the mean value of height, diameter, and Age (years), in main selected wadis (Wadi Mandar, Lithi, and Feiran)**.**



The survivorship curves of *Acacia* populations in the main three wadis show the similarity between the populations of W. Mandar and W. Lithi and the overlapping of W. Feiran curve with them. the decline phase in the age structure at the age segment of 1600 years old at Wadi Lithi, and age segment of 1801 years old of both wadis of Feiran and Mandar (**Fig. 6**).

Figure 6. The survivorship curve of Acacia populations at the three main wadis: W. Mandar, Lithi, and Feiran.



DISCUSSION

The age structure represented by segments where each segment equal to hundred years old. Subsequently, one can extract more deep information in the studied localities. In Wadi Mandar, it is observed that the highest percentage of individuals is found at segment 101-200 years, whereas, the lowest individual percent occurred at the first segment (5-100 years) and the segment of more than 1200 years old (Thomson, 1992). One tree only is found at the segment of 2201 years old. In Wadi Lithi, the highest individual percent is found at the segments of 401-800 years, and the lowest individual percent is found at age segments of more than1801years old (Montgolfler-Kouevi, and Le Houérou, 1980). It is therefore indicated that there is not any significant difference between Wadi Mandar and Wadi Lithi (Gupta and Mohan, 1982) . It is quite clear that no trees older than 2000 years found in Wadi Lithi. On the contrary, Wadi Feiran showed quite different results where the highest percentage of individuals occurred at that age segment of 601-700 years, and no trees occurred at the first age group (5-100 years). In the meantime, lowest percentage of individuals occurred at many different age groups (i.e. in the early age segments of 201-301, 301-400 years, and the middle group 1801-1900 years), (Figs. 2 a, b, & c).

The age of all sampled trees into six main groups, as follows: 5-100, 101-200, 201-400, 401-1000, 1001-2000, and 2001-4000 years. The majority of sampled trees are found in the fourth group age (296 tree), which represents the common age in Acacia trees. On contrary, only fifteen trees are assigned to the first group (5-100 years) and thirty-six trees are found in the second group (101-200 years). The third group of age is represented by seventy-eight trees and the fifth group is represented by a hundred and sixty-five trees. The sixth group of age (2001-4000 years) is represented by twenty-five trees that are considered as the oldest group of trees in the studied area (Maslin et al., 1987). These oldest trees occurred in those ten populations of Wadi Feiran. Generally, one can say that highest percentage of individuals found at age group of 400–1000-year-old, whereas the lowest percentages are found at first and last groups of age. Results show the mean values of height, diameter and age of trees in main selected wadis. It is very obvious that average of these parameters is quite the same in both Wadi Mandar and W. Lithi and much higher values are found in W. Feiran. The differences between age, height, and diameter were tested by ANOVA analysis and the results have showed a great significance between the three localities (Jackson and Jacobs, 1985).

The population pyramids of Acacia in the three main localities. One can recognize these three periods of age structure (Milton, 1983). The pre-reproductive period in Wadi Lithi and wadi Mandar are very small. This reflects a decreased birth rate brought by grazing intensity, human disturbance, and drought problems. However, the populations in these two wadis are characterized by very large reproductive age periods and surely one can predict a smaller reproductive age class later on due to the shortage in the pre-reproductive periods. The post reproductive period is small also in both two pyramids of wadi Mandar and W. Lithi with some age gaps in between segments of age structure.

In Wadi Feiran, the situation is quite different, where the pre-reproductive age period is not represented (i.e. no seedlings or young trees can be observed) but only young trees that are not younger than 100 years old can be seen in these populations. Moreover, the reproductive age period is quite large but still some decline at earlier pre-reproductive age periods is depicted (Mwalyosi, 1990). Also, the post-reproductive age period in Wadi Feiran is very small with a lot of gaps between age segments (Khalid et al., 2024). The main problem in the age structure of these three wadis can be explained in two main points: firstly, the shortage of pre-reproductive age periods in W. Mandar and W. Lithi, and secondly the absence of the first beginning segment of pre-reproductive age period at W. Feiran. In fact, this problem would cause to the lack of reproductive age periods later on and this would eventually threat the whole ecosystem (Khater et al., 2023).

CONCLUSION

Based on the data collected from the thirty-three Acacia populations in the three main wadis (Wadi Mandar, Wadi Lithi, and Wadi Feiran), our findings provide a comprehensive picture of the demographic structure and ecological conditions affecting Acacia populations across South Sinai. The research highlights that Acacia populations exhibit significant variation in tree density, age structure, and health across different habitats. At Wadi Mandar, the populations showed a mix of small, young trees and larger, mature trees, with substantial disturbance due to human activities such as grazing and tree cutting. The populations in Wadi Lithi, especially in areas like Hamer El-Atshan, were generally younger and showed signs of high disturbance from grazing, although some populations were in relatively better condition, such as those in areas like Roknet Amra. In Wadi Feiran, populations showed a high degree of variability, with some sites exhibiting signs of severe disturbance, while others, particularly in more remote areas, demonstrated healthy, vigorous growth. The regression analysis conducted on the relationship between tree diameter and age confirmed a clear linear relationship, allowing us to estimate the age of the 615 surveyed trees. This finding is critical for understanding the age structure and longevity of these populations, which is essential for effective conservation strategies. The ANOVA results further suggest that the demographic structure of these populations can be modeled using the relationship between growth rings and tree diameter, providing a solid foundation for predicting tree age and evaluating the health of Acacia populations. In conclusion, the research underscores the urgent need for targeted conservation efforts to protect mature Acacia trees, particularly in areas heavily impacted by human activities. The variability in population health, combined with age structure data, will guide future management strategies to maintain genetic diversity and ecological function across these critical habitats. Given the central role of Acacia trees in the desert ecosystem, safeguarding these populations is essential for preserving the biodiversity of the region and ensuring the resilience of these ecosystems to future environmental changes.

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