



Floristic diversity and ecological characteristics of Northeastern Gaza strip, Palestine

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Abstract

The current study was carried out to determine floristic diversity and investigate ecological characteristics in the northeastern Gaza Strip, Palestine from 2019-2021 during various seasons. A total of 146 species were recorded belonging to 116 genera and 44 families. Of these *Echinops philistaeus* is believed to be endemic to Palestine, five endangered taxa were also recorded. The predominant families of the study area were Asteraceae (Compositae) with 27 species Poaceae (Gramineae) with 19 species and Fabaceae (Leguminosae) with 13 species. At the generic level *Amaranthus* was represented by five species, while *Avena*, *Bromus*, *Euphorbia*, *Ficus*, and *Urtica* were represented by three species each. Mediterranean and Irano-Turanian elements made up the majority of the chorotypes (65 species). Therophytes made up the majority of the life-form class by 87 species followed by hemicryptophytes (22 species), phanerophyte (17 species), chamaephytes (9 species), geophytes and climbers (5 species each), and parasites represented only by one species. This study provides basic information on the area floristic composition for the future biodiversity conservation projects. It is advised that more research be done to find the plant species that have a wide biological range in this area and to create management strategies that will protect floristic diversity—particularly that of endangered species.

Keywords: Biodiversity; Chorology; Flora; Life form;

Introduction

Palestine is situated in Southwest Asia in the east of the Mediterranean basin, its biogeography has been divided into three regions Mediterranean, Irano-Turanian (semi-desert) and extreme desert. It is considered one of the hotspots and the

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important sources of biological diversity and plant speciation in the Mediterranean region and globally (Al-Sheikh, 2011). The floristic diversity was subjected to decline and changes in vegetation patterns due to anthropogenic factors (Ali-Shtayeh & Jamous 2018; Qumsiyeh & Al-Sheikh 2023). The urbanization and population growth have an impact on the environment, particularly on the plant cover. The environmental monitoring studies showed that there is an increase in carbon dioxide emissions, as a result of the lack of vegetation cover (Zhang, et al. 2022 a; Al Kafy et al. 2022). There are specific ecological characteristics that distinguish any ecosystem, such as vegetative growth, composition, and structure. These characteristics show ecosystem differences and ecological changes that arise due to human activities (Jyoti et al. 2014; Sharma et al. 2014; Ali-Shtayeh & Jamous 2018). Recent studies have proven that the extinction of many plant species and the threats faced by biodiversity is mainly attributed to the anthropogenic activities, in addition to vulnerability of habitats, pollution, overexploitation, and global climatic change (Sharma et al. 2014; Ali-Shtayeh and Jamous 2018; Ford et al. 2021; Al Kafy et al. 2022; Qumsiyeh and Al-Sheikh 2023).

Palestine is distinguished by its geographical location which contributes to its biodiversity and abundance of plant species; it has about 2,600 species, 260 of which are red-listed (Ali-Shtayeh & Jamous 2018; Al-Sheikh & Qumsiyeh 2022).

In addition, this country is a meeting point for the plant species from Africa, Europe, and Asia, which increases its floral diversity (Ali-Shtayeh et al. 2015). Vascular plant species are widespread, 14% of them are flowering and listed on the IUCN Red List (IUCN 2021). According to Moreira et al. (2023), about 11% of vascular plants are globally threatened due to land use. Globally, recent studies have been conducted to investigate the floristic diversity in terms of taxonomic and morphological diversity (Zaman & Badshat 2021; Rawal & Tewari 2022; Zhang et al. 2022 a)

The endemism in the Mediterranean Basin flora, in Palestine is lower than in other regions (Ighbareyeh et al. 2021; Ali-Shtayeh & Jamous, 2018). According to Ali-Shtayeh et al. (2022), 165 taxa of the Palestinian flora are endemic and near-endemic. In total, there are 102 threatened plant taxa belonging to 39 families and 83 genera; that comprising 5.6% of the total Palestinian flora. Few studies dealt with the vascular plants in Palestine; Ali-Shtayeh & Jamous (2018) recorded 1938 vascular plant species comprises 733 genera and 111 families in the West Bank and Gaza Strip (GS). Ali-Shtayeh et al. 2022 wrote a new inventory included 1826 species belonging to 686 genera and 108 families for indigenous vascular plants grown in GS and the West Bank, among them 1216 taxa were recorded in GS. Despite the floristic diversity in the GS, was subjected to few studies that dealt with the floral diversity, ecological, and taxonomical in this region (Madi et al. 2002; Abd Rabou et al. 2008; Abou Auda et al. 2009a; Abou Auda et al. 2009b; Abou Auda 2010; Abou Auda 2011; Abou Auda 2012). Many recent studies have been conducted to investigate floristic diversity in terms of taxonomic and morphological diversity

(Zaman & Badshat 2021; Rawal & Tewari 2022; Zhang et al. 2022 b). To date of issue, there are no recent studies conducted in the Gaza Strip that have dealt with the floristic composition, chorotype, and biological spectrum of its vascular flora.

The current study aims to explore some of the biological and ecological features of flora of GS including the species diversity, habitats, biological spectrum, spinescences, leaf type, leaf arrangement, and chorotype. This study will provide valuable knowledge for researchers, students, and decision-makers as a step towards implementing the conservation programs.

Materials and methods

I. Study area

Palestine is located between 34°15' and 35°40' E and between 29°30' and 33°15' N. This location plays a major role in the impact on determination of its biodiversity, floral characteristics, vegetation cover patterns, and climate conditions (Ighbareyeh et al. 2017). Despite the small area of Palestine, it is characterized by remarkable climatic and topographical diversity as noticed in Gaza and the West Bank areas. This study will cover the Northeastern GS, which is situated between 31° - 32° N and 34° - 35° E. The area of GS is about 365 km² and is bordered to the south by Egypt and to the west by the Mediterranean Sea. The average temperature ranges from 13 °C in winter to 25 °C in summer. In contrast, the maximum temperature ranges from 17 - 29 °C in summer, and the least is 9 - 21 °C in winter. On the other hand, the daily humidity fluctuates between 65% in the daytime and 85% at night in summer and 60% - 80%, in winter (UNEP 2003; Abd Rabou & Radwan 2017).

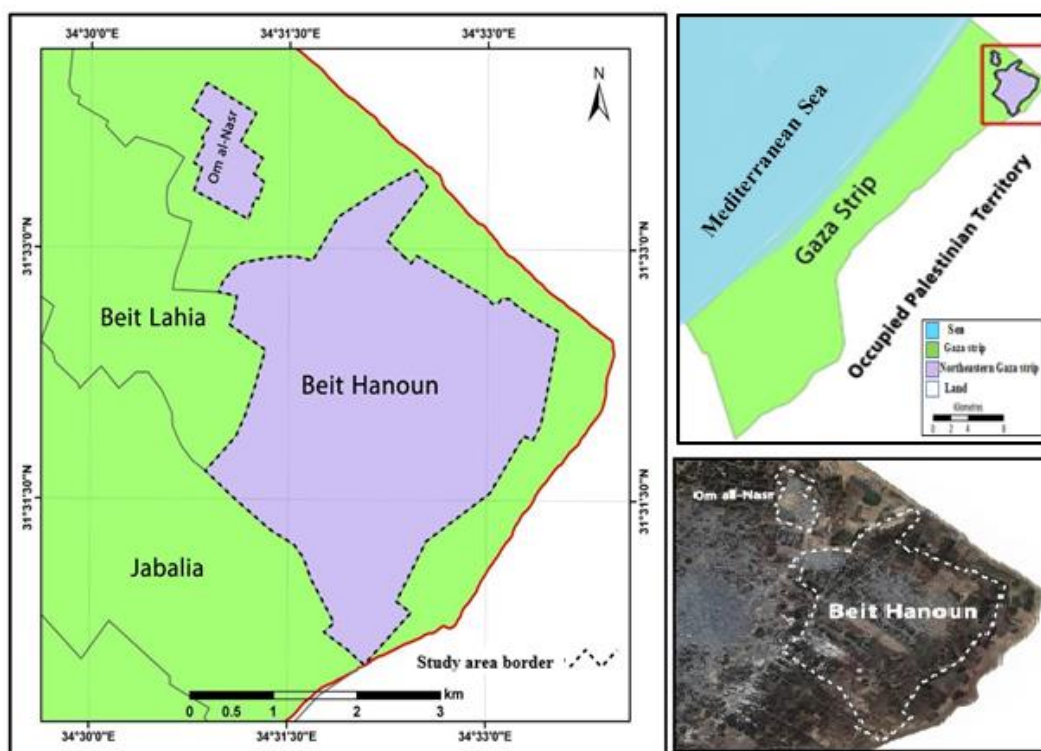
The climate in Palestine is hot, and dry in summer, warm, and rainy in winter this supporting the abundance of plant species. In the current study, samples of plant species were collected from different locations such as the city of Beit Hanoun and the village of Om el Nasser (Map 1) which includes different sites such Alezba, Salah Al-Deen, Hamouda, Qatabania, Aboramadan, Abosafia, Gazalat, Farata, Abugazala, Poura, and Aldooh ((Map 1).

II. Data collection and species identification

Several field and exploratory visits from June 2019 to December 2021 were carried out with the aim of conducting a comprehensive survey of the selected study areas. Different habitats were visited to record the different plant species in the study area i.e., semi-open and open habitats, disturbed areas, cultivated lands, steppes, sands, salty habitat, shady rocks, walls, etc.), a detailed botanical inventory was conducted. Samples were collected and herbarium samples were prepared using the standard herbarium method (Smith & Chinnappa 2015; Jain & Rao 1976). Samples were identified using relevant literatures, publications, databases, and previous Floras (Zohary 1966, 1972, Feinbrun 1978, 1986, Täckholm 1974; Boulos 1999-2005; Horvitz & Danin 2015; Ali-Shtayeh et al. 2022; Ighbareyeh et al. 2022).

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For each taxon, the following information is provided: currently accepted name (according to POWO) and family (according to APG III. APG IV), habitat, habitat classes, duration, life-form according to Raunkiaer (1934) and Ellenberg (1967). Leaf type, leaf arrangement, spinescence, summer shedding were recorded. In addition to the threat status according to the IUCN, and chorology according to Ali-Shtayeh & Jamous (2018), vernacular names and notes on their possible uses were also provided.



Map 1. The location map of the study area in northeastern Gaza strip, Palestine.

Results

Floristic diversity refers to all plant species within the boundaries of the study area, which reflects the natural vegetation cover of the area and its plant resources. A comprehensive documentation of the inventory of vascular plant species in the study area is presented in Table (1). The data related to vernacular names were identified according to previous studies (Horvitz & Danin, 2015; Ali-Shtayeh et al., 2022; Ighbareyeh et al. 2022).

The total number of taxa accounted for in this study was 146 species, 116 genera, belonging to 44 families; out of these families, Gymnospermae are less represented by two families (Cupressaceae and Ephedraceae). Most of the taxa are

included in Eu-dicots, (37 families), while monocots are represented by only six families.

Asteraceae (Compositae) was the largest family with 27 species (18.4 % of the recorded species) followed by Poaceae (Gramineae) with 19 species (13 %) and Fabaceae (Leguminosae-subfamilies: Mimosoideae and Papilionoideae) with 13 species, (8.9 %), while Amaranthaceae s.l. (incl. Chenopodiaceae) including nine species (6.1 %); Boraginaceae, Brassicaceae (Cruciferae), Solanaceae, and Euphorbiaceae represented by five species each (3.4 %); whereas 23 families were represented by only one species for each one. At the generic level, 97 genera out of 116 genera were represented by one species; 13 genera represented by two species, five genera by three species, whereas *Amaranthus* represented by five species (Table 1, Figure 1). According to different studies of the flora of the Mediterranean Basin, the endemic plant species diversity in Palestine is lower than in other regions (Ighbareyeh et al. 2021; Ali-Shtayeh et al. 2022), in the present study only the endemic species *Echinops philistaeus* is recorded. Furthermore, five species are believed to be threatened viz.: *Cupressus sempervirens*, *Ficus palmata* (Endangered), *Epherda alata* (Near threatened) while *Amaranthus spinosus* and *Anchusa azurea* were very rare species.

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Table 1. Floristic list, including habitat type, chorotype and biological features of plant species recorded in the study area of northeastern Gaza strip, Palestine, species ordered alphabetically.

Abbreviations: Habitats: **Ba** = Semi-Steppe Batha; **Ca** = Cultivated areas (weeds); **D** = Desert; **Dh** = Disturbed habitats; **Hr** = Hard rock outcrops; **Hh** = Humid habitats; **Mg** = Mediterranean grasslands; **Mm** = Mediterranean shrubs and forest; **Ns** = Nutrient-rich soils; **R** = Ruderal; **Sh** = Salty habitats; **S** = Sand; **Sr** = Shady rocks; **Ss** = Shrub-steppes. Life forms: **Th** = Therophyte; **Ch** = Chamaephyte; **Cl** = Climber; **G** = Geophyte; **H** = Hemicryptophyte; **P** = Parasite; **Ph (S)** = Phanerophyte shrub; **Ph (T)** = Phanerophyte tree. The summer shedding types: **Ep** = ephemeral; **Pe** = perennate. Chorotypes: **A** = American origin; **Au** = Australian origin; **ES** = Euro-Siberian; **M** = Mediterranean; **IT** = Irano-Turanian; **PI** = Pluriregional; **SA** = Saharo-Arabian; **SS** = Saharo-Sindian; **SU** = Sudanian; **T** = Tropical, **SEA** = S East Asia. Leaf types: **Com** = compound; **Dis** = dissected; **En** = entire; **Sc** = scale. Leaf arrangements: **Al** = alternate; **O** = opposite; **Ro** = rosette; **Wh** = whorled. Abundance: **c** = common or very common; **r**: rare; **rr**; very rare. IUCN categories: **EN**=Endangered; **NT**= Near Threatened; **END**= Endemic-**T**=Threatened

S. No.	Botanical Name (Vernacular Name)	Family	Habitat type	Life form	Summer shedding	Chorotype	Spinescence	Leaf type	Leaf arrangement	Abundance
1	<i>Acacia salicina</i> Lindl. (Akasya)	Fabaceae -subfam. Mimosoideae	Dh	Ph (T)	Pe	Au (introd.)	-	En	Al	c
2	<i>Adonis microcarpa</i> DC. (Dam alnueman)	Ranunculaceae	Ba	Th	Ep	M	-	Dis	Al	c
3	<i>Alhagi graecorum</i> Boiss. (Aleaqul)	Fabaceae –subfam Papilionoideae)	Dh-Sh	H	Pe	M-IT	Stem	En	Al	c
4	<i>Allium ampeloprasum</i> L. (Alkurath alnabtii - basal aleifrit)	Amaryllidaceae	D-Ss	G	Ep	M- IT	-	En	Al	c
5	<i>Amaranthus blitoides</i> S. Watson (Qatifa)	Amaranthaceae	Dh-Ca	Th	Ep	A	-	En	Al	c
6	<i>Amaranthus blitum</i> L.	Amaranthaceae	Dh-Ca	Th	Ep	T	-	En	Al	c

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	(Baqilat - qatifa)									
7	<i>Amaranthus retroflexus</i> L. (Qatifa)	Amaranthaceae	Ca	Th	Ep	Pl	-	En	Al	c
8	<i>Amaranthus spinosus</i> L. (Qatifat shayika)	Amaranthaceae	Ca	Th	Ep	A (introd.)	Sp	En	Al	rr
9	<i>Amaranthus viridis</i> L. (Qatifat hayfa)	Amaranthaceae	Ca	Th	Ep	Pl	-	En	Al	c
10	<i>Ammi majus</i> L. (Khilat shaytania)	Apiaceae	Dh	Th	Ep	M	-	Dis	Al	c
11	<i>Anchusa azurea</i> Mill. (Dhanab alqut-lasan althawr)	Boraginaceae	Ba	H	Pe	ES-M- IT	-	En	Al	rr
12	<i>Anchusa undulata</i> L. Hamhum binafsiji-lasan) (althawr	Boraginaceae	Ba	H	Ep	M	-	En	Al-Ro	c
13	<i>Anthemis pseudocotula</i> Boiss. (Aqhwan-walbusum)	Asteraceae	Ba-D- Ss	Th	Ep	M- IT -SA	-	Dis	Al	c
14	<i>Artemisia monosperma</i> Delile (Aleadhir)	Asteraceae	S	Ch	Pe	SA	-	Dis	Al	c
15	<i>Arundo donax</i> L. (Bus-qasab -ghab)	Poaceae	Hh	Ch	Pe	M- IT	-	En	Al	c
16	<i>Avena barbata</i> Pott ex Link (Shwfan)	Poaceae	Ba	Th	Ep	M	-	En	Al	c
17	<i>Avena fatua</i> L. (Shwfan farigh)	Poaceae	D-Ss	Th	Ep	IT -SA	-	En	Al	c
18	<i>Avena sterilis</i> L. (Shwfan eaqim)	Poaceae	Ba	Th	Ep	M- IT	-	En	Al	c
19	<i>Asparagus horridus</i> L. (Hilyun habi -ynbut)	Liliaceae	S-Hr	Ph (S)	Ep	M- Sa	Stem (cladode)	Sc	Al	c
20	<i>Beta vulgaris</i> L. (Suluq bariy)	Amaranthaceae- subfam. Chenopodoideae	Ba-Sh	Th	Ep	ES-M- IT	-	En	Al	c

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21	<i>Bidens pilosa</i> L. (Husikat wabara)	Asteraceae	Dh	Th	Ep	ES-M-SA	Fruits	Dis	O	c
22	<i>Bromus diandrus</i> Roth (Shuayeira - silsilatun-ealifia)	Poaceae	Ba	Th	Ep	M	-	En	Al	c
23	<i>Bromus madritensis</i> L. (Shuayeira)	Poaceae	Ba	Th	Ep	M- IT	-	En	Al	c
24	<i>Bromus rubens</i> L. (Shuayeira)	Poaceae	Ba	Th	Ep	M- IT -SA	-	En	Al	c
25	<i>Buglossoides tenuiflora</i> (L.f.)L. M. Johnst. (Hajar saghir muzhir)	Boraginaceae	Ss	Th	Ep	M- IT	-	En	Al	c
26	<i>Calendula arvensis</i> L. Bikuriat haqliat -'aqhuan) (alhaql	Asteraceae	Ba-D-Ss	Th	Ep	M- IT	-	En	Al	c
27	<i>Carduus argentatus</i> L. (Shuk eantar-shuk fidiy)	Asteraceae	Dh	Th	Ep	M	bracts-1 eaves	En	Al	c-
28	<i>Carduus getulus</i> Pomel (Shawk alhamir)	Astraceae	D-Ss	Th	Ep	SA	bracts-1 eaves	En	Al	c
29	<i>Carthamus tenuis</i> (Boiss. & Blanche) Bomm. (Qaws eadi)	Asteraceae	Ba	Th	Ep	M	bracts-1 eaves	Dis	Al	c
30	<i>Catapodium rigidum</i> (L.) C.E.Hubb. (Katabudywm khushin)	Poaceae	Ba	Th	Ep	M	-	En	Al	c
31	<i>Centaurea iberica</i> Spreng (Qantariuwn -mirar)	Asteraceae	Dh	Th	Ep	M- IT	Bracts	Dis	Al	-c
32	<i>Chenopodium murale</i> (L.) S. Fuentes, Uotila & Borsch (Fisyua -eafina -darbih)	Amaranthaceae Subfam. Chenopodoideae	Dh-Ns-R	Th	Ep	Pl	-	En	Al	c
33	<i>Chenopodium album</i> L. (Sarmaq)	Amaranthaceae Subfam. Chenopodoideae	Dh	Th	Ep	Pl	-	En	Al	c

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34	<i>Chenopodium murale</i> L. (Eafinat -aghbiria)	Amaranthaceae Subfam. Chenopodoideae	Dh-Ns- R	Th	Ep	Pl	-	En	Al	c
35	<i>Chrozophora tinctoria</i> (L.) Raf. (Tanawm sibghi -ghbira)	Euphorbiaceae	Dh	Th	Ep	M- IT	-	En	Al	c
36	<i>Convolvulus arvensis</i> L. (Madidat -libilab alhuqul)	Convolvulaceae	Ns-R	Th	Ep	Pl	-	En	Al	c
37	<i>Cupressus sempervirens</i> L. (Sarw)	Cupressaceae	Hr	Ph (T)	Pe	M	-	Sc	Al	rr (EN)
38	<i>Cynodon dactylon</i> (L.) Pers. (Thil-njil baladi)	Poaceae	Ba-D- Ss	G-H	Ep	Pl	-	En	Al	c
39	<i>Cyperus macrorrhizus</i> Nees (Alsaed)	Cyperaceae	S	H	Pe	SA	-	En	Al	c
40	<i>Cyperus rotundus</i> L. (Saed mustadir)	Cyperaceae	Dh	G	Ep	T	-	En	Al	c
41	<i>Datura innoxia</i> Mill. (Datura -boqim)	Solanaceae	Ca	Ph (S)	Ep	Pl	-	En	Al	c
42	<i>Daucus aureus</i> Desf. (Jazur)	Apiaceae	Ba	Th	Ep	M	Fruits	Dis	Al-Ro	c
43	<i>Diplotaxis erucoides</i> (L.) DC. (Khafaj jirjiri-sfira)	Brassicaceae	Ba	Th	Ep	M	-	En	Al	c
44	<i>Dittrichia viscosa</i> (L.) Greuter (Tbuq-dbiqa -earq altiyun)	Asteraceae	Dh-Hh	Ch	Pe	M	-	En	Al	c
45	<i>Dodonaea viscosa</i> L. (Shathu dabiq)	Sapindaceae	Dh-Ss	Ph (S)	Pe	SS	-	En	Al	c
46	<i>Drimys aphylla</i> (Forssk.) J. C. Manning & Goldblatt (Basul-bsal bari-einsil bahri)	Asparagaceae	Ba	G	Ep	M	-	En	Ro	c
47	<i>Ecballium elaterium</i> (L.) A. Rich (Qitha' alhimari-fqus alhimar)	Cucurbitaceae	Dh	H	Pe	M- IT	-	En	Al	c

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48	<i>Echinops philistaeus</i> Feinbrun & Zohary (Khashir filastiniune)	Asteraceae	S	Ch	Pe	M	bracts- leaves	Dis	Al	rr END
49	<i>Echium angustifolium</i> Mill. (Zahret al'afeaa)	Boraginaceae	Ba	Ch	Pe	M	-	En	Al	c
50	<i>Ephedra alata</i> Decne. (Ealandi-elanda)	Ephedraceae	S	Ch	Pe	SA	-	Sc	O	rr (NT)
51	<i>Erigeron bonariensis</i> L. <i>Conyza bonariensis</i> (L.) Cronquist = (Shaykh alrabie)	Asteraceae	Dh-Ca	Th	Ep	A (introd.)	-	En	Al	c
52	<i>Erigeron canadensis</i> L. <i>Conyza canadensis</i> (L.) Cronquist = (Shaykh alrabie)	Asteraceae	Dh-Ca	Th	Ep	A (introd.)	-	En	Al	c
53	<i>Erodium cicutarium</i> (L.) LHer. (Raqma shukraniatu-saeat)	Geraniaceae	Ba	Th	Ep	M- IT -ES	-	Dis	Al	c
54	<i>Erodium malacoides</i> (L.) LHer. (Raqma)	Geraniaceae	Ba	Th	Ep	M	-	En	Al	c
55	<i>Eucalyptus camaldulensis</i> Dehn. (Alkinya-kafur)	Myrtaceae	Dh-Hh	Ph (T)	Pe	Au (introd.)	-	En	Al	c
56	<i>Euphorbia maculata</i> L. (Farabiyuon mulatak)	Euphorbiaceae	Ca	Th	Ep	A (Alien)	-	En	O	c
57	<i>Euphorbia pepus</i> L. (Farbiun-hilbita-firfah)	Euphorbiaceae	Ba	Th	Ep	M- IT -ES	-	En	Al	c
58	<i>Euphorbia terracina</i> L. (Farabiyuwn 'ardi-alhalbub al'ardii)	Euphorbiaceae	S	H	Pe	M	-	En	Al	c
59	<i>Fenula communis</i> L. (Kilakh- haltit-zalue)	Apiaceae	Ba	H	Ep	M	-	Dis	Al-Ro	c
60	<i>Ficus carica</i> L. (Tein bariy)	Moraceae	Hh	Ph (T)	Pe	M- IT	-	Dis	Al	c

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61	<i>Ficus palmata</i> Forssk. (Tein)	Moraceae	Hr	Ph (T)	Pe	SU	-	En- Dis	Al	rr (EN)
62	<i>Ficus sycomorus</i> L. (Jomyez)	Moraceae	Dh	Ph (T)	Pe	T	-	En	Al	c
63	<i>Fumaria capreolata</i> L. (Ryz aldajaj almutasaliq)	Papaveraceae	Ba	Th-Cl	Ep	M-ES	-	Dis	Al	c
64	<i>Glebionis coronaria</i> (L.) Cass. ex Spach (Bisum-aqahwan)	Asteraceae	Ns-R	Th	Ep	M	Fruits	Dis	Al	c
65	<i>Hedypnois rhagadioloides</i> (L.) F.W.Schmidt (Ruysat aljabal)	Asteraceae	Ba	Th	Ep	M	-	En	Al	c
66	<i>Heterotheca subaxillaris</i> (Lam.) Britton & Rusby (Hirufika)	Asteraceae	Dh-S	H	Ep	A (Alien)	-	En	Al	c
67	<i>Hordeum murinum</i> <i>subsp. glaucum</i> (Steud.) Tzvelev (Shaer alhayti-shaer aldubu)	Poaceae	Ba- Ns-R	Th	Ep	M- IT	-	En	Al	c
68	<i>Hordeum marinum</i> Huds. (Shaer alhayit)	Poaceae	Hh	Th	Ep	M- IT	-	En	Al	c
69	<i>Hormuzakia aggregata</i> (Lehm.) Gusul (Lisanalnaeja)	Boraginaceae	S	Th	Ep	M	-	En	Al	c
70	<i>Hypericum triquetrifolium</i> Tuna (Qurnah-aren muthalath)	Hypericaceae	Ba	H	Ep	M- IT	-	En	O	c
71	<i>Imperata cylindrica</i> (L.) Rausch. (Hilfa-hleim-sala)	Poaceae	Hh	H	Pe	M-IT -SA	-	En	Al-Ro	c
72	<i>Ipomoea cairica</i> (L.) Sweet (Sete alhuson-shahab alnahar)	Convolvulaceae	Dh	H-Cl	Pe	T	-	Com	Al	r (T)
73	<i>Lactuca serriola</i> L. (Khus minshari-khs zayt)	Asteraceae	Dh-Ns- R	Th	Ep	Es- M- IT	-	Dis	Al	c

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74	<i>Lamium amplexicaule</i> L. (Fam alsamak-at-lamiuwn multafi alsaag)	Lamiaceae	Ba-Dh- Ns-R	Th	Ep	Es- M- IT	-	En	O	c
75	<i>Lantana camara</i> L. (Khashaf-wrdet aldhyyb)	Verbenaceae	Ca	Ph (S)	Pe	T (exotic)	Stem	En	O	c
76	<i>Lathyrus annuus</i> L. (Jalban hawli)	Fabaceae subfam. Papilionoideae	Ba	Th	Ep	M-Es	-	Com	Al	c
77	<i>Lavatera cretica</i> L. (Alkhabiza)	Malvaceae	Ns-R	Th	Ep	M	-	En	Al	c
78	<i>Vicia lens</i> (L.) Coss. & Germ. (Eads)	Fabaceae subfam. Papilionoideae	Dh	Th -Cl	Ep	M	-	Com	Al	r (T)
79	<i>Lolium perenne</i> L. (Zewan mueamar)	Poaceae	Ba	H	Ep	ES- M- IT	-	En	Al	c
80	<i>Lysimachia arvensis</i> L. (Euyan aljumla-srmij- alzarqa')	Primulaceae	Ba	Th	Ep	ES- M- IT	-	En	O	c
81	<i>Malva parviflora</i> L. (Khobiza)	Malvaceae	Ns-R	Th	Ep	M- IT	-	En	Al	c
82	<i>Marrubium vulgare</i> L. (Farasiuwn - hashishat- alkilab alsamua)	Lamiaceae	Ns-R	Ch	Pe	M- IT	-	Dis	Al	c
83	<i>Medicago polymorpha</i> L. (Fisa shayika -qurta)	Fabaceae subfam. Papilionoideae	Ba	Th	Ep	Es- M- IT	-	Com	Al	c
84	<i>Melia azedarach</i> L. (Tizdirikht zanzilikht)	Meliaceae	Dh	Ph (T)	Pe	SEA (introduced)	-	Com	Al	c
85	<i>Melilotus indicus</i> (L.) All. (Handuq hindiun)	Fabaceae subfam. Papilionoideae	Ba	Th	Ep	M	-	Com	Al	c
86	<i>Mercurialis annua</i> L. (Halbub)	Euphorbiaceae	Ba	Th	Ep	M-ES	-	En	O	c
87	<i>Monus alba</i> L. (Altuwat)	Moraceae	Dh	Ph (T)	Pe	IT	-	En	Al	c
88	<i>Nerium oleander</i> L. (Aldaflaa)	Apocynaceae	Hh	Ph (S)	Pe	M	-	En	Al-Wh	c

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89	<i>Nicotiana glauca</i> Graham (Dukhan shajari)	Solanaceae	Dh	Ph (T)	Pe	Pl	-	En	Al	c
90	<i>Notobasis syriaca</i> (L.) Cass. (Kharfish nabaz-ekub)	Asteraceae	Ba-Dh	Th	Ep	M	Bracts Leaves	En	Al	c
91	<i>Olea europaea</i> L (Zaytun)	Oleaceae	Mm	Ph (T)	Pe	M	-	En	O	c
92	<i>Ononis spinosa</i> L. (Yanbut-shabraq shayek)	Fabaceae subfam. Papilionoideae	Ba	H	Pe	M- IT	Stem	Com	Al	c
93	<i>Ornithogalum narbonense</i> L. (Sasil narbuni)	Asparagaceae	Ba-Ss	G	Ep	M- IT	-	En	Ro	c
94	<i>Orobancha mutelii</i> F.W.Schultz (Alhalok)	Orobanchaceae	S	P	Ep	M- IT	-	Sc	Al	c
95	<i>Oxalis pes-caprae</i> L. (Hamasis -hamidat -aqisilis)	Oxalidaceae	Dh	G	Ep	Pl	-	Com	Al	c
96	<i>Papaver humile</i> Fedde (Hanun)	Papaveraceae	D-Ss	Th	Ep	SA	-	Dis	Al	c
97	<i>Parietaria judaica</i> L. (Hashisha zujaj-jedaria)	Urticaceae	Sr	H	Pe	M- IT	-	En	Al	c
98	<i>Paronychia argentea</i> Lam. (Rajul alhamamat -dhasiat fidiya)	Caryophyllaceae	Ba	H	Pe	M	-	En	O	c
99	<i>Phalaris minor</i> Retz. (Khirfar saghir)	Poaceae	D-Ss	Th	Ep	M- IT	-	En	Al	c
100	<i>Phoenix dactylifera</i> L. (Nakhil albalah)	Arecacea (Palmae)	Hh	Ph (T)	Pe	SA	Leaves	En	Al	c
101	<i>Phragmites australis</i> (Cav.) Trin. ex Steud. (Qasabatu-qasib)	Poaceae	Sh	H	Pe	Pl	-	En	Al	c
102	<i>Picnomon acarna</i> (L.) Cass. (Shawk alfar)	Asteraceae	Dh	Th	Ep	M- IT	Bracts Leaves	En	Al	c
103	<i>Plantago lagopus</i> L. (Lisan alhaml)	Plantaginaceae	Ba	Th	Ep	M	-	En	Ro	c

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104	<i>Polygonum arenastrum</i> Boreau (Qardab miliy kadhīb)	Polygonaceae	Dh	Th	Ep	Pl	-	En	Al	c
105	<i>Polygonum aviculare</i> L. (Qadab-bitibat altuyur)	Polygonaceae	Dh	Th	Ep	ES-M- IT	-	En	Al	c
106	<i>Polypogon monspeliensis</i> (L.) Desf. (Dhayl alqut-shaer alfar)	Poaceae	Hh	Th	Ep	M-IT - SA	-	En	Al	c
107	<i>Portulaca oleracea</i> L. (Rejla-baqala)	Portulacaceae	Ca	Th	Ep	Pl	-	En	Al-O	c
108	<i>Prosopis farcta</i> (Banks & Sol) J.F. Macbr. (Vanbut-ghaf-jamibat)	Fabaceae subfam. Papilionoideae	Ba	Ph (S)	Pe	IT	Stem	Com	Al	c
109	<i>Raphanus raphanistrum</i> L. (Fajal bariy)	Brassicaceae	Ba	Th	Ep	ES-M	-	Dis	Al	c
110	<i>Retama raetam</i> (Forssk.) Webb (Alrutum)	Poaceae	S	Ph (S)	Pe	Sa	-	En	Al	c
111	<i>Ricinus communis</i> L. (Khurue)	Euphorbiaceae	Dh	Ph (S)	Pe	T	-	Dis	Al	c
112	<i>Rumex dentatus</i> L. (Humed)	Polygonaceae	Dh	Th	Ep	Pl	-	En	Al	c
113	<i>Rumex spinosus</i> L. (Humed shayik)	Polygonaceae	S-D-Ss	Th	Ep	M	Fruits	En	Al	c
114	<i>Scolymus maculatus</i> L. (Skulims mubaqae)	Asteraceae	Mg	Th	Ep	M	Bracts Leaves	Dis	Al	c
115	<i>Scorpiurus muricatus</i> L. (Dhanb aleaqrab alshaayik)	Fabaceae subfam. Papilionoideae	Ba	Th	Ep	M	-	En	Al	c
116	<i>Silene gallica</i> L. (Silina firansia)	Caryophyllaceae	S	Th	Ep	M-ES	-	En	O	c
117	<i>Silybum marianum</i> (L.) Gaertn. (Kharfish aljamali-shuk alghazal)	Asteraceae	Ns-R	Th	Ep	M- IT	Bracts Leaves	En	Al-Ro	c
118	<i>Sinapis alba</i> L.	Brassicaceae	Ns-R	Th	Ep	ES- M- IT	-	Dis	Al	c

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	(Khardal 'abyad -rashad albahr)									
119	<i>Sinapis arvensis</i> L. (Fajilat-shalwa)	Brassicaceae	Ba	Th	Ep	M	-	Dis	Al	c
120	<i>Sisymbrium irio</i> L. (Huayra-salih)	Brassicaceae	Ns-R	Th	Ep	M- IT	-	Dis	Al	c
121	<i>Solanum elaeagnifolium</i> Cav. (Sajwat zaytiati-badhinjan bariy)	Solanaceae	Ca	Th	Pe	A (Alien)	Stem Leaves	En	Al	c
122	<i>Solanum nigrum</i> L. (Almaghadu al'asuadu-waenab althaelab)	Solanaceae	Dh-Ca	H	Ep	ES-M- IT	-	En	Al	c
123	<i>Sonchus asper</i> (L.) Hill. (Khada alearus-tifaf jasi)	Asteraceae	Hh	Th	Ep	M	Leaves	En	Al	c
124	<i>Sorghum halepense</i> (L.) Pers. (Suraghm halabi)	Asteraceae	Dh-Ca	Ch	Ep	T	-	En	Al	c
125	<i>Stipa capensis</i> Thunb. (Samea-robid)	Poaceae	D-Ss	Th	Ep	SA - IT	-	En	Al	c
126	<i>Tagetes minuta</i> L. (Mukhmalia)	Asteraceae	Dh-Ca	Th	Ep	A (Alien)	-	Dis	Al-O	c
127	<i>Tamarix nilotica</i> (Ehrenb.) Bunge (Alethil)	Tamaricaceae	D-Sh	Ph (T)	Pe	SA	-	Sc	Al	c
128	<i>Torilis nodosa</i> (L.) Gaertn. (Qumla eaqdia-jzar shaytani)	Apiaceae	Ba	Th	Ep	ES-M-IT	Fruits	Dis	Al	c
129	<i>Thymelaea hirsuta</i> (L.) Endl. (Almitnan)	Thymelaeaceae	Ba	Ph (S)	Pe	M-SA	-	En	Al	c
130	<i>Tragopogon bupthalmoides</i> (DC.) Boiss. (Lihyat altays)	Poaceae	Ba	H	Ep	IT	-	En	Al	c
131	<i>Tragopogon coelesyriacus</i> Boiss. (Dhanb alfurs -lhiat altays)	Poaceae	Ba	H	Ep	M- IT	-	En	Al	c
132	<i>Trifolium campestre</i> Schreb.	Fabaceae subfam.	Ba	Th	Ep	M	-	En	Al	c

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	(Alnufl-alnaflalnaayim)	Papilionoideae								
133	<i>Trifolium purpureum</i> Loisel. (Nafl'urjuani)	Fabaceae subfam. Papilionoideae	Ba	Th	Ep	M	-	Com	Al	c
134	<i>Urospermum picroides</i> (L.) F.W.Schmidt (Aleaidid almariri-qadid)	Asteraceae	Ba	Th	Ep	M- IT	Stem Bracts	En	Al	c
135	<i>Urtica membranacea</i> Poir. ex Savigny (Quris)	Urticaceae	Ns-R	Th	Ep	M	Stem	En	O	c
136	<i>Urtica pilulifera</i> L. (Qurays nijaj)	Urticaceae	Ns-R	Th	Ep	M-ES- IT	Stem	En	O	c
137	<i>Urtica urens</i> L. (Qures adi)	Urticaceae	Ns-R	Th	Ep	M-ES	Stem	En	O	c
138	<i>Vachellia farnesiana</i> (L.) Willd. (Ghilan-tlah 'anbari)	Fabaceae subfam. Mimosoideae	Dh- Ca	Ph (T)	Pe	A (Alien)	Stipules	Dis	Al	c
139	<i>Verbascum sinaiticum</i> Benth. (Qantariuwn malty)	Scrophulariaceae	Ss-D	H	Pe	M- IT-SA	-	En	Al	c
140	<i>Verbascum sinuatum</i> L. (Aleurur -albusir alqatim)	Scrophulariaceae	Ba	H	Pe	M- IT	-	En	Al	c
141	<i>Verbesina encelioides</i> (Cav.) A.Gray (Birbisia safra')	Asteraceae	Dh	Th	Ep	A (Alien)	-	En	Al-O	c
142	<i>Vicia sativa</i> L. (Jilbana-beqa)	Fabaceae subfam. Papilionoideae	Ba-Ss	Th -Cl	Ep	M	-	Com	Al	c
143	<i>Withania somnifera</i> (L.) Dunal (Eabeab muna wim)	Solanaceae	Ns-R	Ch	Pe	M-IT	-	En	Al	c
144	<i>Xanthium spinosum</i> L. (Loziq shuki-shobit)	Asteraceae	Dh- Ca	Th	Ep	Pl	involucr e-leaf base	En	Al	c
145	<i>Xanthium strumarium</i> L. (Liziq silei-shbiet silei)	Asteraceae	Dh- Ca	Th	Ep	Pl	involucr e	En	Al	c
146	<i>Ziziphus spina-christi</i> (L.) Desf. (Sedra)	Rhamnaceae	Ss-D- Hh-Mg	Ph (T)	Pe	SU	stipules	En	Al	c

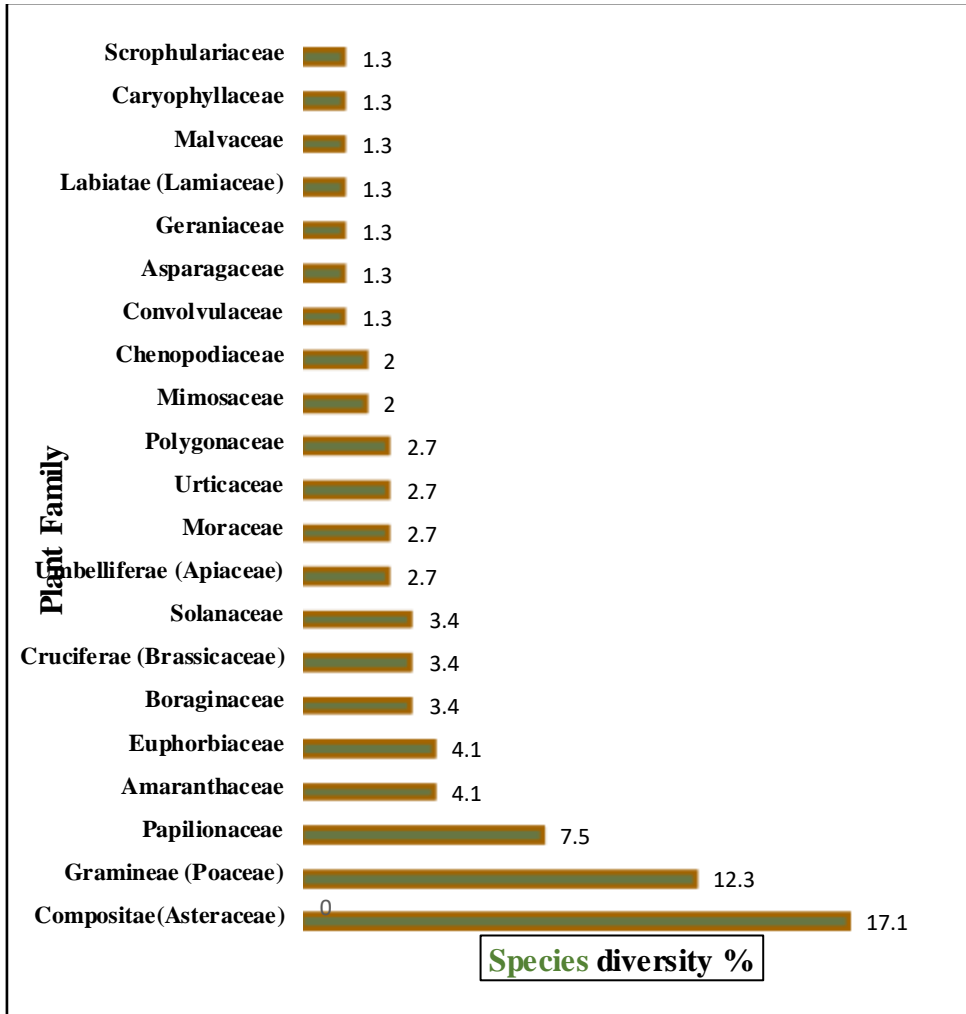


Fig.1. Number of species distribution in plant families of the study area

Discussion

The present study presented an overview of floristic diversity and ecological characteristics in the northeastern Gaza Strip (GS), Palestine, with special emphasis on floral species, habitats, life forms, and chorology of plant species. The current investigation was the first research related to plant biodiversity in this area. This study showed the vascular plant diversity, where 146 species were found distributed in 116 genera and 44 families. Most families identified were Asteraceae (Compositae), Poaceae (Gramineae), Fabaceae (Leguminosae), Boraginaceae, Brassicaceae (Cruciferae), and Solanaceae. This result is in accordance with that of (Ali-Shtayeh & Jamus, 2018; Ali-Shtayeh et al. 2022).

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Based on the results obtained, it was clear that GS is characterized by the abundance of vascular plants among the common species recorded were: *Adonis microcarpa*, *Alhagi graecorum*, *Allium ampeloprasum*, *Amaranthus blitoides* ...etc. This may be a result of the geographical location, abundance of water, and medium-moderate climate (Ali-Shtayeh et al. 2022). This indicated that they may be rare vascular plant species, and this was pointed out by Ssegawa & Nkuutu (2006). The analysis of floristic checklist of northeastern GS revealed that there are numerous recorded species of special importance, and many have medicinal uses such as *Paronychia argentea*, *Silybum marianum*, *Chrozophora tinctoria*, *Ricinus communis*, *Solanum nigrum*, *Amaranthus spinosus*, *A. viridis*, *Asparagus horridus*, *Ficus carica*, *F. sycomorus*, *Urtica pilulifera*, *U. urens*, *Nerium oleander*, *Cupressus sempervirens*, *Cyperus rotundus*, *Cynodon dactylon*, *Malva parviflora*, *Eucalyptus camaldulensis*, *Olea europea*, *Phoenix dactylifera*, *Alhagi graecorum*, *Portulaca oleracea*, *Tamarix nilotica*, *Thymelaea hirsuta* and *Lantana camara* which is consistent with the study conducted by Abou Auda (2011), Abd Rabou et al. (2008); Ali-Shtayeh et al. (2014)

According to the analysis of preferable habitats, results showed that the most common habitats are semi-steppes, (Batha) represent 34.9% of the total area, followed by disturbed habitats (22.7%), cultivated areas (12.3%) and nutrient-rich soils (11.6%). Conversely, the least common habitats of recorded species were shady rocks (0.6%), walls (0.6%), Mediterranean grasslands (1.3%), hard rock outcrops (2%), and salty habitats (2.7%) (Table 1; Figure 2). This variation in the distribution of vascular plant species in different habitats may be due to several factors including climate, topography, and geology (Wubu et al. 2023).

Life form is the main feature of plant species, the results obtained based on Raunkiaer's classification and analysis of all plant species in our study showed that therophyte (annuals) were represented by 87 species (59.5%), followed by hemicryptophytes (perennials) with 22 species (15%). The phanerophytes (trees & shrubs) were represented by 23 species (15.7 %) and dominated by: *Acacia salicina*, *Asparagus horridus*, *Datura innoxia*, *Dodonaea viscosa*, *Eucalyptus camaldulensis*, *Ficus carica*, *F. sycomorus*, *Lantana camara*, *Melia azedarach*, *Morus alba*, *Nerium oleander*, *Nicotiana glauca*, *Olea europaea*, *Phoenix dactylifera*, *Prosopis farcta*, *Ricinus communis*, *Retama raetam*, *Tamarix nilotica*, *Thymelaea hirsuta* *Vachellia farnesiana* and *Ziziphus spina-christi*. The geophytes represented by 10 species (6.8%) and dominated by: *Allium ampeloprasum*, *Drimia aphylla*, *Ornithogalum narbonense*, *Oxalis pes-caprae*, *Cynodon dactylon*. The chamaephytes (dwarf shrub) with 9 species (6.1%) and dominated by: *Artemisia monosperma*, *Arundo donax*, *Dittrichia viscosa*, *Echium angustifolium*, *Marrubium vulgare*, *Sorghum halepense*, and *Withania somnifera*. The climbers represented by 5 species (3.4%) and dominated by *Fumaria capreolata* and *Vicia sativa*, while parasites represented by *Orobanche mutelii* (0.7 %). These categories recorded (5-14) species represented life form and they came in the second rank in prevalence in GS. Only the parasite category which represented life form

recorded one species. Therophyte, geophytes, and hemicryptophytes are non-woody plants that represent (81.3%) of the flora of GS, while chamaephytes, phanerophyte shrubs, and trees are woody plants which are represented by 21.8% (Table 1; Figure 3). The ratio of herbaceous to woody plant species was 4:1, in addition to 31 spiny species were recorded (21%). These results were consistent with the study conducted by Badshah et al. (2013).

According to the leaf type, the entire leaves were noticed in 104 species (71.2%), while the dissected were observed in 27 species (18.4), compound leaves in 11 species (7.5%), while in the remaining 5 species (3.4%), leaves was scale leaves (outlined in Table 1). The most dominant leaf arrangement was alternate in 127 species (87%), followed by opposite in 17 species (11%), rosette in 8 species (5.4%), while the least common leaf arrangement was whorled recorded in one species (Table 1).

The results showed that therophytes (annual plants) represented the dominant life forms representing 59.5% of the studied species (87 species). This may be attributed to the seasonal character of the water supply that supports the annual plants similar finds were reported by Naqinezhad et al. (2009). These findings are consistent with many previous studies (Badshah et al. 2013; Kherissat & Al-Esawi 2019; Zaman & Badshah 2021; Haq & Badshah 2021).

Annually, rainfall intensity influences the floristic structure, even if it is less than five millimeters, this impacts the plant species diversity (Westbrooke et al. 2005). Thus the low percentage of chamaephytes (6.1%) , phanerophyte shrubs, and trees (15.7%) indicated by the results may be due to shortage in rainfall, it typically receives about 45.22 millimeters (1.78 inches) of precipitation and has 60.62 rainy days (16.61% of the time) annually. (<https://weatherandclimate.com/palestine/gaza>). This low percentages are consistent with previous studies (Alsherif et al. 2013; Kherissat & Al-Esawi 2019). According to Di Biase et al. (2021), phanerophytes grow and spread in forests; the low prevalence of phanerophytes in our area may be due to the absence of suitable conditions

Phytogeographical analysis is important for classifying species into groups with similar distributions (Fattorini 2017; Di Biase et al. 2021). Chorotype is the distribution type of plant species that represents the prevailing climatic conditions (Azizi & Keshavarzi 2014). The chorotype analysis of the plant species recorded in this work are shown in Table (1). The results of the phytogeographical analysis showed that the dominant plants were Mediterranean and Irano-Turanian (47.3%), followed by Mediterranean (26%), Sudanian (1.4%) and Saharo-Sindian (0.7%) which represent the lowest detected chorotype in GS according to (Figure 4). Alien and invasive species (of American or Australian origin) were represented by 8 species, the most common are: *Acacia salicina*, *Amaranthus blitoides*, *Erigeron bonariensis*, *Erigeron bonariensis*, *E.canadensis*, *Eucalyptus camaldulensis*,

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Euphorbia maculata, *Heterotheca subaxillaris*, *Tagetes minuta*, *Vachellia farnesiana*, and *Verbesina encelioides*. Also, the results showed the plant species were either mono-regional (59.9%), bi-regional (26.2%), or pluri-regional (13.8%) (Table 1; Figure 4). These results were congruent with that reported by Danin (1983, 1992, 1993, 2204); Danin and Plitmann, (1987); Taifour and Oqlan (2016) and Oran (2014) in Sinai, Jordan, Palestine and Pakistan areas.

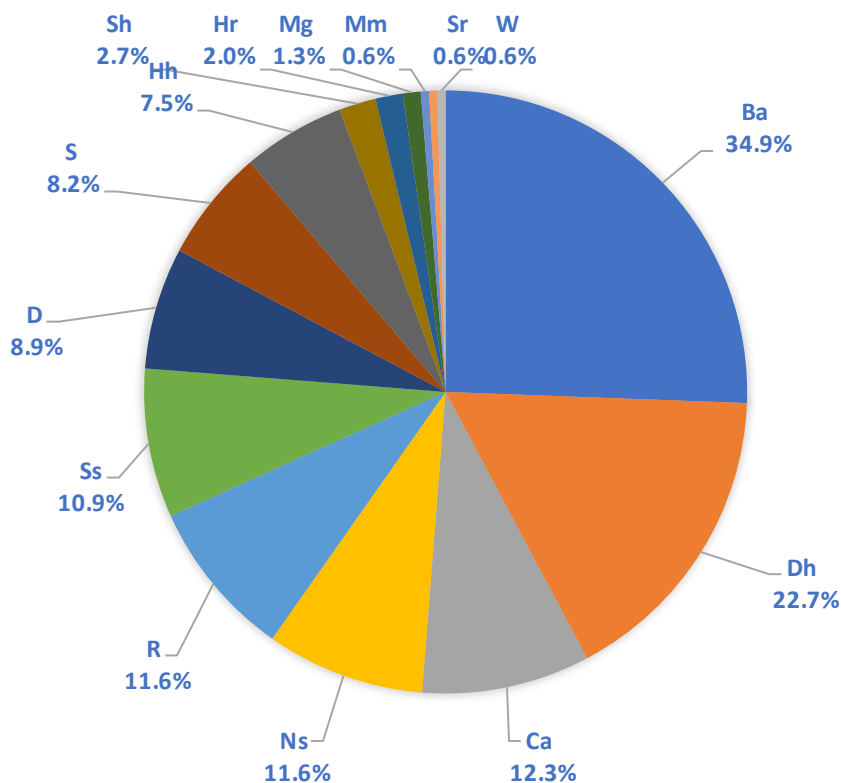


Fig. 1. Habitat preferences of plant species recorded in the study area.

Abbreviations: **Ba** = Semi-steppes Batha; **Ca** = Cultivated areas (weeds); **D** = Desert; **Dh** = Disturbed habitats; **Hr** = Hard rock outcrops; **Hh** = Humid habitats; **Mg** = Mediterranean grasslands, **Sh** = Salty, **Mm** = Mediterranean maquis and forest, **Sr** = Shady rocks, **W** = Walls, **Ns** = Nutrient-rich soils, **R** = Ruderal, **Ss** = Shrub-steppes, **S** = Sand.

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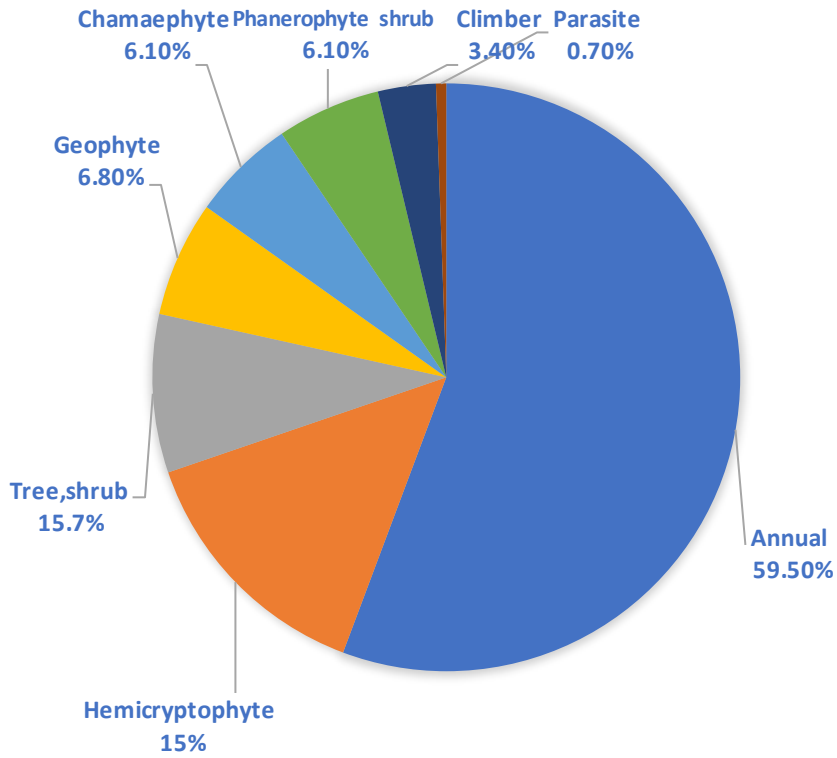


Fig. 2. Distribution of life forms of plant species recorded in study area

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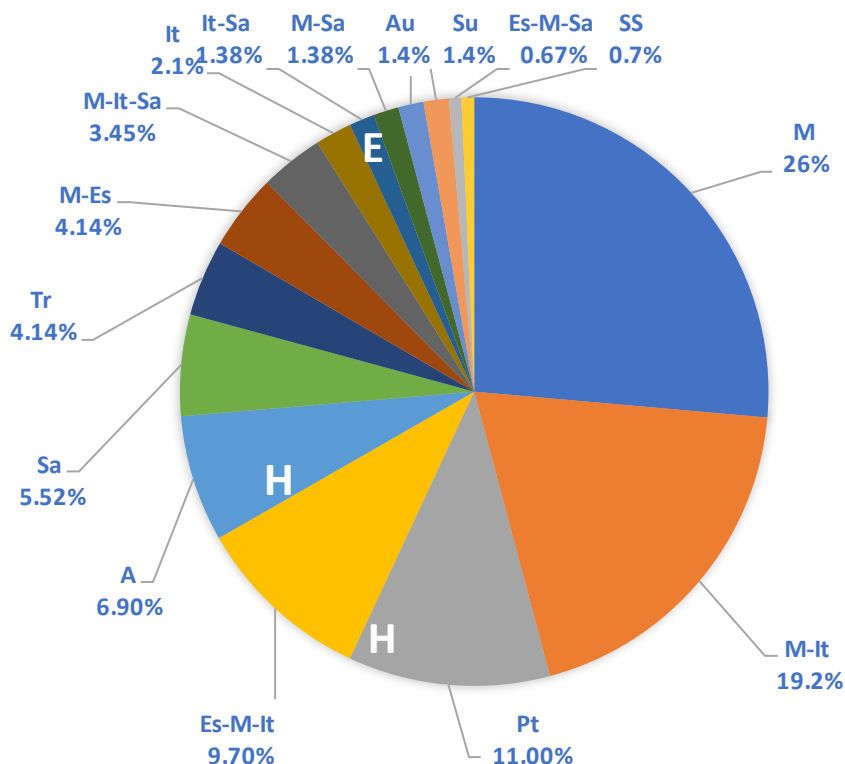


Fig. 3. Chorotypes of plant species recorded in the study area.

Abbreviations: **A**= American origin; **Au** = Australian origin; **Es** = Euro-Siberian; **M** = Mediterranean; **It** = Irano-Turanian; **Pt** = Pluri-reginal-bor-trop; **Sa** = Saharo-Arabian; **Ss** =Saharo-Sindian; **Su** = Sudanian; **Tr** = Tropical.

Conclusion

According to the results, the study area in the northern Gaza Strip (GS) had floral diversity and many flower species belonging to vascular plants. This may be due to the availability of ecological factors suitable for its presence. Although there was an abundance of diversity in flowering vascular plants, however, some of these species are threatened with extinction and decrease. As well as there were differences in the distribution patterns of plant species. This research provides background information on floristic composition and ecological characteristics, which can be an important source and reference for biodiversity conservation. Further studies are recommended to explore other previously unidentified plant species and to promote effective systems to conserve floristic diversity, especially endangered species.

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