

Imperiled Ecosystems in Palestine: Rare Plants as Indicators

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Abstract

Palestinian areas face the same stresses on floral biodiversity as other areas (desertification, climate change, urbanization, rapid population growth, industrial development, etc.) but face additional threats such as local Israeli colonial activities (building infrastructure, colonial settlements, population displacement). Much work remains to be done on mapping the current status of plants in the area and delineating clearly those plants most endangered by these threats. This preliminary meta-analysis identified 600 species that are of concern in the Israeli occupied West Bank of which 187 are endangered, 171 very rare species, 238 rare (R, found in 11–30 sites), and four already extinct in this area. Plants thus provide the loudest alarm bell for a deteriorating environment in need of protection. We argue that protection is feasible: (1) in situ in the declared protected areas which are just beginning to be studied and managed properly, (2) in situ in special areas of rich biodiversity that would be informally protected, (3) ex situ in botanic gardens such as that at the Palestine Institute for Biodiversity and Sustainability.

Introduction

The Global Strategy for Plant Conservation (GSPC) was developed during COP-6 meeting of the Convention on Biological Diversity (CBD) and identified 16 targets for endangered and rare plant conservation in 2002 and updated in 2010. However, the progress in this area has been uneven and most countries have yet to design strategies related to GSPC targets (Sharrock, 2020). Part of the difficulty in plant conservation is not having well-structured or established mechanisms and guidelines that help countries conserve endangered plant species and ecosystems even within protected areas (Heywood, 2018). There is indeed a need for evidence-based and structured conservation efforts for threatened taxa (Sutherland et al., 2004). The situation is even more difficult in developing countries which lack resources, whether financial or human capacity, to protect their endangered flora and fauna (Adenle et al., 2015). Yet for some developing countries like Palestine the challenges are compounded by protracted Israeli occupation/colonization (Qumsiyeh et al., 2017).

Palestine is part of the Fertile Crescent where humans first developed agriculture. Its rich flora and fauna is partly due to geography (bottleneck area between Africa and Eurasia) and partly related to geology (Great Rift Valley creating various elevations and climatic areas). The Palestinian flora is rich with over 2600 species and some 10% of those are listed in various red lists (Post, 1933; Zohary, 1966, 1972; Feinbrun-Dothan, 1978; Danin, 1992, 2004; Fragman et al., 1999; Taifour et al., 2017; Pahl and Qumsiyeh, 2021). Far fewer studies dealt with rare species in Palestine (Dafni and Agami, 1976; Sapir et al., 2003; Shmida et al., 2002; Shmida and Pollak, 2007; Ali-Shtayeh and Jamous, 2018). This article attempts to review what is known on threatened taxa with the aim of proposing protection measures in and out of designated protected areas in the occupied Palestinian Territories.

Rare plants

Historic Palestine underwent political changes in the past 100 years including the creation of the state of Israel on 78% of the country in 1948–49 then the occupation of the remaining 22% (the West Bank and Gaza Strip AKA occupied Palestinian Territories) beginning in 1967. In this limited review we focus on the West Bank (Gaza needs much more research). According to the last checklist of Flora that was published by Al-Sheikh (2019), the West Bank has 1612 plant species belong to 117 families and there is a paucity of data even here. In fact, we are now publishing papers related to the rare plants in the West Bank to add to this list (see Pahl and Qumsiyeh, 2021; Al-Sheikh and Qumsiyeh, 2021).

There is even a deficiency of plants listed in the IUCN red list regarding Palestine: 186 species of which 172 are Least Concern and 11 are included as of concern and 3 insufficient data (BirdLife International, IUCN and UNEP World Conservation Monitoring Centre, 2019). There are also species listed at <https://redlist.parks.org.il/list/species/endangered> based on Fragman et al. (1999), Sapir et al. (2003), and Shmida and Pollak (2007). The decisions made by these authors was based on dividing the country (historic Palestine, now Israel and the occupied Palestinian territories) into 1 × 1 km squares for determining the rare species and they included thus a total of 370 species on the Israeli “Red List.” Corresponding data on the Palestinian areas are sparse and fraught with contradictions.

Ali-Shtayeh and Jamous published a paper reviewing the rare plants of the occupied Palestinian areas (2018). They used criteria of creating “red numbers” found in Sapir et al. (2003) with slight modifications. It was not clear from this paper what actual data were collected for the West Bank and we found many errors in that paper. The 102 species listed by Ali-Shtayeh and Jamous (2018) as rare/threatened (either endangered, critically endangered or vulnerable) included 18 species that are actually not found in the West Bank and Gaza (occupied territories) (see Al-Sheikh, 2019). These are: *Asphodelus viscidulus*, *Astragalus fruticosus*, *Consolida orientalis*, *Crucianella maritima*, *Cutandia maritima*, *Cyperus corymbosus*, *Descurainia sophia*, *Enneapogon desvauxii*, *Heteranthemis viscidhirta*, *Lepidium latifolium*, *Maerua crassifolia*, *Medicago murex*, *Myrtus communis*, *Orchis punctulata*, *Polygonum maritimum*, *Reseda globulosa*, *Salvia sclarea*, and *Silene papillosa*. Three others listed as rare/endangered are also not even found in historic Palestine (*Tetraena alba*, *Tripodion vulneraria*, *Mickaunia campanuloides*). One species listed as critically endangered by Ali-Shtayeh and Jamous (2018) is quite common in the West Bank (*Euphorbia peplus*). Some species listed were listed with old names (e.g., “*Prunus arabica*” which should be *Amygdalus arabica* and “*Consolida orientalis*” which should be *C. hispanica*). Further in their table 7, they list extinct species but one of them is not extinct (*Cyperus jeminicus*) and one is not found and has never been found in historic Palestine (*Olimarabidopsis pumila*), a third is found in Wadi Araba and not in the West Bank (*Halocnemum strobilaceum*), and a fourth is in the Hermon Mountain and upper Galilee also not in the West Bank (*Phlomis chrysophylla*).

We constructed our own preliminary list based on GBIF analysis,¹ the criteria of Sapir et al. (2003), our own field data as well as published works (Arafah et al., 2002; Melamed et al., 2009; Fragman-Sapir, 2017; Rottenberg, 2000). To exclude species not found in the Palestinian territories, a GBIF search was conducted for each species.

That list we produced (available at <https://www.palestinature.org/flora/Rare-Plants-of-the-OWB.pdf>) includes 600 plant species of concern in the West Bank alone (Gaza is little studied) which should be considered. The number of species we consider rare/threatened in the West Bank (data is deficient in Gaza) include 187 endangered (O, found in 1–3 sites of the 1 km² grids), 171 very rare species (RR, found in 4–10 sites), and 238 rare (R, found in 11–30 sites) and four extinct. A selected group of rare or endangered species are shown in Figs. 1 and 2. Some like *Adonis palaestina* and *Crocus palaestinus* carry the name of Palestine and one species was designated as the national flower of the state of Palestine (Fig. 1).

We must stress that this is a rough estimate reflecting current data but better data are needed. Indeed more data is being collected and new records of interesting plants are being discovered in the area (e.g., Al-Sheikh and Qumsiyeh, 2021). There will be even a new species described by Kreutz from the *Ophrys apifera* var *libanotica* (see Fig. 2). Forty one species from the 187 “O” species in our list are included in Israeli list (Fragman-Sapir, 2017) and 34 species from 238 RR species are included in Israeli list as well as three of the four are extinct. Thus a total of 78 our species are included in the Israeli list. Yes we believe we will find more with additional field work.

Protected areas in Palestine and Plant biodiversity

The National Biodiversity Strategy and Action plans for Palestine (NBSAPP) was done in Ministry of Environment (MOE) (1999). As a priority NBSAPP called for establishment of protected areas (Qumsiyeh and Amr, 2016). Protected areas account for only 9% of the Occupied Palestinian Territories (OPT) compared to 19% globally (SP (State of Palestine), 2020; SP, 2021). The Directorate for Forests, Rangelands and Wildlife has offices in all governorates of the West Bank. Forty rangers are responsible for inspecting and patrolling the designated 51 protected areas (Fig. 3) and the natural forests throughout the areas under the jurisdiction of the Ministry of Agriculture (MOA). Of the 19 protected areas that were ostensibly to be handed over to the Palestinian Authority under the Oslo agreement, only eight are under the actual control of the Ministry in charge (Agriculture) in total amounting to less than 15 sq. km. The remaining are within area C (under direct Israeli control) or overlapped areas. In 2015, the Palestinian ministerial committee approved a list of 49 protected areas but most of these fall in parts of the OPT that are under direct control by the occupying power. In effect the eight protected areas total less than 15 km² are under Palestinian effective control making management difficult. Garstecki et al. (2010) gave the most comprehensive account on the protected areas in the Palestinian Territories. Details on the status of the protected areas of the West Bank were outlined by Qumsiyeh and Amr (2016).

Al-Sheikh (2011) identified six Important Plant Areas (IPA) of the West Bank. These areas host a variety of plant species, many of which are considered endemic to Palestine. In general, the Palestinian IPAs are dominated by maquis vegetation, with trees such as the Palestinian Pistachio (*Pistacia palaestina*), Palestine Buckthorn (*Rhamnus palaestinus*), Palestine Oak (*Quercus calliprinos*) and Boissier Oak (*Q. boissieri*).

The IUCN did a quick review of biodiversity for 15 protected areas (Al-Hashmee, Deir Ammar, Ein Darra, Fahmeh, Jabal Alkabeer, Jesrualem Wilderness, Sheikh katrawny, Sheikh zeyd, Shoubash, Sirris, Tammoun, Tayyasir, Um Al Tut, Wadi Al Dillb, Wadi Zarqa Ulwi) (Garstecki et al., 2010). But in terms of actual plant surveys for the protected areas or rich biodiversity areas likely to be protected soon, there is only limited studies on five areas: Wadi Quff (Al-Sheikh and Mahassneh, 2016), Wadi Al-Zarqa Al-Ulwi (PMNH, 2018), and Wadi Al-Makhrour (Chattas, 2021).

The threats to plants in the Palestinian territories are many anthropogenic factors such as population growth, massive migration of Israeli populations into the area and displacement of local population into increasingly urbanized systems, industrialization, and

¹The GBIF country filter was set to “country = PS”, which refers to “State of Palestine” (<https://www.gbif.org/occurrence/search?country=PS>). This would also yield historic records that were then double checked for their location. Only if in the territory of the current West Bank or Gaza strip, they were included. This process resulted in a list of 173 species



Fig. 1 Some of the rare plants in the West Bank (Occupied Palestinian Territory). Top row: *Adonis palaestina*, *Allium carmeli*; Middle row: *Allium rothii*, *Arum dioscordis*; Bottom row: *Crocus palaestinus*, *Iris haynei* (national flower, light colored variety).

building redundant infrastructure that separates Israeli colonizers from native people (EQA, 2015). Destruction of native trees and planting *Pinus halepensis* in large tracts of the land accompanying the formation of the state of Israel has also affected biodiversity negatively (Ginsberg, 2006).

We also have an issue with invasive species introduced in the past few decades. Some of these plants are devastating the local rare species (Dufour-Drouot, 2012; see Table 1). The State of Palestine has just started a program to identify and manage alien/invasive species.

Discussion

There are classically four phytogeographical zones recognized in Palestine but they were expanded to five and their boundaries refined by Soto-Berelov et al. (2015). These areas are important in the West Bank and Gaza to delimit different distribution patterns of rare plants. The very high number of rare plants listed in our preliminary review (more needs to be done) is related to the changes



Fig. 2 Some of the rare plants in the West Bank (Occupied Palestinian Territory). Top row: *Ophrys cf. holosericea/lebanotica* (new species being described by Kreutz), *Scutellaria tomentosa* Middle row: *Orchis galilea*, *Orchis sancta*; Bottom: *Iris atrofusca*.

in the landscape seen over the past few decades. The floral elements in Palestine are threatened by human induced habitat destruction like elsewhere on the planet. It intensified in our area because of the political situation including colonization which includes: massive Israeli migration and settlement on Palestinian lands, squeezing Palestinians into smaller enclaves, and developing separate/redundant infrastructure (Isaac and Hilal, 2011). These and climate change/desertification has already caused significant damage including in vulnerable plant groups like Orchids (Pahl and Qumsiyeh, 2021). What can be done in such rapid changes in our region is limited but we think the main focus should be on protected areas.

Under the Agriculture Law for the year 2003, the Agriculture Ministry “in cooperation with other competent authorities shall develop nature reserves management plan and conserve all plants and living organisms living in protected areas.” The main entity tasked with setting policies, approving protected areas and changing their borders is the Environment Quality Authority (EQA) of the nascent state of Palestine. The EQA is about to embark on a major project to reevaluate all protected areas performing proper fauna and flora studies and designing appropriate management plans that protects the whole ecosystem, including endangered

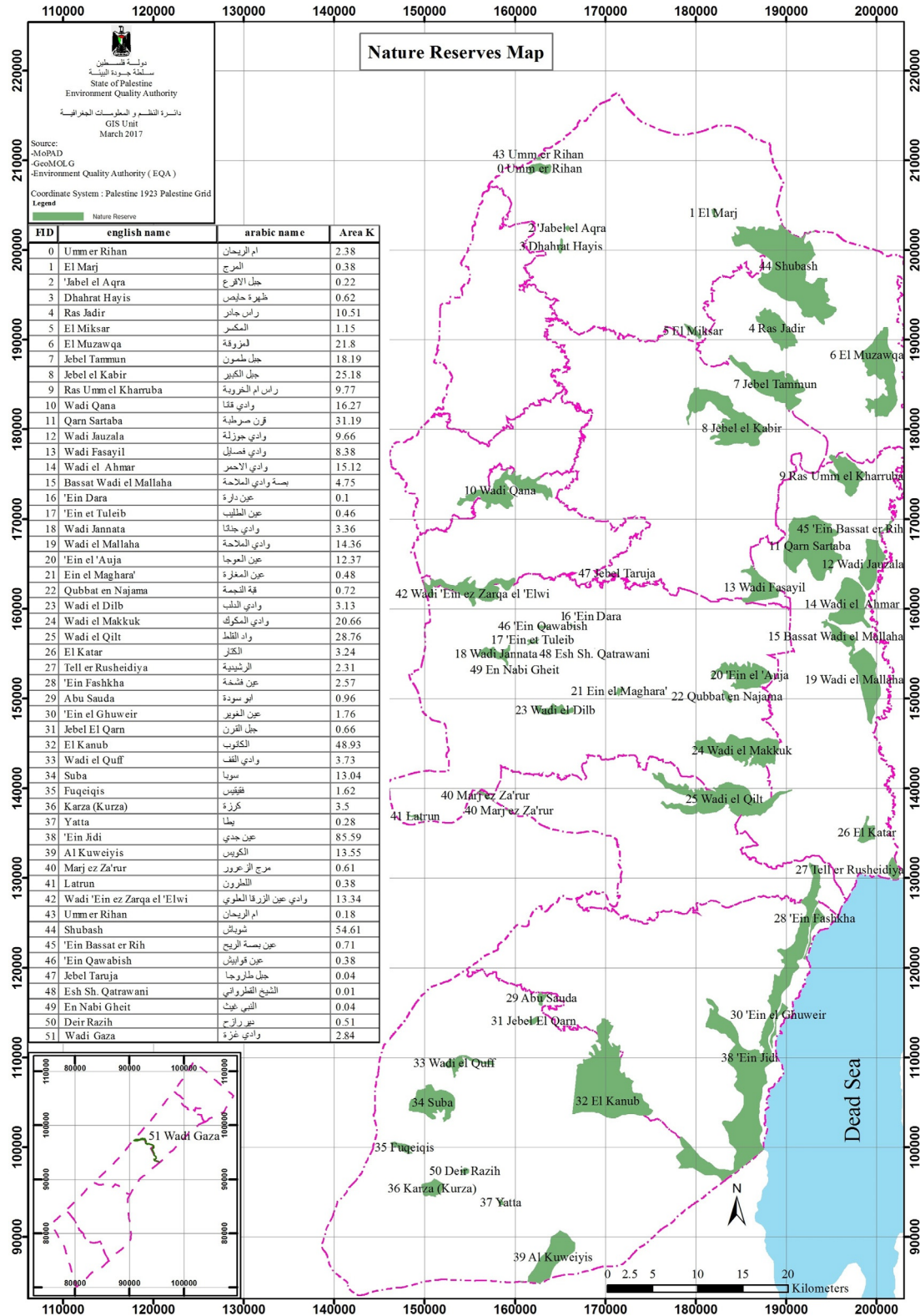


Fig. 3 Originally recognized 50 protected areas in the West Bank and one in Gaza, Occupied Palestinian Territories. One locality was later removed. All remaining 50 include many of the key rare floral species and all have threats with weak levels of protection in an unstable geopolitical climate. Yufit DS, Mallinson PR, Muir KW, Kozhushkov SI and de Meijere A (1996) Experimental charge density study of 7-dispiro[2.0.2.1]heptane carboxylic acid. *Acta Crystallographica B* 52: 668–676.

Table 1 Invasive plants species occurring in the occupied West Bank.

<i>Species</i>	<i>Introduction into Palestine</i>	<i>Origin</i>
<i>Acacia cyclops</i>	1920	Southwestern Australia
<i>Acacia karroo</i> Hayne	1927–30	Southern Africa
<i>Acacia paradoxa</i> DC	1920	Southeastern Australia
<i>Acacia salicina</i> Lindl.	1920	Eastern Australia
<i>Acacia saligna</i>	1920	Southwestern Australia
<i>Acacia victoriae</i>	1948	Australia
<i>Ailanthus altissima</i>	1960	China
<i>Ambrosia confertiflora</i>	1990	Southern United States and Mexico
<i>Atriplex holocarpa</i>	1960	Southern Australia
<i>Azolla filiculoides</i>	Unknown (first found 1980)	South America
<i>Carpobrotus edulis</i>	Unknown	South Africa
<i>Conyza bonariensis</i>	1896	South America
<i>Conyza albida</i>	1957	South America
<i>Conyza canadensis</i>	1939	Canada
<i>Cyperus involucratus</i>	Unknown	East Africa
<i>Cyperus odoratus</i>	1980	Tropical regions
<i>Datura stramonium</i>	1920	Tropical south America
<i>Dodonaea viscosa</i>	Unknown	Australia
<i>Eichhornia crassipes</i>	Unknown	Northern Brazil
<i>Eucalyptus camaldulensis</i>	1890	Australia
<i>Ficus benghalensis</i>	1940	India
<i>Ficus microcarpa</i>	Unknown	India, Sri Lanka, southern China, northern Australia
<i>Ficus religiosa</i>	Unknown	India, Pakistan, Bangladesh
<i>Heterotheca subaxillaris</i>	1975	Eastern United States
<i>Ipomoea aquatica</i>	2009	Central China
<i>Lantana camara</i>	Unknown	Tropical central America
<i>Myriophyllum aquaticum</i>	Unknown	South America
<i>Nicotiana glauca</i>	1898	Western South America
<i>Oenothera drummondii</i>	1912	North Carolina
<i>Oxalis pes-caprae</i>	1906	South Africa
<i>Parkinsonia aculeata</i>	1922	Southern United States
<i>Paspalum distichum</i>	1939	Southern United States to Caribbean Islands and tropical South America
<i>Pennisetum clandestinum</i>	1920	East Africa (Congo, Tanzania, Kenya, Rwanda)
<i>Phytolacca americana</i>	1898	United States
<i>Pinus brutia</i>	1927	Northeast Greece, southwest Turkey, Cyprus, Lebanon
<i>Pistia stratiotes</i>	Unknown	South America
<i>Prosopis juliflora</i>	1948	Mexico, northern South America
<i>Ricinus communis</i>	1894	Topical Africa
<i>Robinia pseudoacacia</i>	1922	Southeastern United States
<i>Salvinia molesta</i>	1970	Southern Brazil
<i>Schinus molle</i>	1919	Chile, northern Argentina
<i>Schinus terebinthifolius</i>	Unknown	Subtropical Brazil
<i>Sesbania sesban</i>	Unknown	East Africa
<i>Solanum elaeagnifolium</i>	1957	Southwestern United States, northeastern Mexico
<i>Verbesina encelioides</i>	1970	Southern United States, Mexico
<i>Washingtonia robusta</i>	1905	Southwestern United States
<i>Xanthium strumarium</i>	1921	Western United States

From Dufour-Dror JM (2012) Alien invasive plants in Israel. In: *The Middle East Nature Conservation Promotion Association*. Ahva Publishing: Jerusalem, IL, vol. 1, pp. 213 plus our own observations.

plants. In protecting endangered plants it is important to have a holistic approach involving looking at area management (Volis, 2016) and hence protected areas become critical. In situ conservation in protected areas is however beset by various difficulties and it is important for us to consider other options for conservation both inside and outside protected areas in situ (Heywood, 2018). But we must also consider the option in severely threatened areas like Palestine of engaging in ex situ conservation (see also Mounce et al., 2017; Chen and Sun, 2018). Fragman-Sapir (2017) reported 160 rare species found in the Jerusalem Botanical Garden.

Based on the discussion above we propose strategies based on: (1) Strengthened in situ conservation in the 50 protected areas starting with those that host the highest number of endangered plants (much more research is needed in this area), (2) Strengthened laws and in situ conservation in certain areas where some key rare species occur outside of protected areas but in vulnerable habitats

(e.g., *Ranunculus peltatus* in Jinsafut pool; Palestine Institute for Biodiversity and Sustainability (PIBS), 2018) and the designation and protection of these should be done according to IUCN criteria (IUCN, 2012, 2013), and (3) Developing more ex situ conservation including seed banking in well managed botanical gardens (Mounce et al., 2017; Chen and Sun, 2018) like those at PIBS (Qumsiyeh et al., 2017). This three pronged approach must be carried out urgently and simultaneously to protect the threatened and endangered flora in our area.

The Critical Ecosystem Partnership Fund with Birdlife International recently funded projects related to conservation of rare and endangered plant in Palestine in line with global strategies (Sharrock, 2020). In one of these projects we at the Palestine Institute for Biodiversity and Sustainability, we engaged in both in situ and ex situ conservation efforts focusing on things like orchids and irises and newly identified taxa not reported before in our area (see also Pahl and Qumsiyeh, 2021; Al-Sheikh and Qumsiyeh, 2021). Finally, it is important in protecting plants to take issues of social and economic factors into consideration and not merely the standard technical and scientific assessments (Kellert, 1985). The National Biodiversity Strategy and Action Plans for the State of Palestine is being updated in 2021–22 and there is great interest in doing better surveys of rare and endangered fauna and flora in these areas and to ensure adequate management plans with clear goals and timelines are implemented. Not only is better research needed, but research has to also be translated to well-documented educational modules that ensures “buy-in” from the public in ways that protect our endangered plant ecosystems.

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