CONSERVATION IN THE MIDDLE EAST: LOCAL AND INTERNATIONAL COLLABORATIONS[1]

Ori Fragman-Sapir[2]

ABSTRACT

The rich flora of the Middle East is celebrated in the Jerusalem Botanical Gardens, where endangered species are propagated and protected. In this paper I share our primary projects and the organizations with which we work. Local and international collaborations are detailed and prominent plants are shown. My hope is that this information will promote understanding and collaborations to ensure plant conservation for future generations.

Key words: Conservation, desert, endangered species, Levant, Middle East, plant diversity.

Israel and its surroundings are situated in a climatic and continental junction. The rich local flora is a treasure of rare and common species, many of which are grown in the Jerusalem Botanical Gardens. In this paper I share our projects regarding several plant groups and endangered species.

The average annual rainfall in the region ranges between 900 mm in Galilee in the north to 16 mm in the far south, at the coast of the Red Sea. This is an impressive climatic gradient that causes a series of different habitats, where different plant species evolve and survive. The richness of the local flora is also positively affected by geological differences, distance from the Mediterranean Sea, different degrees of natural and human disturbances, and the fact that the region is located at a continental junction between Africa, Asia, and Europe.

Climatically one can divide the region into the following four zones: (1) Mediterranean climatic zone, characterized by average annual rainfall of more than 400 mm. Winters are cool and wet; summers are long, hot, and dry. (2) Transition climatic zone, characterized by annual rainfall averages of 200–400 mm. Summers here are longer than in the Mediterranean zone. (3) Semi-desert climatic zone, characterized by annual rainfall averages of 70–200 mm. Rainstorm fluctuations and dry years occur from time to time. (4) Extreme desert climatic zone, characterized by annual rainfall average of less than 70 mm. Here rainstorms are rare and very unpredictable. Completely dry years are common.

The area is divided into two main phytogeographic regions: the Mediterranean and the Saharo-Arabian Regions. In the semi-desert and transition zones one can also find many Irano-Turanian species, and in the extreme desert one can find some Sudanian species.

Natural, undisturbed lands are limited today. Large nature reserves exist in the periphery of the region, while small nature reserves dot the central parts, and some are very small. In this context there is a growing importance of botanical gardens as rescue gardens and as a source for materials for reintroductions and establishment of new populations of endangered species.

The following data summarize the flora of Israel and its surroundings in numbers: native, ca. 2400 species; endemic and sub-endemic, 285 species; endangered, 419 species (160 grown in the Jerusalem Botanical Gardens, see Table 1); protected, 257 species (Fragman et al., 1999; Shmida & Pollak, 2007; Shmida et al., 2011); alien, ca. 170 species, which are ca. 7% of the flora (Dufour-Dror, 2010); ornamental, ca. 5400 species and varieties (Jerusalem Botanical Gardens, <https://jbg.gardenexplorer.org/>, and the Israel Ministry of Agriculture databases <http://shaham.moag.gov.il/ProfessionalInformation/Pages/List_of_garden_plants_in_Israel_november_2016.aspx>); and Jerusalem Botanical Gardens collection, > 6000 species.

In the Jerusalem Botanical Gardens we grow endangered plants of the southern Levant Region, primarily plants of Israel, the Palestinian Territories, Jordan, Lebanon, Syria, Egypt (Sinai Peninsula), and northern Saudi Arabia. Table 1 lists 160 rare and endangered species grown in the Jerusalem Botanical Gardens.

[1] I greatly appreciate financial support to the Jerusalem Botanical Gardens by the Israel Ministry of Agriculture through the Israel Botanical Gardens Council.

[2] Scientific Director, Jerusalem Botanical Gardens, Hebrew University, Jerusalem, 9190401 Israel. fragman@botanic.co.il.
doi: 10.3417/D-16-00013A

Figure 1. Landscaping with native annuals outside of Tel Aviv.

About half of the flora of the region is annual, a treasure of species for food, gardening, and medicine. We have cultivated many of these annuals and use them in ecological restoration projects as well as in gardens (Fig. 1). A good example of the annuals is the conservation project for the genus *Agrostemma* L. *Agrostemma githago* L. and *A. gracile* Boiss. are two locally endangered species that we grow and propagate. Utilizing these species, we engage in the following activities: grow wonderful displays in our gardens, collect large seeds with volunteers, clean seeds with volunteers and special groups, prepare seed packages for sale in the garden's shop and selected garden centers, distribute seeds to community gardens and schools, and distribute seeds to other botanical gardens and shelter gardens.

A more difficult challenge is to grow and display unattractive endangered annuals, some of which would be considered weeds by many. Here we have to address the issue of biodiversity and the importance of all plant species for the world and humankind. When we educate, we portray nature as a large genetic encyclopedia. But what do we really know? Perhaps only the first page of this encyclopedia. The rest is still unknown: we do not know which plant will provide the next medicine for cancer, which plant will provide a new food source for us, and in many cases we also do not understand the importance of a certain taxon in its ecosystem. These are the economic reasons for the conservation of the entire flora. In addition, there are moral and religious reasons for conservation as well.

Another important topic that we tackle is annual plant communities. In a series of experiments held in the Jerusalem Botanical Gardens and led by Ronen Kadmon of Hebrew University, we are trying to understand what factors increase plant diversity (Ben Hur et al., 2012). This experiment "field" produces invaluable data every year. After analysis of the data, we will be better able to understand these plant communities and wisely manage lands to increase plant diversity.

Two perennial plant species were rescued by the Jerusalem Botanical Gardens just before they became extinct in Israel. Both species (*Salvia bracteata* Banks & Sol. and *Campanula peregrine* L.) were propagated in the gardens; grown in the ground and in containers; and spread in nature and in other local botanical gardens, rescue gardens, school gardens, and parks. *Salvia bracteata* was planted this year by a high school club called "green-team" in a nearby semi-natural location in Jerusalem, less than a mile from its last natural site.

Another important group that is easy to protect and cultivate is the geophytes. *Sternbergia clusiana* (Ker Gawl.) Ker Gawl. ex Spreng. is an endangered

Table 1. List of 160 rare and endangered species grown in the Jerusalem Botanical Gardens.

Taxon	Family
Acinos rotundifolius Pers.	Lamiaceae
Adonis aestivalis L.	Ranunculaceae
Aegilops vavilovii (Zhuk.) Chennav.	Poaceae
Agrimonia eupatoria L.	Rosaceae
Agrostemma githago L.	Caryophyllaceae
Agrostemma gracile Boiss.	Caryophyllaceae
Alliaria petiolata (M. Bieb.) Cavara & Grande	Brassicaceae
Allium albotunicatum O. Schwarz	Amaryllidaceae
Allium basalticum Fragman & R. M. Fritsch	Amaryllidaceae
Allium desertorum Forssk.	Amaryllidaceae
Allium dumetorum Feinbrun & Szel.	Amaryllidaceae
Allium meronense Fragman & R. M. Fritsch	Amaryllidaceae
Allium schubertii Zucc.	Amaryllidaceae
Allium sinaiticum Boiss.	Amaryllidaceae
Amberboa iljiniana Grossh.	Asteraceae
Anacyclus nigellifolius Boiss.	Asteraceae
Andrzeiowskia cardamine Rchb.	Brassicaceae
Anthemis amblyolepis Eig	Asteraceae
Anthemis brachycarpa Eig	Asteraceae
Anthemis hyalina DC.	Asteraceae
Antinoria insularis Parl.	Poaceae
Arabis auriculata Lam.	Brassicaceae
Arabis turrita L.	Brassicaceae
Arenaria tremula Boiss.	Caryophyllaceae
Bellevalia warburgii Feinbrun	Asparagaceae
Biebersteinia multifida DC.	Biebersteiniaceae
Boissiera squarrosa (Sol.) Nevski	Poaceae
Callipeltis factorovskyi (Eig) Ehrend.	Rubiaceae
Catabrosa aquatic (L.) P. Beauv.	Poaceae
Catapodium marinum (L.) C. E. Hubb.	Poaceae
Cerastium illyricum Ard.	Caryophyllaceae
Chorispora purpurascens (Banks & Sol.) Eig	Brassicaceae
Chrysanthemum viscosum Desf.	Asteraceae
Cirsium alatum (S. G. Gmel.) Borbov	Asteraceae
Cirsium gaillardotii Boiss.	Asteraceae
Clinopodium vulgare L.	Lamiaceae
Consolida pusilla (Labill.) Schrödinger	Ranunculaceae
Convolvulus fatmensis Kunze	Convolvulaceae
Corchorus trilocularis L.	Tiliaceae
Crocus hermoneus Kotschy ex Maw	Iridaceae
Crypsis minuartioides (Bornm.) Mez	Poaceae
Cucumis acidus Jacq.	Cucubritaceae
Cutandia maritima (L.) Barbey	Poaceae
Descurainia sophia (L.) Webb ex Prantl	Brassicaceae
Dianthus libanotis Labill.	Caryophyllaceae
Elytrigia repens (L.) Nevski	Poaceae
Enarthrocarpus arcuatus Labill.	Brassicaceae
Enneapogon desvauxii P. Beauv.	Poaceae
Enneapogon persicus Boiss.	Poaceae
Ferula daninii Zohary	Apiaceae
Glaucium leiocarpum Boiss.	Papaveraceae
Glyceria notata Chevall.	Poaceae

Table 1. Continued.

Taxon	Family
Hyoscyamus albus L.	Solanaceae
Hypochaeris glabra L.	Asteraceae
Iberis odorata L.	Brassicaceae
Iris atrofusca Baker	Iridaceae
Iris atropurpurea Dinsm.	Iridaceae
Iris bismarckiana Regel	Iridaceae
Iris hermona Dinsm.	Iridaceae
Iris lortetii Barbey	Iridaceae
Iris mariae Barbey	Iridaceae
Iris petrana Dinsm.	Iridaceae
Iris vartanii Foster	Iridaceae
Isatis armena L.	Brassicaceae
Lathyrus cassius Boiss.	Fabaceae
Lathyrus clymenum L.	Fabaceae
Lathyrus gloeosperma Warb. & Eig	Fabaceae
Lathyrus gorgonii Parl	Fabaceae
Lathyrus hirsutus L.	Fabaceae
Lathyrus lentiformis Plitmann	Fabaceae
Lathyrus roseus Steven	Fabaceae
Lathyrus sphaericus Retz.	Fabaceae
Legousia pentagonia (L.) Thell.	Campanulaceae
Lepidium latifolium L.	Brassicaceae
Lepidium microstylum Boiss. & Heldr.	Brassicaceae
Linaria triphylla (L.) Mill.	Plantaginaceae
Linum bienne Mill.	Linaceae
Lolium persicum Boiss. & Hohen.	Poaceae
Lolium subulatum Vis.	Poaceae
Lupinus hispanicus Boiss. & Reut.	Fabaceae
Lupinus luteus L.	Fabaceae
Maresia nana (DC.) Batt.	Brassicaceae
Matthiola arabica Boiss.	Brassicaceae
Medicago italica (Mill.) Fiori	Fabaceae
Medicago murex Willd.	Fabaceae
Misopates calycinum Rothm.	Plantaginaceae
Moenchia erecta (L.) G. Gaertn., B. Mey. & Scherb.	Caryophyllaceae
Myagrum perfoliatum L.	Brassicaceae
Myosurus minimus L.	Ranunculaceae
Narcissus obsoletus (Haw.) Spach	Amaryllidaceae
Oenanthe prolifera L.	Apiaceae
Oldenlandia capensis L. f.	Rubiaceae
Onopordum carduiforme Boiss.	Asteraceae
Onosma giganteum Lam.	Boraginaceae
Ornithopus pinnatus (Mill.) Druce	Fabaceae
Paeonia mascula (L.) Mill.	Paeoniaceae
Papaver decaisnei Elkan	Papaveraceae
Paronychia palaestina Eig	Caryophyllaceae
Petrorhagia zoharyana Liston	Caryophyllaceae
Phlomis aurea Decne.	Lamiaceae
Phlomis platystegia Post	Lamiaceae
Phlomis pungens Willd.	Lamiaceae
Pulicaria inuloides (Poir.) DC.	Asteraceae
Polygonum arenarium Waldst. & Kit.	Polygonaceae
Ranunculus constantinopolitanus (DC.) D'Urv.	Ranunculaceae
Ranunculus lateriflorus DC.	Ranunculaceae
Ranunculus pinardii (Steven) Boiss.	Ranunculaceae
Rheum palaestinum Feinbrun	Polygonaceae

Table 1. Continued.

Taxon	Family
Rumex aeroplaniformis Eig	Polygonaceae
Salvia bracteata Banks & Sol.	Lamiaceae
Salvia ceratophylla L.	Lamiaceae
Salvia eigii Zohary	Lamiaceae
Salvia indica L.	Lamiaceae
Salvia microstegia Boiss. & Balansa	Lamiaceae
Salvia multicaulis Vahl	Lamiaceae
Salvia pinnata L.	Lamiaceae
Saxifraga tridactylites L.	Saxifragaceae
Scandix blepharicarpa O. Cohen	Apiaceae
Scandix palaestina (Boiss.) Boiss.	Apiaceae
Scandix stellata Banks & Sol.	Apiaceae
Scrophularia hierochuntina Boiss.	Scrophulariaceae
Senecio hoggariensis Batt. & Trab.	Asteraceae
Sideritis curvidens Stapf	Lamiaceae
Silene macrodonta Boiss.	Caryophyllaceae
Silene oxyodonta Barbey	Caryophyllaceae
Silene sedoides Poir.	Caryophyllaceae
Silene tridentata Desf.	Caryophyllaceae
Sisymbrium runcinatum Lag. ex DC.	Brassicaceae
Sorbus torminalis (L.) Crantz	Rosaceae
Sorbus umbellata Fritsch	Rosaceae
Stachys arvensis (L.) L.	Lamiaceae
Stachys paneiana Mouterde	Lamiaceae
Stachys zoharyana Eig	Lamiaceae
Tetragonolobus requienii (Sanguin.) Sanguin.	Fabaceae
Tordylium syriacum L.	Apiaceae
Trifolium angustifolium L.	Fabaceae
Trifolium billardieri Spreng.	Fabaceae
Trifolium hirtum All.	Fabaceae
Trifolium salmoneum Mouterde	Fabaceae
Trigonella brachycarpa (M. Bieb.) Moris	Fabaceae
Trigonella filipes Boiss.	Fabaceae
Triplachne nitens (Guss.) Link	Poaceae
Triticum dicoccoides (Körn. ex Asch. & Graebn.) Schweinf.	Poaceae
Turritis laxa Sm.	Brassicaceae
Verbascum berytheum Boiss.	Scrophulariaceae
Verbascum caesareum Boiss.	Scrophulariaceae
Vicia articulata Hornem.	Fabaceae
Vicia basaltica Plitmann	Fabaceae
Vicia bithynica (L.) L.	Fabaceae
Vicia cypria Kotschy	Fabaceae
Vicia esdraelonensis Warb. & Eig	Fabaceae
Vicia lathyroides L.	Fabaceae
Viola modesta Fenzl	Violaceae
Viola occulta Lehm.	Violaceae
Xeranthemum annuum L.	Asteraceae
Xeranthemum cylindraceum Sm.	Asteraceae
Xolantha guttata (L.) Raf.	Cistaceae
Zaleya pentandra (L.) C. Jeffrey	Aizoaceae
Ziziphora tenuior L.	Lamiaceae
Zoegea purpurea Fresen.	Asteraceae

autumnal species in the Jerusalem area, and its rescue is one of the success stories of ex situ conservation in the Jerusalem Botanical Gardens (Fig. 2). Dozens of plants were rescued from a nearby building site in the early 1980s, and today more than 500 plants thrive in the gardens in a self-sustaining population that does not need any special care.

We are also studying other geophytes groups: systematic research on the genus *Allium* L. is held in the gardens and has already provided four new local species and further understanding of this group (Fragman-Sapir & Fritsch, 2011; Brullo et al., 2014; Friesen & Fragman-Sapir, 2014). Some of these *Allium* species are already used in hybridization and cultivation of new cultivar varieties in The Netherlands (Fig. 3). Other geophytic plants are in trials in the gardens and elsewhere in the country; thus, they are protected and perhaps will be used later in gardens and as cut flowers. Our bulb collection is part of the garden's display, providing excitement for visitors throughout the year.

An important international collaboration is held with the Royal Botanic Garden of Jordan on a small desert fig named *Ficus palmata* Forssk.; the tree is endangered in both countries, occurring in remote desert springs (Fig. 4). We have chosen this species for several reasons: (1) it is ornamental and can be used in arid gardens instead of exotic trees, (2) its figs are edible, (3) it is traditionally used in medicine by local Bedouins, (4) it is endangered and needs protection, and (5) it is variable and becomes very similar to the common fig (*F. carica* L.) in the Petra area, and therefore there is scientific interest in the relationship between the two species and in understanding whether they hybridize, or perhaps change gradually one into the other. In February 2014 a mutual delegation from both gardens went on a collecting trip in southern Jordan from Wadi Rum (not far from the Saudi border) to Petra, sampling 30 trees in 30 locations. Cuttings were collected and rooted in both gardens. They form the base of a continuing research on this interesting tree. A second plant that was already chosen for our collaborative research is the ornamental *Dianthus libanotis* Labill., again a rare plant of both countries (Fig. 5).

There are many people and organizations that help the Jerusalem Botanical Gardens with various plant conservation projects. They are our botanical garden staff, garden volunteers, special volunteer groups (mentally disabled, war trauma victims, and more), foreign horticulture scholars, the Israel Nature and Parks Authority, the Society for Protecting Nature in Israel, local and international botanical gardens, local shelter gardens, community gardens, the municipality

Figure 2. *Sternbergia clusiana* (Ker Gawl.) Ker Gawl. ex Spreng., rescued and flourishing in the Jerusalem Botanical Gardens.

Figure 3. *Allium basalticum* Fragman & R. M. Fritsch, an endangered species described in 2011 and grown in the Jerusalem Botanical Gardens.

Figure 4. Jordanian-Israeli team collecting *Ficus palmata* Forssk. cuttings in southern Jordan.

Figure 5. *Dianthus libanotis* Labill., a rare species studied in the Jerusalem Botanical Gardens.

of Jerusalem, schoolteachers and pupils, the Jewish National Fund, Kalanit—the Israel Plant Information Center, professional and amateur botanists, and the general public.

We hope that this information will promote understanding and collaboration to ensure plant conservation for future generations. We invite all our neighboring colleagues in Jordan, the Palestinian Territories, Egypt, Syria, and Lebanon to join us in mutual efforts to save our local botanical treasures.

Literature Cited

Ben-Hur, E., O. Fragman-Sapir, R. Hadas, A. Singer & R. Kadmon. 2012. Functional trade-offs increase species diversity in experimental plant communities. Ecol. Lett. 15(11): 1276–1282.

Brullo, C., S. Brullo, O. Fragman-Sapir, G. Giusso del Galdo & C. Almeri. 2014. *Allium therinanthum* (Amaryllidaceae), a new species from Israel. Phytotaxa 164(1): 29–40.

Dufour-Dror, J. M. 2010. Alien Invasive Plants in Israel. Israel Nature and Parks Authority, Jerusalem. [In Hebrew.]

Fragman-Sapir, O. & F. M. Fritsch. 2011. New species of *Allium* sect. *Melanocrommyum* from the eastern Mediterranean. Herbertia 65: 31–50.

Fragman-Sapir, O., U. Plitmann, D. Heller & A. Shmida. 1999. Checklist and Ecological Data-base of the Flora of Israel and Its Surroundings. Mifalot "Yeffe Nof" and The Middle East Conservation Promotion Association, Jerusalem. [In English and Hebrew.]

Friesen, N. & O. Fragman-Sapir. 2014. A new *Allium* species from section *Molium* from Israel: *A. akirense* (Amaryllidaceae). Phytotaxa 173(2): 140–148.

Shmida, A. & G. Pollak. 2007. The Red Data Book: Endangered Plants of Israel, Vol. 1. Israel Nature and Parks Authority.

Shmida, A., G. Pollak & O. Fragman-Sapir. 2011. The Red Data Book: Endangered Plants of Israel, Vol. 2. Israel Nature and Parks Authority, Jerusalem. [In Hebrew.]