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RELATIVES OF ORNAMENTAL PLANTS IN THE FLORA OF ISRAEL

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ABSTRACT

The distribution and habitats in Israel of over a hundred wild local representatives of recognized ornamental species are tabulated. The various fates which may befall wild species taken into cultivation as ornamentals, including changes in their phenotypic variation, are illustrated by case histories of *Anemone coronaria*, *Cyclamen persicum*, *Hyacinthus orientalis*, *Lilium candidum* and *Tulipa agensis*.

Ornamental plant species that grow wild in Israel have spread far afield, though the local representatives of these species may not have been the actual progenitors of today's garden varieties. One way in which these plants have spread is purely allegorical; plants in the lands of Bible readers have been invested with Biblical names.[1]

A second way involves more than names but still does not represent physical introductions of wild plants from Israel. Different phytogeographic elements merge peripherally in this area, and garden plants belonging to Euro–Siberian, Irano–Turanian, Saharo–Arabian or omni–Mediterranean areas were not usually developed from an eastern Mediterranean stock. However, even the origins of those ornamentals whose wild forms are endemic to the eastern Mediterranean can rarely be traced back to the area of Israel.

Some of these species, which have some standing as ornamentals today, were introduced to central and western Europe from the Ottoman Empire during the 16th, 17th and 18th centuries. During the 300 years of plant exploration and collection in the Levant the gene pool of ornamental plants from the area under discussion was hardly tapped because introductions (to Europe) were made from more northerly parts of the Ottoman Empire. Among reasons for the lack of introductions from further south one can cite the hazards of travelling in this area, which are evident from

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[1] For example, in much of the Bible plant literature the "Rose of Sharon" in the Song of Solomon 2:1 is held to refer to the Palestinian *Narcissus tazetta* L. and the "Lily of the Valley" in the same verse to *Hyacinthus orientalis* L. According to Zohary (1982), both names, and also the "Lily among the Thorns" in the following verse, are poetical allusions to *Lilium candidum* L. However, in the gardening world the name Rose of Sharon has been given to the ornamental shrub *Hibiscus syriacus* L. of East Asian origin while the Lily of the Valley is the temperate liliaceous *Convallaria majalis* L. whose medicinal and other virtues, which render it suitable for its Biblical context, are extolled in 17th-century gardening literature, e.g. by Rea (1676).

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the travel accounts of the Renaissance botanists Rauwulf and Belon and up to those of 19th century explorers such as Michaux (see Coats, 1969). The lack of a local gardening tradition during the heyday of plant collecting may have been a further obstacle to introductions from Palestine. The tulips, hyacinths and narcissi which drew the attention of the Austrian ambassador Busbecq in Turkey and were soon afterwards introduced to central and western Europe, were already domesticated garden forms. There was no similar concurrence of flower gardening and diplomatic relations in the southern part of the Levant.

It is probable that physical transfer of ornamental or potentially ornamental plants from the area studied took place in classical times, notably with troop movements during the Roman occupation and again, a thousand years later, during the Crusader period. However, documentation to this effect is generally unreliable. In contrast to introductions made from the Renaissance period onwards, in which botanical gardens and a network of garden-minded botanists were involved, earlier transfers of plants probably led only rarely to the establishment of alien species in a new environment. The same ornamentals were probably introduced repeatedly without becoming established.

As a result of lack of exploration, numerous garden-worthy species of Israel, some of them close relatives of the ones actually introduced to cultivation, were by-passed and still await utilization. The present account does not deal with these potential new ornamentals but is confined to accepted horticultural species. It is intended as an inventory of, and short guide to, local sources of germplasm and a review of some of the fates that await wild flowers which are brought into cultivation.

LOCAL WILD FORMS OF ACCEPTED ORNAMENTAL PLANTS

Some general features of 125 species of the local flora, which are recognized as ornamentals outside Israel, are set out in Tables I–V. The nomenclature used is that adopted in the Flora Palaestina (Zohary, 1966, 1972; Feinbrun-Dothan, 1978 and in press). The phytogeographic areas, or chorotypes, of each species are based on Gruenberg-Fertig's definitions (1966). Not all species which appear in the garden dictionaries which we consulted (Bailey, 1949; Chittendon, 1951; Bailey & Bailey, 1976; Everett, 1981, 1982) have been included in the tables. On the other hand, some of the species listed, e.g. *Cnicus benedictus* and *Silybum marianum* (Table III), are on the borderline with regard to their present status as ornamentals and are grown as collectors' items or for special effects. Numerous species comprising the Mediterranean phytogeographic element (M on tables) were known in classical times. For example, in his Enquiry into Plants written around 320 BC, Theophrastus, as interpreted by Hort (1911), mentions *Myrtus communis, Vitex agnus-castus*, the two species of *Cistus* and *Ruscus aculeatus* (Table I) and refers to the tougher, glossier, pink-flowered *Cistus creticus* as "male" and the more delicate white-flowered *C. salvifolius* as "female". In addition there are references to *Glaucium flavum* (Table II), *Scilla autumnalis* (Table IV), and the water plants shown in Table V. Some of the species may have been cultivated incipiently in the Mediterranean basin, perhaps more for consumption than for aesthetic enjoyment. Thus *Nerium oleander* (Table I), *Althea officinalis* and *Ferula communis* (Table II), *Malva sylvestris* and *Salvia horminum* (Table III) and *Lilium candidum* and *Urginea maritima* (Table IV), are mentioned in the Enquiry in enological, culinary and medicinal contexts. *Anemone coronaria* and *Narcissus tazetta* are the only species from our lists which are presented as "garland flowers" by Theophrastus, and not *A. coronaria* (notwithstanding its Linnean binomial) but the more northern red flowered *A. pavonina* Bowles and Stearn, which does not grow in Israel, may have been the garland anemone of the Romans, at least in the first century AD (Johnstone, 1972).

Figure 1 shows the local distribution areas which are indicated by numbers in the tables. The map shows that more than half of the country is desert or semi-desert. Only a few of the species are more or less confined to desert or near desert areas (see tables) but quite a number penetrate deserts from other areas, e.g. *Asphodelus fistulosus, Chrysanthemum coronarium* and *Salvia horminum* (Table III). Adaptability to a variety of habitats may be a prerequisite for attaining the status of a cultivated plant. On the other hand, species that are spill-overs from the Euro–Siberian phytogeographic region are largely confined to wet habitats when they are herbaceous

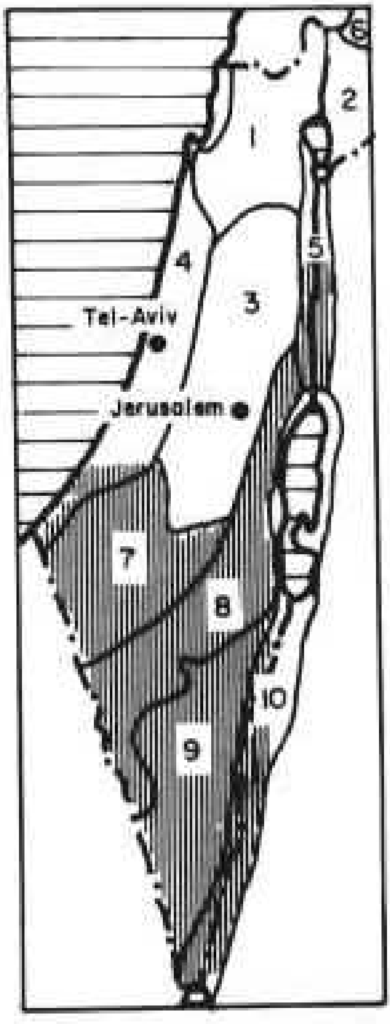

Fig. 1. Geographic areas of Israel. For explanations of the numbers designating areas, see Abbreviations used in Tables I–V.

Abbreviations used in Tables I–V

Phytogeographic areas. EB – Euro–Siberian. IT – Irano–Turanian. M – Mediterranean. SA – Saharo–Arabian. E – East. S – South. W – West. N – North.

Distribution in Israel. (1) Galilee, Mt. Carmel, Menashe Mts., Esdraelon Valley. (2) Golan Heights. (3) Judean Mts., Judean Foothills, Samaria. (4) Mediterranean Coastal Area. (5) Jordan Valley between Dead Sea and Sea of Galilee. (6) Mt. Hermon. (7) Negev Lowlands. (8) Judean Desert and Negev Highlands. (9) Southern Negev. (10) 'Arava and Dead Sea valleys.

Occurrence. cc – very common; c – common; r – rare; rr – very rare.

TABLE I

Wild forms of ornamental woody plants

Species	*Family*	*Phytogeographic area*	*Distribution in Israel*	*Habitat*	*Occurrence*	*Population structure*
Trees						
Arbutus andrachne L.	Ericaceae	EM	1,3	Maquis on marl	c	Small stands
Cercis siliquastrum L.	Caesalpiniaceae	EM–NM (WIT)	1,3	Maquis	r	Single trees or small stands
Crataegus azarolus L.	Rosaceae	EM	1,2	Humid maquis	c or r	Scattered individuals or small stands
Paliurus spina-christi Mill.	Rhamnaceae	EM–NM–WIT (SEB)	1,4	Alluvial soils among shrubs	rr	Single trees or small stands
Shrubs						
Artemisia arborescens L.	Compositae	M	1,4	Rocky slopes	r	Scattered individuals or small stands
Myrtus communis L.	Myrtaceae	M (SWIT–EB)	1,2,6	Maquis and stream banks	r	Small stands and thickets
Nerium oleander L.	Apocynaceae	M (WIT, SA)	1–6	Stream banks and wadi beds	c	Small stands
Phlomis viscosa Poir.	Labiatae	EM	1–3	Maquis, garigue and batha	c	Small stands or single plants

Rhamnus alaternus Boiss.	Rhamnaceae	M	1–4	Maquis	c or r	Scattered individuals or small stands
Rosa canina L.	Rosaceae	EB–M–WIT	1,3	Maquis	r	Small stands
Rosa phoenica L.	Rosaceae	EM	1–5	Stream banks and edges of swamps	r	Small stands
Salvia fruticosa Mill.	Labiatae	EM (NM)	1,3,4	Maquis and garigue	cc	Small stands
Viburnum tinus L.	Caprifoliaceae	M	1	Maquis in shade	r	Small stands
Vitex agnus-castus L.	Verbenaceae	M (IT)	1–6,8,10	Stream banks and wadi beds	c	Small stands and thickets
Dwarf Shrubs						
Cistus creticus L.	Cistaceae	M (EB)	1–4	Batha and maquis	cc	Large stands
Cistus salvifolius L.	Cistaceae	M	1–4	Batha and maquis	cc	Large stands
Globularia arabica J. et Sp.	Globulariaceae	ESA	4,8	Sandy loams in coastal area; rock crevices in desert	r	Small stands
Lavandula stoechas L.	Labiatae	M	4,6	Batha on sandy loam poor in calcium	rr	Small stands
Marrubium vulgare L.	Labiatae	M–IT	1–3,5	Waste places and roadsides on chalk	c	Small stands
Ruscus aculeatus L.	Liliaceae	M (SEB)	1,2,4,6	Shade of maquis	c	Small stands
Sedum nicaense All.	Crassulaceae	M	1,3,4	Soil pockets in rocks	cc	Clustered
Teucrium polium L.	Labiatae	M–WIT	1–10	Batha, arid hills and deserts	cc	Small stands
Climbers						
Calystegia sepium (L.) R. Br.	Convolvulaceae	Temperate regions	1,4,5	Near water	c	Small stands
Clematis cirrhosa L.	Ranunculaceae	M	1–4,6	Maquis	c	Single plants or small stands
Clematis flammula L.	Ranunculaceae	M (W)	1–3	Maquis	r	Single plants or small stands
Lonicera etrusca Santi var. *etrusca*	Caprifoliaceae	M	1–4,6	Maquis and garigue	cc	Small or large stands
var. *hispidula* Boiss.		EM	1	Maquis	r	Small stands

TABLE II
Wild forms of ornamental herbaceous perennials

Species	*Family*	*Phytogeographic area*	*Distribution in Israel*	*Habitat*	*Occurrence*	*Population structure*
Achillea fragrantissima (Forssk.) Sch. Bip.	Compositae	ESA–WIT	7–10 (3)	Wadis in desert	cc	Large stands
Alkanna orientalis (L.) Boiss.	Boraginaceae	EM–WIT	6 (8)	Rocky sites in desert	r	Single plants or small stands
Athaea officinalis (L.) Perr.	Malvaceae	EB–IT–M	4,5	Swamps and stream banks	rr	Small stands
Anchusa italica Retz.	Boraginaceae	M–IT	1–4	Ploughed and fallow fields	c	Small stands
Anthemis tinctoria L. var. *dioscoidea* Vahl	Compositae	M	1–3	Batha	r	Small stands
Antirrhirum majus L.	Scrophulariaceae	M	1,6	Shady cliffs and summer-dry streams	r	Small stands
Asperula libanotica Boiss.	Rubiaceae	EM	1,2,6	Maquis and fallow fields	r	Small stands
Asphodelus aestivus Brot.	Liliaceae	M (WIT)	1–8,10	Batha and steppes	c	Large stands
Asphodeline lutea (L.) Reichenb.	Liliaceae	EM (SEB)	1–3,6,8	Batha and steppes	c	Large stands
Bellis perennis L.	Compositae	EB (M)	1,2	Wet sites near springs	r	Small stands
Bellis silvestris Cyr.	Compositae	M (WIT)	1,3–5	Batha	cc	Small stands
Caralluma europea (Guss.) N.E.Br. var. *judaica* Zohary	Asclepiadaceae	EM	1–3	Rock crevices	r	Small stands
Cymbalaria muralis P.G. Gaertn.	Scrophulariaceae	M–EB	3,6	Sporadic on cliffs	rr	Small stands
Eremurus spectabilis Bieb.	Liliaceae	EM–WIT	6	Subalpine steppe	r	Small stands
Eryngium maritimum L.	Umbelliferae	M	4	Coastal spray zone	r	Small stands
Ferula communis L.	Umbelliferae	M	1–5,8	Batha	cc	Large stands

Ferula tingitana L.	Umbelliferae	SM	1–3	Limestone cliffs	c	Small stands
Glaucium flavum Crantz	Papaveraceae	M (EB)	4	Coastal spray zone	c	Small stands
Limonium graecum (Poir.) O. Kuntze	Plumbaginaceae	M	4	Maritime cliffs	rr	Small stands
Limonium sinuatum (L.) Mill.	Plumbaginaceae	M	4	Sandy soils in coastal spray zone	c	Swards
Lythrum salicaria L.	Lythraceae	Temperate regions and Australia	1–5	Stream banks and swamps	c	Small stands
Michauxia campanuloides L'Hér.	Campanulaceae	EM	1,2	Limestone cliffs	rr	Small stands
Salvia bracteata Banks & Sol.	Labiatae	WIT	3	Fallow fields and stony ground	rr	Small stands
Salvia hierosolymitana Boiss.	Labiatae	EM	1,3,8	Batha and maquis	c	Small stands or single plants
Salvia sclarea L.	Labiatae	M–IT	1,2	Batha	r	Small stands
Salvia verbenaca (L.) Vervain	Labiatae	M (WIT)	1,3,4,7	Fallow fields and disturbed sites	c	Small to large stands
Scutellaria galericulata L.	Labiatae	EB (M–WIT)	1	Marshes	rr	Small stands

TABLE III

Wild forms of ornamental annuals and biennials[1]

Species	*Family*	*Phytogeographic area*	*Distribution in Israel*	*Habitat*	*Occurrence*	*Population structure*
Adonis aestivalis L.	Ranunculaceae	M–IT–EB	1,3	Fields and batha	c	Extensive stands
Adonis aleppica Boiss.	Ranunculaceae	EM	3,4	Fields	c or r	Small stands
Asphodelus fistulosus L.	Liliaceae	M	1–4,7,8	Batha and fallow fields	c or r	Small stands
Anagallis arvensis L.	Primulaceae	M–IT–EB	1–10	Fields and batha humid habitats	cc	Swards
Campanula erinus L.	Campanulaceae	M–WIT	1–3,5,7,8	Rocks and in shade	c	Small stands
Campanula rapunculus L.**	Campanulaceae	EB–M–WIT	1–3	Batha and rocky hillsides	r	Small stands
Campanula strigosa Banks & Sol.	Campanulaceae	EM–WIT	1–5,10	Fields	c	Small stands
Campanula sulphurea Boiss.	Campanulaceae	EM	4,7,8	Sandy soils	c	Small stands
Centaurea cyanoides Bergg. & Wahlenb.	Compositae	EM	1,3,4	Fields and batha	c	Local swards
Chrysanthemum coronarium L.	Compositae	M	1–5,7,8,10	Ruderal and fields	cc	Swards
Chrysanthemum segetum L.	Compositae	M (WIT–EB)	1–5	Fields and ruderal	c	Large stands
Cnicus benedictus L.	Compositae	M–IT	2,4,5,7,8,10	Batha and fields	c	Small stands
Iberis odorata L.	Cruciferae	M (IT)	3	Damp patches	rr	Small stands
Lavatera trimestris L.*	Malvaceae	M	1–5	Heavy soils	c	Small stands
Legousia speculum-veneris (L.) Chaix in Vill.	Campanulaceae	WIT–M–EB	1–4	Cultivated and fallow fields	c	Small stands
Limonium thouinii (Viv.) O. Kuntze	Plumbaginaceae	SA	5,7–10	Saline dry soils in desert	cc	Small or large stands
Lupinus luteus L.	Papillionaceae	M	4,10	Batha and fields on sandy soils	r	Swards

Lupinus micranthus Guss.	Papillionaceae	M	1,3,4	Batha and fields	r	Small stands
Lupinus pilosus Murr.	Papillionaceae	EM	1–3	Batha and fallow fields	c	Swards
Malcolmia chia (L.) DC.	Cruciferae	EM	1,3–5	Batha	c	Small stands
Malva sylvestris L.**	Malvaceae	M–EB (WIT)	1–8	Ruderal and wadis in desert	c	Small stands
Matthiola tricuspidata (L.) R.Br.	Cruciferae	M	4	Coastal spray zone	r or locally common	Clustered
Mesembryanthemum crystallinum L.	Aizoaceae	M–WEB	1,4	Coastal spray zone	c	Small stands
Molucella laevis L.	Labiatae	EM (WIT)	1–5,7	Fields on alluvial soils	cc	Large stands
Papaver rhoeas L.:	Papaveraceae					
Papaver subpiriforme Fedde	Papaveraceae	EM	1,3,4	Fields	c	Large stands
Papaver syriacum Boiss. & Bl.	Papaveraceae	EM	1–4	Fields	cc	Large stands
Reseda alba L.	Resedaceae	M–WIT (EB)	1,3–5,8	Waste places	c	Clustered
Salvia horminum L.	Labiatae	M (WIT)	1–5,7,8,10	Fields and batha	cc	Large stands
Scabiosa prolifera L.	Dipsaceae	EM	1,3–5	Fallow fields and waste places	cc	Large stands
Sedum hispanicum L.	Crassulaceae	M–EB	1–4	Soil pockets in rocks	c	Small stands
Silybum marianum (L.) Gaertn.	Compositae	M–IT (EB)	1–5,7,8,10	Ruderal and fields	cc	Large swards
Verbascum orientale (L.) All.	Scrophulariaceae	EM	1–5	Batha and rocks	r	Scattered
Veronica persica Poir.	Scrophulariaceae	IT (M)	1,4,5	Weed in gardens	r	Small stands

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[1] Unless marked by an asterisk the wild forms are winter annuals flowering at the end of winter and/or in early spring. * – summer flowering; ** – biennial or short-lived perennial.

TABLE IV

Wild forms of bulbous, cormous or rhizomous ornamentals

Species	*Family*	*Phytogeographic area*	*Distribution in Israel*	*Habitat*	*Occurrence*	*Population structure*
Allium neapolitanum Cyr.	Liliaceae	M	1,3,4	Maquis, garigue and batha	c	Small stands
Allium schubertii	Liliaceae	EM	1–5	Fields and alluvial soils	r	Small stands
Anemone coronaria L.	Ranunculaceae	M	1–8	Batha	cc	Large stands
Colchicum decaisnei Boiss.	Liliaceae	EM	1,2	Alluvia soils and shade of maquis	r	Small stands
Colchicum ritchii R.Br.	Liliaceae	SA	7,8	Loess steppes	c	Large stands
Colchicum stevenii Kunth.	Liliaceae	EM	1–4,7	Batha and rock crevices	c	Local swards
Crocus cancellatus Herb.	Iridaceae	EM–WIT	2	Batha on basalt, tuff and scoria at 1000–1100 m	r	Small stands
Crocus ochroleucus Boiss. et Gaill.	Iridaceae	EM–WIT	1–3,6	Maquis & among rocks on basalt	rr or locally c	Small stands
Cyclamen coum Mill.	Primulaceae	EM–WIT	1,2,6	Maquis in shade	rr	Small stands
Cyclamen persicum Mill.	Primulaceae	EM	1–6	Rocks and batha	cc	Swards or small stands
Fritillaria persica L.	Liliaceae	EM–WIT	1–3	Batha and maquis	r	Small stands
Gladiolus italicus Miller	Iridaceae	M–WIT	1,3,5,7,8	Fields	c	Weed colonies
Gladiolus atroviolaceus Boiss.	Iridaceae	IT	3–5,7,8	Fields on marl and basalt	c	Weed colonies
Gynandriris sisyrinchium (L.) Parl.	Iridaceae	M–WIT	1–4,7,8	Batha, steppes, and fallow fields	cc	Large or small stands
Hyacinthus orientalis L.	Liliaceae	EM	1,6	Shade of maquis among rocks	r	Small stands
Iris histrio Reichenb.	Iridaceae	EM	1,2	Rocky sites in maquis	r	Small stands or scattered clones
Iris mesopotamica Dykes	Iridaceae	EM	1–6	Rocky batha, cemeteries and ruins	c	Clustered

Iris vartanii Foster	Iridaceae	EM	1–3	Rocky batha	r	Small stands or scattered clones
Ixolirion tataricum Herbert	Amaryllidaceae	IT	3,6–8	Steppes and batha	c (local)	Small stands
Leontice leontopetalum L.	Berberidaceae	EM–IT	3,4,7,8	Loess plains and fields	c	Large stands and local swards
Lilium candidum L.	Liliaceae	EM	1	Limestone cliffs	rr	Small stands
Muscari commutatum Guss.	Liliaceae	M–WIT	1–4,7,8,10	Rocky and stony ground	c	Small stands
Narcissus serotinus L.	Amaryllidaceae	M	4	Calcareous sandstone	rr	Small stands
Narcissus tazetta L.	Amaryllidaceae	M (WIT)	1–6,8	Alluvial soils, swamps, or rock crevices in batha & maquis	c	Large stands
Ornithogalum divergens Boreau	Liliaceae	M	1,3–5	Batha and fields	r	Small stands
Ornithogalum lanceolatum Labill.	Liliaceae	EM	1–3	Batha above 1000 m	r	Small stands
Ornithogalum narbonense L. subsp. *narbonense*	Liliaceae	M–WIT	1–4	Cultivated ground & abandoned fields	c	Small stands
Pancratium maritimum L.	Amaryllidaceae	M (EB)	4	Coastal spray zone	cc	Large stands
Paeonia mascula (L.) Mill.	Paeonidaceae	M (EB)	1	Shade of maquis	rr	Scattered individuals
Ranunculus asiaticus L.	Ranunculaceae	M (IT)	1–8	Batha and steppes	cc	Large stands
Scilla autumnalis L.	Liliaceae	M (EB)	1,3,4	Batha and maquis	c	Small stands
Scilla hyacinthoides L.	Liliaceae	NM	1,3,4,7	Batha and fields among rocks	c	Small stands
Tulipa agenensis DC. ssp. *agenensis*	Liliaceae	EM	1–3	Maquis, garigue, batha	c	Small stands
Tulipa systola Stapf	Liliaceae	WIT	1,3,8,9	Rocky batha and steppe	c	Small stands
Urginea maritima (L.) Baker	Liliaceae	M	1–5,8	Batha, fallow fields and field margins	c	Large stands

TABLE V
Wild forms of ornamental water plants

Species	*Family*	*Phytogeographic area*	*Distribution in Israel*	*Habitat*	*Occurrence*	*Population structure*
Iris pseudoacorus Baker	Iridaceae	EB–M–IT	1	Streams, ponds, and ditches	rr	Small stands
Nuphar lutea (L.) Sib. & Sm.	Nymphaceae	EB–M–IT	1,4,5	Streams and ponds	rr	Clustered
Nymphaea alba (L.) Boiss.	Nymphaeaceae	EB–M	4	Streams and ponds	rr	Clustered
Nymphaea caerulea Savigni	Nymphaeaceae	Tropical Africa	4	Streams and ponds	rr	Clustered

perennials, e.g. *Althea officinalis*, *Bellis perennis*, *Lythrum salicaria* and *Scutellaria galericulata* (Table II), and to weedy habitats when they are annuals, e.g. *Adonis aestivalis*, *Anagallis arvensis*, *Legousia speculum-veneris* and *Malva sylvestris* (Table III).

CHANGES UNDER CULTIVATION

Many of the changes brought about by cultivation have an impact on the species as a whole: (i) The geographic range of the species may expand since the domesticated form is not exposed to the full range of environmental variables. (ii) Ornamental garden plants in which flowers are not harvested, are more liable to naturalization in new areas into which they are introduced than crop plants, including floricultural crops. Thus the distribution area of the species may expand. (iii) Excessive harvesting during incipient domestication may endanger the survival of the species. (iv) Mutations arising under or protected by domestication may add an extra dimension to the genetic variation present in the species. The above trends are well illustrated by the fates of some local geophytes which have become ornamental plants.

Another trend for which local wild plants furnish evidence is loss of variation in the derived gene pool of cultivars.

Expansion of the Geographic Range by Means of Cultivated Forms

In ornamentals, as in other domesticated plants, the problem of survival is taken care of by the grower and hence the plant can occupy wider areas. In creating artificial environemnts which suit the plant's growing needs, man has learned that the native habitat is not necessarily optimal for the desired performance, such as rapid development and high yield of flowers or foliage. Maatsch (1956) cites *Cyclamen persicum* Mill. as a species which performs better in some of its new artificial environments than in areas to which it is indigenous.

Wild *C. persicum* has a disjunct distribution. It occurs: (i) from southern Turkey through Syria, Lebanon and Cyprus to the northern half of Israel (Table IV); (ii) in Crete, Rhodes and the eastern Aegean as far north as Mytelene, and (iii) in Tunis. Cultivated forms are grown mainly as pot plants in all extra-tropical parts of the globe with a floricultural industry. Maatsch (op. cit.) finds similarities in air humidity, temperatures and total hours of sunshine between the plants' natural November to March growing season in Israel and the May to September peak season for cultivars grown out-of-doors in Alsmeer, Holland. Uniform potting composts augmented by nutrients fulfil and optimize the plant's edaphic needs. Yet the florist's cyclamen could not have achieved its present distribution if it had not undergone changes in genetic factors determining its growth rhythm. In its Mediterranean distribution wild *C. persicum* is totally summer dormant. The discovery that seedlings can be grown to maturity without a rest period was a milestone in its breeding history (Wellensiek et al., 1961; Lyons & Widmer, 1980). Moreover, cultivated forms can be brought into flower at all times of the year without artificial light regimes. Schwartz (1938, 1964), the chorographer of the genus *Cyclamen*, postulates that this taxon had its origins in the evergreen rainforest of warm–temperate zones. He contends that all species of

Cyclamen have maintained some traits that are characteristic of understorey plants of such forests. According to Schwartz, the silvery zonation and the prostrate spread of foliage leaves are features which equip the plant for growth under low light intensity; the tubers, which are partially above ground in some species, may have had a former function in myrmecophily; some species, such as *C. neapolitanum* Ten. and *C. purparescens* Mill. have remained evergreens and photosynthesize throughout the year. In Schwartz's view, drought resistance and summer dormancy in the Mediterranean species are specializations which have been reversed in the case of *C. persicum* by back mutations under domestication. It is not known whether such changes could establish themselves readily because they fit the basic make-up of the species.

From our observations in Israel, *C. persicum* is tolerant of shade. It is variable in flowering time and in the timing and proportion of flower production relative to leaf production. The heritability of such differences in growth rhythm within the winter growing season has not been examined. Ozeri and Kadman-Zahavi (pers. commun.) find that long photoperiods induce summer dormancy in the wild form.

So far the elimination of dormancy intervals has not boosted the species' capacity for reproducing and thriving in some of its new areas without man's aid, as has been the case in *Tulipa agenensis* (see below). However, potentially the evergreen florist's cyclamen is adapted to warm–temperate and subtropical regions.

Expansion of the Wild Distribution Area

Examples of this trend are provided by the genus *Tulipa*. The symmetrical and colourful flowers of the tulip, issuing from easily-handled bulbs, may have had an aesthetic appeal to collectors of earlier times. The plants' naturalization and spread in the new areas to which they were introduced must have been aided by their vegetative longevity through annual renewal bulbs. Since tulips made their appearance in Turkish, Persian and Mogul art and literature only in the middle of the 16th century and there are apparently no descriptions or reproductions which fit its flower in European sources prior to that time, Marais (1980) concludes that probably "all European and most Middle Eastern tulips were brought westwards from central Asia by migrating tribes."

Following Feinbrun-Dothan (in press), we regard *T. agenensis* DC. as an indigenous eastern Mediterranean species. In Israel, its subspecies *agenensis* grows in primary Mediterranean maquis and garigue associations (Table IV) and a second subspecies, *T. agenensis* subsp. *boissieri* (Regel) Feinbr., is endemic to this country and confined to sandy loam and calcareous sandstone soils of the Coastal Plain.[1]

It appears that subsp. *agenensis* was introduced into western Europe in the 17th century. Parkinson's (1629) *T. boloniensis* and also a description by Clusius of tulips growing in Dutch gardens in that century (Solms-Laubach, 1899) more or less fit this

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[1] One can even evoke Bible references for an early impact of this plant on our area. According to the interpretation of Moldenke and Moldenke (1958), subsp. *agenensis* (*T. montana* auct. non Lindl.) signifies the Rose of Spring (Ecclesiastes 50) and subsp. *boissieri* (syn. *T. sharonensis*) the Rose of Sharon (Song of Solomon, see Introduction).

20–30-cm tall, woolly-bulbed plant, whose scarlet flowers have a rhomboidal black blotch edged with yellow at the base of each perianth segment and whose outer perianth segments are longer than the inner ones. In the early 19th century the species was named by de Candolle after its collection site at Agen, France, and has since been known as a not uncommon field plant in southern France and northern Italy. Levier (1894) mentions its being sold by flower vendors in Florence and recounts that the vendors could distinguish it from another "paleo-tulip", *T. praecox* Tenore.

Paleo-tulips (Levier, ibid.; Solms-Laubach, 1899) were intact species that had become part of local segetal floras in contrast to neo-tulips that were escaped garden tulips of hybrid origin. During much of the 19th century the area of origin of *T. agenensis* remained unclear. Localities in Lebanon and Palestine were described as "in cultis" in Boissier's Flora Orientalis. The occurrence of populations in undisturbed hill habitats in these countries and in southern Turkey was only gradually recognized. The species has never been recorded in Greece or Yugoslavia, and this gap between the area of origin or ancient establishment and the secondary distribution area points to a transfer by flower-minded travellers.

Threat of Extinction through Overuse

An example of this fate is provided by genuinely wild forms of the White or Madonna Lily, *Lilium candidum* L. The ornamental status of this lily is of great antiquity. Together with the Lotus flower, *Nelumbo alba* L., *Lilium candidum* is regarded as the earliest species to be taken into cultivation for its decorative qualities. According to Warburg (1929), the White Lily may already have been cultivated in Asia Minor in the middle of the second millenium BC. Moreover, it is depicted on artefacts from the Aegean Bronze Age, e.g. on a vase excavated on the Cycladian island of Santorini (Thera) and dating to before 1,500 BC (Marinatos, 1969, pl. 25). From the excavations at Thera it can be inferred that lilies growing wild were actually used as cutflowers at the time. The same red lilies, probably the native Aegean *L. chalcedonicum* L., which are shown growing out of the substrate in the striking Spring Fresco of Thera (Warren, 1975), are depicted as cutflowers in vases on window jamb decorations (Marinatos, 1974). In subsequent eras *L. candidum* became widely distributed in the Near East and Mediterranean as an ornamental and medicinal plant and reached central Europe during the Early Middle Ages.

Lilium candidum, including the Greek *L. peregrinum* Mill., has no near relatives among southwest Asian or Mediterranean lilies. Species resembling it most closely morphologically, such as *L. longiflorum* Thunb., are native to the Far East. According to Warburg (op. cit.), the area of origin of the White Lily may have extended over formerly forest-covered parts of Asia Minor, Thessaly, the eastern Mediterranean and the southern part of the Balkan Peninsula. In the Balkans, the area of origin postulated by Woodcock and Stearn (1950), wild populations have been superseded or blurred by naturalized ones, while single, relict, genuinely wild stands occur in Macedonia and particularly in the eastern Mediterranean (Table IV). Naturalization has also extended the species' range to the central and western Mediterranean. Abundant local occurrence is reported in particular in wooded regions in the Canary

Islands, the Balearic Islands, Corsica, Sardinia, and Sicily, and in various floras single localities are mentioned in southern France, Morocco, Algeria, Tunis and on the west coast of Italy and Dalmatia. Most of these localities are in the vicinity of villages, churches or ruins of former habitation. In contrast, the wild stands in Macedonia, Lebanon and Israel occupy niches in neighbourhoods that were probably never inhabited or cultivated.

The shrinkage of the postulated wild distribution must be basically due to the disappearance of forests from the area since the last pluvial era. *Lilium candidum* flowers after the beginning of the summer drought in May–June, and the disappearance of a forest cover that affords shade during the period of fruit ripening may have pushed the species into remaining wood and maquis areas. Throughout historical times wooded areas which were potential habitats were destroyed by man. Yet, even today, numerous suitable niches for this lily persist in the northeastern corner of the Mediterranean and far outnumber the few relict colonies of the species. It appears that direct utilization of wild plants by local inhabitants has caused the final decline.

The area of northern Israel and Lebanon was densely populated in Biblical and especially in Roman times. The ancient use of flowers for ornament forestalled seed production, while utilization of bulbs for preparation of wound ointments interfered with vegetative reproduction. In Christian times the flower was adopted as a symbol of chastity by the Church. Until recent times (see Fonck in Warburg, 1929), residual wild colonies were further reduced by the use of flowers for altars and transplantation to monastery gardens. In the summer-dry eastern Mediterranean part of the postulated wild area, in contrast to the situation in the Balkan Peninsula and that in the more humid areas of secondary colonization, conditions for naturalization from garden plantings were unfavourable. Hence the species disappeared when the wild population was used up.

The site where the White Lily was first rediscovered in Upper Galilee in 1925 was an underground karst pit in the maquis. In addition to providing summer shade, this niche also has the attributes of a hiding place necessary for plants that are threatened by man. Some of the other localities discovered on Mt. Carmel and in Upper Galilee are on cliffs which can only be reached with difficulty. It has not really been established whether, in this case, the cliffs fulfil the roles ascribed to them by Davis (1951), i.e. satisfy climatic edaphic requirements or protect from plant competition and grazing, or whether they have served to protect relict plants from man. During the last two decades *L. candidum* has been protected by law in Israel. Because of self incompatibility, re-establishment from drastically reduced residual stands may present a problem. The recent observation of seedling plants in an Upper Galilee population (G. Neeman, pers. commun.) either indicates that the founder colony consisted of more than a single clone or that individual local plants are self compatible.

Increase of Genetic Variation

A common aim in ornamental plant breeding is the production of morphological diversity and novelty. Examples of species which have responded well to the manipulations inspired by this aim and in which cultivars exhibit a variability not found in nature are *Hyacinthus orientalis* L. and *Cyclamen persicum* Mill. (Table IV). In both species spontaneous chromosome doubling has played a part in the breeding process.

Wild *Hyacinthus orientalis* has a narrow geographic range on limestone rock around the northeastern corner of the Mediterranean (southern Turkey, Syria, Lebanon, Cyprus and Israel).

Within the 400 years since its introduction from Turkey to the Botanical Garden of Padua the species has gained greatly in variability in response to the efforts of successive generations of hyacinth breeders. Darlington who chronicled these changes (Darlington et al., 1951; Darlington, 1963) assumed the starting material to be highly uniform. However, this may not be entirely the case. Wild populations studied by the authors in Israel show variation in leaf width, flower size and proportional length of the tube and lobes of the perianth. The number of flowers per raceme is inconstant (5–8) and, while the majority of plants have pale blue flowers, more intensely blue-flowered individuals do occur. Recently, Wendelbo (1980) described a new subspecies, subsp. *chionophilus* Wendelbo, which occupies altitudes of between 1,600 and 2,500 m in SE Turkey and differs from the typical subspecies of lower altitudes in broader leaves and more deeply lobed perianth segments. This subspecies could feasibly have donated genes to breeding stocks based on subsp. *orientalis*.

The garden forms illustrated and described in the 16th and early 17th centuries show little change from wild plants. The earliest variants reported had white or pink flowers or a double perianth. Stem fasciations leading to an increase in the number of flowers per inflorescence, changes in the shape of the perianth and additional flower colours of yellow and lilac came later. The species outcrosses in nature and enforced self fertilization in breeders' gardens may have enhanced mutability, as assumed by Darlington (1963), in addition to laying open recessive mutations already present in the wild material. Likewise, the change in the mating system may have provoked the formation of unreduced gametes, for triploids appeared and were unwittingly selected by breeders because of their higher vigour. Darlington et al. (1951) found that each of the chromosomes in the set of $x = 8$ is "balanced in itself" and hence, as a rare phenomenon in flowering plants, triploids and aneuploids in the range between 16 and 32 chromosomes are sexually fertile. It may be worth noting that the set of $x = 8$ is itself regarded as derived from the set of $x = 9$ present in the other two members of the genus *Hyacinthus* (Bentzer et al., 1974). The authors postulate that the loss of a small chromosome may have occurred following an unequal translocation.

Through crosses between forms with gene mutations and changes in the number of chromosomes thousands of distinct recombinant varieties were produced, of which some hundred survive today. Many of these were characterized chromosomally by Darlington et al. (1951). Thus the proportional presence of given anthocyanins in the petal, which determines flower colour (e.g. see Harborne, 1967, p. 286), may be connected with the number of times a certain chromosome carrying the pigment gene is present in the genome. From the studies of Darlington et al. (op. cit.) diversity is largely based on dosage effects of varying representation of whole chromosomes in the genome and not on alterations of chromosome parts. In recent times higher chromosome numbers, up to the tetraploid level, are being selected. Varieties with a wild-type flower colour are among the most vigorous. Selection has led to an increase in the number of leaves per flowering bulb, and this may reflect a need to fit varieties to the exclusive practice of vegetative propagation. It has not been verified whether wild forms respond as readily as the commercial varieties to the various methods for inducing bulblet formation.

Cyclamen persicum Mill. is also a breeders' plant. This species, perhaps even more than the hyacinth, is far from uniform in nature. Even on superficial examination, we found Israeli populations to be variable in their winter growth rhythm, as mentioned before, in leaf markings and shape, colour (white, pink, lilac, purple) and colour pattern of the perianth.

Though there is documentation of introductions of *C. persicum* to western Europe from the 17th century onwards and Parkinson (1629) in that century described an unusual form, the double and dark red flowered "*C. antiochenum*", intensive breeding began only in the second half of the 19th century. Initial selection was for more intense flower colours than those common in nature and reddish (malvidin-pigmented) petals. The genetic basis of flower pigmentation is sufficiently well understood today (van Bragt, 1962; Wellensiek et al., 1963) to allow one to conclude that at first recessive alleles likely to be present in the wild source material were selected and manipulated. From the end of the 19th century onwards peonidin glycosides, which are altogether rare in nature, appeared as new mutations in different breeding accessions. These pigments gave rise to a range of red and salmon-flowered cultivars. Another new feature was the appearance of fertile autotetraploids with a chromosome number of $4x = 96$ and with a much larger flower size than that attained by initial selection for flower size in diploids. Most modern pot cyclamens are tetraploid; some cultivars have a chromosome number of $2n = 92$ and, in some cases, the loss of one set of homologues is reflected in a deviating flower pigmentation. Among other novel traits enriching the cultivar assortment are a frilled edge of the corolla and a crested midrib of the corolla.

Unlike the hyacinth, *C. persicum* has maintained its mating system of cross pollination under domestication. Furthermore, vegetative propagation has not been practiced in the past and has only recently evoked interest. Thus individuals in a cultivar are only identical in the type traits selected by the breeder, in contrast to the fully identical plants in a clonal variety of hyacinth.

Shrinkage of Variation under Cultivation

Loss of variation in the domesticated as compared to the wild form is common in cultivated plants because introductions cannot embrace the entire wild gene pool and because of the streamlining by breeders to fit cultivation needs. This streamlining may be less drastic in ornamentals which have not yet attained crop plant status and in which achievement of diversity is a paramount aim. A narrowing of the genetic base may, however, also occur under garden conditions.

Anemone coronaria (Table IV) may serve as an example. It was introduced from the Near East and domesticated in western Europe about 400 years ago (Johnstone, 1972). As is often found in cultivated plants, the variation in germination rate has been narrowed, and only forms with an accelerated germination were maintained; moreover the trait of summer dormancy of freshly collected seeds, which is predominant in wild plants in Israel (Horovitz et al., 1972), has been lost by selection for summer germination. Another summer response reduced by domestication is the sensitivity to long photoperiods which induce dormancy in wild plants (Kadman-Zahavi et al., in press).

The species is extremely variable and, during much of its domestication history (Johnstone, op. cit.), it was a collectors' plant with a premium on variation in floral morphology. Vegetative propagation was practiced to maintain some of the variant forms. Phenotypic diversity of the wild species has been studied in Israel, in the northern half of which *A. coronaria* has an almost continuous distribution and forms dense populations in a variety of habitats. It appears that even at times when hundreds of varieties of *A. coronaria* were grown as garden plants (Johnstone, 1972), only a small part of the natural variation was represented in the cultivar assortment. Even if introductions to cultivation were heterozygous for genes determining the colour of the perianth, pollen, stamen filaments and pistils, and the shape and range in numbers of perianth lobes, the floral polymorphism that could be regenerated from these introductions had its limits. Moreover, since fewer plants were cultivated than grow wild, replenishment of variability through mutations under cultivation was unlikely to occur at the same rate as in nature.

In the present century, *A. coronaria* has become a commercial cutflower crop and is now entirely seed propagated. The species is cross pollinated and, apart from several recent ventures to produce fertile hybrids, only some few varieties which breed true for selected traits under open pollination are maintained. Alleles which do not fit the type traits are discarded. Thus, in the standard varieties developed from garden plants, only the few perianth colours which are determined at homozygous loci are maintained. The present loss in floral polymorphism is not altogether irreversible. With larger scale cultivation, more numerous viable mutations arise and can be retrieved by the breeder. Since *A. coronaria* is mutable we define the impoverishment of polymorphism in this species as shrinkage rather than loss.

Ornamental plants have an even shorter history of cultivation than many crop plants. Hence comparisons between such plants in their wild state and in flower gardens and fields can teach lessons on short term effects of plant domestication.

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