THE IRISES STILL EXIST: THE CONSERVATION STATUS OF SPECIES *IRIS* SECTION *ONCOCYCLUS* IN ISRAEL, A CENTURY AFTER THEIR DESCRIPTION

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ABSTRACT - The changes in the distribution of the species *Iris* section *Oncocyclus* in Israel during the last hundred years are described, according to the following chronological stages: the deterioration phase (1876-1953); the arrest phase (1954-1970); the restoration and stabilisation phase (1971 to present). Ten narrow endemic taxa of the section (c. 25%) are distributed in Israel, the only area in the Middle East in which the species are genuinely protected. Field studies revealed that at present they occur in no more than 10-28 quadrates of 1 km^2 area per species. Therefore, their conservation status, according to IUCN categories, is determined as "Endangered" (En). Even if the law today protects all *Iris* species in Israel, 45-95% of the populations of each taxon are not practically conserved within official reserves. The highly endangered taxa *Iris atropurpurea* and *Iris hieruchamensis* are represented by small-sized reserves of less than 1 km^2 area. Recommendations for future protection and conservation activities are presented.

KEY WORDS - *Iris, Oncocyclus,* Nature Conservation, vendegered species endemic, Israel

INTRODUCTION

The section *Oncocyclus* of the genus *Iris* comprises 30-35 species (c. 50 taxa); more than half of these are distributed in the Levant (Dykes, 1913; Rodionenko, 1961; Mathew, 1989; Rix, 1997). All taxa of the section in Israel are narrowly endemic, very limited in their distribution areas (Avishai, 1975; Feinbrun, 1986). They grow mainly in open scrub or herbaceous formations, occurring in the edges of the Mediterranean territory as well as in the Coastal Plain and the semi-desert areas. All districts are characterised by many plant species of Irano-Turanian origin (Ginsburg, 1956; Gazit-Ginsburg, 1960; Avishai, 1977). The original populations, never very large, were drastically reduced during the last hundred years by commercial exploitation, rapid habitat destruction caused by continuing development pressure

and by picking because of their exceptionally showy flowers. Since 1964, law has protected all *Iris* species in Israel, but despite this legislation they are currently threatened by extinction. The aim of this study is to describe the changes in the distribution of the species in Israel, focusing on the reasons which led to the reduction of populations; to identify the conservation status of the species; and to recommend future protection and conservation activities.

Nine species of the section *Oncocyclus* are recorded in *Flora Palaestina* (Feinbrun, 1986; cf. table 1). Due to the fact that reproductive isolation is lacking in the section (Avishai, 1977; Avishai and Zohary, 1977; 1980), it is impossible to consider the different taxa as distinct biological species. Consequently, at present it is preferable to consider each eco-geographical isolated continuity of populations as a separate taxon, without specifically treating its taxonomic status. This treatment is very significant from the nature conservation aspect, as each eco-geographically isolated aggregate of populations seems to represent a separate gene pool. Therefore, much attention is needed to prevent the extinction of each taxon, i.e., a unique gene pool. According to this concept, the section in Israel is presented as comprising ten separate taxa. Four taxa are distributed in northern Israel, characterized by bicoloured flowers and spotted falls: *Iris bismarkiana* Dahman and Spreng., ex Regel *I. hermona* Dinsm., *I. lortetii* Barbey var. *lortetii* and var. *samariae* (Dinsm.) Feinb. The other taxa grow in respectively arid areas of the centre and south of the country. They are characterized by lilac-blue or purple to dark brown flowers and uniform unspotted falls: *I. atrofusca* Bak., *I. atropurpurea* Bak., *I. haynei* (Bak.) and *I. mariae* Barbey. Two additional taxa of this group have not yet been described but were published as *nomen nudum*. The eastern Northern Negev populations, previously included in *I. atrofusca,* are presented here as *I. loessicola* Kushnir (1949). The populations of the sand dunes in the central Northern Negev (*I. petrana* Dinsm. p.p., sensu Feinbrun, 1986) are named here *I. hieruchamensis* (Avishai, 1976).

Materials and Methods

By focusing on the years 1850-1950, a wide literature survey was carried out, aiming to extract information and notes about the geographical sites of the *Iris* species in Israel and their abundance. The geographical data for sites and distribution of populations had been documented and partly presented during the early seventies (Avishai, 1975, 1977). No previous quantitative data had been collected and localities were poorly and partially recorded. Accordingly, it is impossible to compare the number of sites and populations during most part of the period discussed (1850 to present). The changes in the distribution of the species of *Iris* section *Oncocyclus* in Israel are determined and described, mainly on the basis of careful examination of literary notes. The studied period is divided into three chronological stages.

The present distribution of each species was studied by extensive field surveys in Israel during 1990-1998. The size of the distribution area of each species is recorded by estimating the total potential area in which the populations may occur. The distribution of the populations was studied by recording quadrats of 1 km^2 in which the taxa exist (table 2). The quadrats were documented using topographical maps (1:50,000, Israel grid). Estimations of the number of individuals per species were also included in the surveys and are briefly discussed.

TABLE 1: A CHRONOLOGICAL VIEW OF THE SPECIES IRIS SECTION ONCOCYCLUS IN ISRAEL AND JORDAN, ACCORDING THEIR DATES OF DESCRIPTION

Date of description	Species	Author	Collector (date of collection): district\locality of collection	Reference	First publication of Icon (* illustrated in colour)
1859	«Hula Lily»	Thomson	Idem. (?1852): Hula Valley.	The Land and the Book, 256.	see: *Iris bismarkiana*.
1865	*Iris sari* auct. [=I. bismarkiana]	Tristram Post Boissier	Idem. (1864): near Nazareth. ??: Moab, Hula. Gaillardot (c. 1855): near lake Hula.	1865: The Land of Israel, 485. 1884: Fauna & Flora of Palestine, 423. 1883: Post, Fl. Syr. Pal. Sinai, edit. 1, 769. 1884: Boiss., Flora Orientalis *5*, 121	see: *Iris bismarkiana*.
1876	***Iris haynei***	Baker	Hayne (1872): Mt. Gilboa.	Gard. Chron. 1876, ser. 2: 710.	**1904:** Gard. Chron., suppl., April. 23. **1950*:** in Hebrew publications.
1882	*I. helenae* Barbey (non Koch) [= Iris mariae]	W. Barbey	C. & W. Barbey (1880): Sinai Coastal Plain.	Herborisations au Levant, 159.	see: *Iris mariae*.
1882	***Iris lortetii***	W. Barbey	Lortet (1880): Lebanese area of the eastern Upper Galilee.	Herborisations au Levant, 178.	**1882*:** ibid., tab. 7. **1892*:** Bot. Mag., t. 7251. **1893*:** Gartenflora 42., f. 102.
1889	***Iris atropurpurea*** [incl. var. eggeri]	Baker	Comm. source by Damman & Co., Naples (1889): «introduced from Syria», but later corrected as «from Palestine».	Gard. Chron. 1889, ser. 3, 5: 330.	**1890:** Vien. Ill. Gart.-Zeit. 15: 353. **1891*:** Gartenflora 40: 649, t.. 1361. **1891:** Bul. Soc. Toscana Ortic. 16: 144. **1893*:** Bul. Soc. Toscana Ortic. 28, t. 7. **1893*:** Gartenflora 42, f. 101.
1890	***Iris bismarkiana***	E. Damman & C. Sprenger ex Regel	Comm. source by Damman & Co., Naples and by Sprenger, (1888): «from the Lebanon» and also «imported from Palestine».	Wiener Illustr. Gartenzeitung 15: 352, f. 72.	**1890:** ibid., f. 72. **1893*:** Bul. Soc. Toscana Ortic. 28, t. 7. **1893*:** Gartenflora 42. **1904*:** Bot. Mag, t. 7986.
1891	***Iris mariae***	W. Barbey	see: *I. helenae* Barbey.	Österreichische Botanische Zeitschrift 41: 207.	**1893*:** Bul. Soc. Toscana Ortic. 28, t. 7. **1893*:** Gartenflora 42, f. 106.
1893	*Iris sari* var. nazarena [= Iris bismarkiana]	Foster	see: *I. bismarkiana*.	Gard. Chron. 1893: 133.	see: *Iris bismarkiana*.
1893	***Iris atrofusca***	Baker	Comm. source by Herb & Wulle, Naples (?1893): «from the east side of the River Jordan in Palestine».	Gard. Chron. 1893, ser. 3, 1: 384.	**1893*:** Bul. Soc. Toscana Ortic. 28, t. 7. **1893*:** Gartenflora 42, f. 100. **1894*:** Bot. Mag. tab. 7379, (as I. atropurpurea var. atrofusca).
1933	***Iris hermona***	Dinsmore	? Bacher (1912). Dinsmore: S Kuneitra, eastern Golan Heights.	Post Flora 2nd edit., 2: 596 (1933); Pl. Post. et Dinsm. fasc. 2: 8 (1934).	**1970*:** in Hebrew publications. **1986:** Fl. Palaest. 4: Pl. 158.
1933	***Iris nigricans***	Dinsmore	Comm. source by Krelage & Sons (1898). Dinsmore: Amman area in Transjordan («probably introduced to Italy in 1890 as a form of *I. atropurpurea*»)	Post Flora 2nd edit., 2: 600 (1933); Pl. Post. et Dinsm. fasc. 2: 11 (1934).	**1946:** Davis in J. R. Hor. Soc. 71, f. 32. **1986:** Fl. Palaest. 4: Pl. 163.
1933	***Iris petrana***	Dinsmore	Dinsmore: Shawbak, in S Transjordan.	Post Flora 2nd edit., 2: 599 (1933); Pl. Post. et Dinsm. fasc. 2: 10 (1934).	The figure of *Iris petrana* in Fl. Palaest. 4 (1986) is of *I. hieruchamensis*.
1933	*Iris samariae* =***I. lortetii*** *var.* **samariae** (Dinsm.) Feinbr.	Dinsmore	Dinsmore: Bayta near Nablus, in Samaria.	Post Flora 2nd edit., 2: 598 (1933); Pl. Post. et Dinsm. fasc. 2: 9 (1934). var. *samariae*: Fl. Palaest. 4: 121 (1986).	**1975*:** in Hebrew publications.
1933	*I. atropurpurea* v. gileadensis *I. hauranensis* *I. jordana* *I. biggeri* [= Iris haynei \ atrofusca]	Dinsmore	Whiting: above Jabok. Van Tuhergen (before 1905). Bacher: near Mkays. Wallace (1913). Dinsmore: Baysa'an area. Bigger: Faqqu'ah [Mt. Gilboa].	all in: Post Flora 2nd edit., 2: 598-601 (1933); Pl. Post. et Dinsm. fasc. 2: 9-11 (1934).	
1949	***Iris loessicola*** (nom. nud.)	Kushnir	Kushnir (1947): E Nothern Negev, near 'Arad.	Pal. J. Bot. 4 (4): 231.	**1950*:** in Hebrew publications. **1956:** Flora of the Land of Israel Iconography 101-150 (as *I. atrofusca*).
1976	***Iris hieruchamensis*** (nom. nud.)	Avishai	Avishai (1970): C Northern Negev near Yerucham.	in Zohary, New Analyt. Flora Israel: 452.	**1970*:** in Hebrew publications. **1986:** Fl. Palaest. 4: Pl. 164 (as *I. petrana*).

Conservation status for each species is presented, using the IUCN categories (IUCN, 1980). Rarity and potential threat of extinction are identified using a local method which incorporates different factors of vulnerability to classify the conservation status (Cohen and Shmida, 1992). The main parameters are data on distribution and habitat and estimations of potential extinction. Seven main factors affecting the threat of extinction are determined, each is estimated by one of three qualitative levels and priority ranking of the taxa for conservation activities is suggested (Table 3).

DESCRIPTION OF SPECIES – AN HISTORICAL REVIEW

The chronological stages of species description are summarized in Table 1. References to diagnoses as well as author names are included in the table and not cited in the following review. During the first stage, 1876-1893, six species were described as new to science; most were recorded in the Cis-Jordan territories. Three of these species were described by Baker, the *Iris* specialist from the Royal Botanic Gardens Kew, to whom many new species from all over the world were sent. The next stage is credited to a single person, John Edward Dinsmore. In the 1930s he described many new taxa. Four of his new species, which are distributed in Israel and Jordan, are currently taxonomically accepted as separate taxa. Two additional taxa (not yet validly described) were further identified in the northern Negev deserts of S Israel by Israeli botanists during the next decades.

Since the middle of the nineteenth century, a splendid very large flowered *Iris* has been reported in northern Israel by several travellers. Thomson (1859) named it the "Hula Lily" in his *The Land and the Book*. Tristram collected the same *Iris* near Nazareth, on the 16th March 1864, during his long voyage in the Holy Land. This unique finding is described in his travel diary: "An Iris, the most gorgeous I ever beheld, white and purple, unfolded its glories under the bushes" (Tristram, 1865, p. 485). Later, he erroneously recorded the species as *I. sari* Schott (Tristram, 1884). Post (1883) and Boissier (1884) also recorded this misapplied name for the same local taxon (*I. bismarkiana*).

The first species of the section *Oncocyclus* described from the Holy Land was collected by Hayne in April 1872. The discoverer was a fellow traveller of Tristram during his voyage to the land of the Gilead (Tristram, 1884, p. 423). Baker described the new *Iris* in 1876, basing his diagnosis on a couple of Hayne's dried specimens (Baker, 1892). The species was rather mysterious and undercollected during the next decade until its recollection for commercial uses (Mallett, 1904).

Two additional new species of the section were described in C. and W. Barbey's book *Herborisation au Levant* (Barbey, 1882). They located the first in the sandy area of the N Sinai Coastal Plain in the end of March 1880, during their voyage in the Levant. It was named *I. helenae* Barbey (presynonym of *I. mariae*), dedicated to W. Barbey's mother, Hélène-Marie. The other species was named *I. lortetii* after its discoverer, Dr. Lortet of Lyon, who collected it on the 19th May 1880 in the Lebanese area of the Upper Galilee, during his travels to Syria. A glorious coloured print of *I. lortetii* (45x29 cm) was shown in Barby's book, the first published print of an *Oncocyclus Iris* from the Holy Land. This print caused much excitement to *Iris* lovers in Europe and directed a great deal of attention to searching for and locating, more splendid irises in the area.

All *Oncocyclus* irises later described were from commercial sources. The new species were imported from Palestine and south Lebanon by seed merchants and nurseryman from Naples during 1889-1893. *I. atropurpurea* was described in 1889 by Baker based on live material "from Syria", introduced by Damman & Co. This company was also responsible for exporting the splendid "Hula Lily" in 1888. It was named by Regel in 1890, following Sprenger's proposal (Sprenger, 1904), as *I. bismarkiana* and later by Foster as *I. sari* var. *nazarena*. The last species included in this stage – *I. atrofusca*, was introduced by Herb and Wulle Co. of Naples from "the East Side of the river Jordan" and described by Baker in 1893, based on live material of this source.

The same six *Oncocyclus* species are recorded in the first edition of the *Analytical Flora of Palestine* (Eig *et al.*, 1931). Additional species from Palestine were published by Dinsmore (Post, 1933; Dinsmore, 1934). Staying in Jerusalem for many years, since the first decade of this century, he intensively searched the neglected areas of the country. He also grew all the species in his *Iris* garden at the American Colony Hostel in Jerusalem. According to his own surveys (e.g., West, 1934; Whiting, 1943) and to additional material received from local *Iris* lovers (e.g., Bigger, 1934), Dinsmore recorded many new distribution sites for the local *Oncocyclus* irises. He described eight new species from the *Flora Palaestina* area, most of them from Trans-Jordan. Four of his species are treated today as separate taxa: *I. hermona*, *I. nigricans* Dinsm., *I. petrana*, and var. *samariae* of *I. lortetii*.

CHANGES IN THE DISTRIBUTION OF THE SPECIES IN ISRAEL

There have been significant changes in the distribution of the species of *Iris* section *Oncocyclus* in Israel during the last hundred years. Three chronological stages for these changes are described:

1. The Deterioration Phase (1876-1953):

The transfer of small quantities of *Iris* rhizomes from the wild to the garden, particularly to cemetories, already occurred in the Holy Land during ancient times. The most commonly distributed species in Muslim graveyards in Israel is *Iris mesopotamica* Dykes, but some *Oncocyclus* irises also had been planted. Some populations, which are recently spontaneously growing near or within ancient villages, are supposedly of human planting. These include some populations of *I. lortetii* (Hula Valley), *I. bismarkiana* (Hula Valley, W Lower Galilee) and *I. hermona* (near graveyards and Mohammedan Saint shrines in the C Golan Heights). A few introduction activities were later reported by Dinsmore (Post, 1933): the transferring of the "Hula Lily" (*I. bismarkiana*) to villages in the western Lebanon by Rev. Eli Smith in about 1870, as well as the growing of *I. hauranensis* Dinsm. (syn. of *I. haynei*) by resident of the southern side of the Sea of Galilee. Davis (1946) also mentioned this population of *I. hauranensis*, which was extinct since his observation. However, a massive uprooting of the *Oncocyclus* irises in Israel did not begin before the late 1880s, when they were a main object for commercial exploitation.

It is preferable to use the year 1876 as the starting point of the deterioration phase, as it indicates the description date of the first species in Israel, *I. haynei*. However, it seems that the true turning point was the publication of the large coloured print of *I. lortetii* in Barby's book in 1882. In addition to the focus on searching for more splendid

irises in the area, much effort was invested to export this glory and natural beauty to European gardens. Not more than ten years later, the Messrs. Herb & Wulle (1893), the owners of a commercial company in Naples, considered both *Iris lortetii* and *I. bismarkiana* (as *I. sari nazarena*) as "the most beautiful irises in the world".

The first *Iris* species described as a result of export was *I. atropurpurea,* which Damman & Co. of Naples introduced to Europe in 1889. This species was distributed widely on the light soils of the coastal strip of Israel. Today, most of its relic populations are distributed far away from the urban centre of Israel, but some of them still survive in the north Tel-Aviv area, in the vicinity of Jaffa. Sprenger (1904) and Mallett (1904), both mentioned Jaffa in the context of supplying local material of different *Oncocyclus* irises. It is reasonable to assume that the first for export were the nearest and most accessible species. One of the persons involved was Mr. George Egger of Jaffa, who was presumably also the local supplier for *I. atropurpurea* as indicated by the names *I. eggeri* (Dykes, 1913) and var. *eggeri* (Dinsmore, 1934). Egger was the vendor of *I. bismarkiana*, featured in *Curtis's Botanical Magazine* (Wright, 1904), and was probably Dykes' correspondent in Jaffa for field information on *I. grant-duffii* Baker (Dykes, 1909). The origin of *I. atropurpurea*, recorded by Baker when he first described the species, is "from Syria" (also a common name for Palestine), but later it was recorded specifically "from Palestine" (Herb and Wulle, 1893; Baker, 1894). The commercial companies kept its origin a professional secret. However, it seems that the original material was brought directly from the neighbourhood of Jaffa.

In a preliminary article on the "splendid irises from Palestine" which was published on the same date in two horticultural journals (Herb and Wulle, 1893; Wulle, 1893), the authors presented five *Oncocyclus* irises, most colour figured (Table 1). *I. atrofusca* was recorded as their own discovery and *I. mariae* was introduced commercially for the first time. All species were advertised as available in the nursery and were highly recommended for cultivation in a mild climate, in which "splendid results can be obtained".

The publishing of the diagnoses of four *Oncocyclus* irises from Palestine in the horticultural journals and not the usual botanical ones contributed to the growing fame of the species amongst horticulturists. By this time, locating of most of the species in nature was complete, as well as establishment of commercial relationships with local sources. Now that the large irises from the Holy Land were familiar to gardeners, the requirement for fresh material increased; therefore large quantities of rhizomes were uprooted and exported annually. Unfortunately, cultivated specimens rarely survive in open garden for more than two seasons, as the rhizomes require a hot and dry dormancy period, causing a continuous demand for fresh material. It took about ten years for the agents of the commercial companies to exhaust most of the local potential. Most species were listed at this time in the catalogues of the main nurseries in Europe (e.g., Krelage and Sons, 1892-1913; Van Tubergen, 1893-1909). Krelage and Sons, reported in their 1892's list *I. atropurpurea*, *I. bismarkiana* and *I. lortetii*, in 1893 *I. mariae*, in 1895 *I. atrofusca* and in 1898 they introduced from the East of the Dead Sea a Niger iris, described many years later *as I. nigricans* (Dinsmore, 1934). The drastic "Oncocyclus iris robbery" in Palestine which almost led to the species disappearance, was reported by Sprenger (1904): "*I. bismarkiana* - now probably non-existent, owing to unscrupulous collectors" and in addition: "they will certainly become extinct as the collectors in Jaffa plunder them every spring in a condonable manner".

Following this commercial exploitation, surviving *Iris* populations fell victim to large-scale development during the next decades. From 1920, both the human population of Palestine and agricultural areas grew rapidly, accordingly the *Iris* populations declined. The shift from traditional tilling to modern (mechanical) agricultural techniques played a critical role for extinction of many populations. In particular, *Iris atropurpurea* suffered greatly from citrus plantation as well as urbanisation which invaded its habitat, drastically reducing the light soil areas of the coastal strip. Parallel to this, as a result of improved personal security (thanks to the British mandate rule), the population of the nomad tribes in desert zones (the distribution areas of *I. atrofusca, I. hieruchamensis, I. loessicola* and *I. mariae*) grew and the *Iris* populations suffered from over-grazing. Since the establishment of the state of Israel in 1948, the human population increased dramatically and the picking of showy flowers became a common practice among the Jewish community.

The deterioration stage, which began with commercial introduction shortly after the species discovery and continued by rapid habitat destruction because of development pressure as well as the picking of flowers, reached its low peak in the early 1950s.

2.The Arrest Phase (1954-1970):

In this grave position, threatened by real extinction, relief was at hand for the *Oncocyclus* irises from the public awakening of nature lovers in the young Israeli State. The first outcry which regarded the irises as the "natural treasures of Israel", was published by scientists of the committee for nature conservation c\o the Botanical and Zoological Societies (Eilon-Sireni, 1953). The necessity of protection of wild flowers, as well as prevention of uprooting and picking were broadly emphasized. *Iris haynei* was presented as greatly suffering from rhizome transfer to private gardens. *I. bismarkiana* and *I. lortetii* (the latter illustrated on the front cover), were recorded as requiring urgent attention. Public awareness of nature conservation, which was increased the same time all over the world, led to establishment of a popular movement, the *Society for the Protection of Nature in Israel* (SPNI) in 1954.

Over the following years, SPNI was occupied chiefly in the advancement of nature conservation acts and educational activities. Despite this, the widespread picking of *Oncocyclus* irises continued during the 1950s, in which *I. atropurpurea* and *I. haynei* were the main victims. Furthermore, popular Hebrew publications mentioned that *I. atropurpurea* was sold in flower shops in Tel Aviv and noted its suffering because of new wide citrus groves planting. Alon (1955) and Zohary (1959a) recorded it as "threatened by real extinction as only a few populations exist in neglected localities". *Iris atrofusca, I. bismarkiana, I. haynei, I. lortetii* and *I. mariae* were all also recorded in these years as very rare and endangered species (Zohary, 1959b; Zohary & Gruenberg-Fertig, 1959). *Iris haynei* was severely damaged by uprooting and in danger of degeneration in the large areas designated for afforestation on Mt. Gilboa. SPNI's activities to prevent its extinction were one of the main reasons for the enactment of the Nature Reserves Act in 1963 and the Species Protection Law in 1964. All *Iris* species in Israel were included within the Endangered Species Law. Some of the reserves were specifically determined because of the presence of *Oncocyclus* irises (Table 4). The Nature Reserves Authority (NRA) was established in 1964 as an official agent for the enforcement of these acts and to manage the newly announced nature reserves.

In this positive atmosphere, since 1965, the SPNI and the NRA began a nationwide educational offensive to protect all native flora, especially the *Oncocyclus* irises. Because

wild flower picking was a very serious problem, great effort was invested for explanatory activities. These included the publishing of pamphlets and posters, articles in the newspapers and on the radio as well as extensive educational activities amongst the young generation by elementary school and kindergarten teachers. The high success of this fight was so unique that it is regarded as a key point and a symbolic act for the SPNI. In 1970, a figure of an *Oncocyclus* iris was chosen to represent the emblem of the new society (figure 1). This well symbolized the SPNI's goals: to urgently protect the splendid, endemic, rare and endangered items in the natural environments of Israel.

3. The Restoration and Stabilisation Phase (1971 to present):

Since the 1970s, the rate of decline slowed significantly. The *Oncocyclus* irises were protected by law, partially conserved within nature reserves and not threatened by flower picking. Nevertheless, they arevery limited in their distribution and still threatened by extinction (Agami and Dafni, 1975). Specific studies were carried out by Avishai (1975; 1977) assisted by the NRA's staff, to restore these populations. The research focused on extensive surveys to locate the relic populations, and studying the species in nature and in Jerusalem Botanical Gardens. The results revealed that most species suffered from a variety of problems, mainly due to the growth of agricultural areas, over-grazing, urbanisation, afforestation, virus infection and species fertility (Table 3).

Avishai's recommendations led to restoration acts, which were enacted in the late 1970s within the nature reserves. These included increased seed yield by human-assisted pollination, chiefly for *I. lortetii*, *I. bismarkiana* and *I. hermona*; establishment of new reserves, e.g., for *I. hieruchamensis*; protection against over-grazing, e.g. for *I. mariae* and *I. lortetii*; preventing afforestation, e.g. for *I. bismarkiana* and *I. lortetii*. A proper management for nature reserves was begun, e.g., protection against over-grazing but also use of grazing to reduce competition. This is accompanied by routine observations of the population dynamics by the rangers of the NRA.

The chronological stages of changes in the distribution of the *Oncocyclus* irises in Israel can be summed up as follows: (1) The deterioration phase (1876-1953); commercial exploitation of large amounts of rhizomes following the species' description and continuing development pressure in the country. (2) The arrest phase (1954-1970); the establishment of the Society for the Protection of Nature; enactment of the Endangered Species Protection Law and Nature Reserves Act, accompanied by extensive educational activities. (3) The restoration and stabilisation phase (1971 to present); research of population dynamics; increased seed yield by human-assisted pollination; protection by proper management of Nature Reserves.

Figure 1 - The emblem of the Society for the Protection of Nature in Israel (SPNI).

THE CONSERVATION STATUS OF THE *ONCOCYCLUS* IRISES IN ISRAEL

Zohary and Gruenberg-Fertig (1959) recorded all the *Oncocyclus* irises in Israel as "very rare". Agami and Dafni (1975) recorded *I. atropurpurea* as "threatened by real extinction"; *I. haynei, I. hermona, I. lortetii* (both varieties) and *I. mariae*, as "threatened by population reducing which may lead to extinction". The first designation of an *Oncocyclus* iris from Israel, based on international conservation categories, was for *I. lortetii* (var. *lortetii*). Its status was identified as "Endangered" by Lucas and Synge (1978), according to the IUCN categories. In the *Red Data Book of Israel Plants (1 - Upper Galilee)*, both *I. lortetii* var. *lortetii* and *I. bismarkiana* were recorded as "Endangered" (Cohen & Shmida, 1992). Creating a local method for identifying rarity and potential threat of extinction, the authors used different factors of vulnerability to identify conservation status. This method was generally used for the present study. The main included parameters are: (1) data on distribution and habitat; (2) subjective estimations for potential extinction.

1. Distribution and Habitat

All species are restricted in their general distribution to the south Levant areas. *Iris atropurpurea, Iris hieruchamensis* and *I. lortetii* var. *samariae* are distributed only in Israel. *Iris bismarkiana, I. hermona* and *I. lortetii* var. *lortetii* penetrate to small areas in SW Syria and\or S Lebanon (Mouterde, 1966; Chaudhary *et al.*, 1975). *Iris atrofusca* and *I. haynei* are also widely distributed in Jordan (Feinbrun, 1986), while *I. mariae* penetrates to the Sinai coast in NE Egypt (Tackholm, 1974). The information from the neighbouring countries is scanty and the conservation of the *Iris* species is often unclear.

Avishai (1975) recorded the first detailed geographical data on the population level in Israel. It seems impossible to estimate the number and area size of localities before Avishai's survey, as no quantitative data had been recorded. However, for some species of there is evidence of extinction of known populations. These are for *I. atropurpurea* which had been rather common in the centre Coastal Plain district (e.g., Eig, 1926), *I. bismarkiana, I. lortetii* var. *samariae, I. haynei* and chiefly *I. loessicola* which was widely distributed and has been recently remained in loess fields edges only.

The distribution of each of the ten taxa was studied by extensive field surveys in Israel during 1990-1998. The findings of these surveys are summarized in Table 2. The size of the distribution area of each species was recorded by estimating the total potential area in which the populations may occur. This data, despite much approximation, is included to present comparative parameters. The distribution of the populations was studied by recording quadrats of 1 km^2 in which the taxa exist. All taxa are distributed in no more than 10-28 quadrats per taxa. *I. hieruchamensis* and *I. lortetii* var. *samariae* are known from quite a small number of quadrats and their total estimated distribution area is also small compared with others. *Iris atrofusca* and *I. bismarkiana* occur in a relatively high number of quadrats (26-28), however this is also a quite small number of localities for a species. Most populations form dense stands of rosette leaves, sometimes the entire population perhaps represents a single clone; accordingly it is problematic to recognize "an individual" in the field. Observations show that most populations are limited in their areas, the number of individuals in each is of medium size (approx. 103). In *I. lortetii* for instance, the

observed flower stems were counted during 1992 in about 50% of the total populations, resulting in about 10,000 flower buds (Cohen and Shmida, 1992).

Specificity for the natural habitat is characterized chiefly by the soil factor but also other ecological parameters (Ginsburg, 1956; Gazit-Ginsburg, 1960). Five species grow in stony slopes of calcareous formations, a common habitat in the Levant. The others are more specific in their soil conditions, which may affect species distribution. *I. atropurpurea* and *I. hermona* are specific to limeless soils (light or basalt); *I. hieruchamensis*, *I. loessicola* and *I. mariae* are limited to (sandy) loess in desert areas.

2. Vulnerability - estimation for potential extinction

The main factors affecting the threat of extinction are summarised in Table 3. All the species are highly attractive, the main factor which increases potential vulnerability. Israel's small and developed area makes the possibility of remoteness poor and accessibility mainly convenient due to the open habitats of the plants, leading to threatened populations. Human activities are the major factors that may lead to, or currently cause reduction or damage to the surviving populations: urbanization, agricultural development, over-grazing, afforestation and conservation. The volume of effect of these factors has estimated for each taxon by three subjective levels of vulnerability (abbreviations in Table 3). *Iris atropurpurea*, *I. loessicola* and *I. mariae* are highly vulnerable taxa because of potential development activities.

From the conservation aspect, i.e., the percentage of quadrats that occur within official Nature Reserves (Tables 2-3), it can be seen that all species are of high vulnerability. Although law protects all *Iris* species in Israel, most of their populations do not occur in official reserves. The threat of extinction of the non-conserved populations is genuinely high as new contour schemes and development programmes in Israel usually only take Nature Reserves into consideration. For *I. loessicola*, *I. lortetii* var. *samariae* and *I. mariae*, no more than 15% of the populations of each

TABLE 2 - DISTRIBUTION AND HABITAT OF SPECIES *IRIS* SECTION *ONCOCYCLUS* IN ISRAEL

Species	**Total estimated distribution area (Km²)**	**Total number known distribution quadrats (1 Km²)**	**% of quadrats within official Nature reserves**	**Habitat soil specificity**
Iris atrofusca	2500	28	20%	calcareous slopes
Iris atropurpurea	1000	17	25%	limeless light soils
Iris bismarkiana	1500	26	35%	calcareous slopes
Iris haynei	1000	23	55%	calcareous slopes
Iris hermona	500	21	45%	basalt areas
♦*Iris hieruchamensis*	200	15	20%	sandy-loess soils
♦*Iris loessicola*	500	19	5%	loess fields
Iris lortetii lortetii	500	24	25%	calcareous slopes
♦*Iris lortetii samariae*	200	10	10%	calcareous slopes
Iris mariae	4000	22	15%	sandy-loess soils

♦ *species names of controversial status or nom. nud.*

species are protected, accordingly their conservation position is very low. Moreover, by considering the total area of each Nature Reserve (Table 4) it can be seen that the above parameter indicates just a part of the highly vulnerable taxa. The area size of many reserves is so small that some species are poorly conserved, even if they are more or less properly protected. For *I. hieruchamensis*, despite the fact that 20% of the total recorded quadrats are protected, they occur in just one small reserve, 0.56 km^2 in area, the total protected area for this species all over the world. In the case of *I. atropurpurea*, 25% of its recorded 1 km^2 quadrats are distributed within four small reserves, a total area of 1.443 km^2, the entire worldwide protected area for *I. atropurpurea*. Furthermore, this species forms dense populations in two (0.035 and 0.53) km^2 areas of the above reserves, while in the other reserves and additional unprotected localities a low number of individuals survive. The last wide population area of *I. atropurpurea* still remains near Natanya, but unfortunately, as it is not protected, it is possible that it will be extinct during the coming years (summer 1998) because of building activities. *Iris bismarkiana* and *I. lortetii* var. *lortetii* are also in a similar critical position. *Iris bismarkiana* occurs naturally in seven reserves (35% of the total quadrats), six of which are very small (0.05-1.52 km^2 areas). The same is true for *I. lortetii* which occurs in five reserves, four of 0.14-1.52 km^2. The Nahal Dishon Nature Reserve is the only area of normal size for actual conservation (13.3 km^2) in which both species occur. *I. loessicola* and *I. lortetii* var. *samariae*, despite two medium sized a reserves for each taxon, are poorly distributed at the edges of the reserves. The reserves that include *I. mariae* are relatively large, but the species is

TABLE 3: **VULNERABILITY** - PRESENT FACTORS THAT MAY LEAD OR CURRENTLY CAUSE REDUCTION OR DAMAGE TO THE SURVIVING POPULATIONS OF SPECIES IRIS SECTION ONCOCYCLUS IN ISRAEL AND PRIORITY FOR CONSERVATION ACTIVITIES.

SPECIES	UR	AG	GR	AF	FE	VI	FE	NR		PR
Iris atrofusca		+	++*		+		+	++		3
Iris atropurpurea	+++*							++		1
Iris bismarkiana	+		+	+	+++*	+++*	+++*	+		3
Iris haynei		+	+	+				+		4
Iris hermona		+	+					+		4
♦ ***Iris hieruchamensis***		+	+		+		+	++		1
♦ ***Iris loessicola***	+	+++*	+++		++	++*	++*	+++		2
Iris lortetii lortetii			++	+	+	+	+	++		3
Iris lortetii samariae		+	+		+	+	+	+++		2
Iris mariae		++*	+++*		++		++	+++*		2

+++ highly destructive; ++ intermediate; + slight.

UR urbanization; **AG** agricultural development; **GR** over-grazing; **AF** afforestation (shade); **VI** virus infection or insect attack; **FE** fertility problems; **NR** limitation of nature reserves; **PR** priority for conservation activities. * refered by the same damaged factor by Avishai (1975).

poorly represented. In contrast, *I. atrofusca, I. haynei*, and *I. hermona* occur in more or less normal-sized reserves, and within these the future conservation of the species is clear.

Specific problems such as leaf diseases, virus infection, insect attack or fertility seem to play a significant role in the vulnerability of each taxon, but have been poorly studied. The leaf diseases of the local *Oncocyclus* irises were preliminarily reported by Kushnir (1949) but not critically studied for the populations in nature. *iris. bismarkiana* was observed as significantly proof to virus infection and *I. loessicola* to insect attack. Field observations revealed also that some species or populations have low fertility, especially *I. bismarkiana* and some of the desert taxa. However, further comprehensive field studies are needed to re-determine and clarify the specific problems of each taxon in its natural environments.

3. Conservation status and priority ranking

Data on rarity, i.e., the worldwide number of populations and individuals per taxon, led to identification of the conservation status of all the *Oncocyclus* irises in Israel as "Endangered" (En) (IUCN, 1980). The current high vulnerability of most taxa significantly contributes to this classification as well as indicating that immediate action should be taken to protect and conserve the populations. Although all taxa are highly endangered, it seems that ranking the taxa according to their vulnerability may assist in identifying priority for future conservation activities (Table 3).

The first priority is *I. atropurpurea,* because of the very small surviving populations and high vulnerability to potential urbanization. *Iris hieruchamensis* is of a similar status as it is protected within a single small reserve. *Iris loessicola*, *I. lortetii* var. *samariae* and *I. mariae* are of the second priority. All three are highly endangered, as they are poorly represented in Nature Reserves, the former two are highly threatened by potential agricultural development. *Iris atrofusca, I. bismarkiana, I. lortetii* var. *lortetii* are of a medium vulnerability position due to specific problems of each taxa. The former two, despite being properly represented within the reserves, occur in small-protected areas. Large populations of *I. bismarkiana* in the Lower Galilee will undoubtedly fall victim to urbanization development in the environs of Nazareth during the coming years. *I. haynei* and *I. hermona* are respectively conserved within Nature Reserves and their vulnerability is quite low.

GENERAL DISCUSSION AND CONCLUSIONS

Altogether, the historical review and the results of our field surveys indicate that decrease in habitats and population extinction have occurred in Israel for the *Oncocyclus* irises. Despite the currently stabilised position of the taxa within Nature Reserves, they are much limited in their populations and threatened by extinction. Today, the main factors affecting the potential extinction are human activities. These have shaped the number of populations to a critical stage during the last hundred years. At this point, each population disappearance will significantly reduce the genetic variability, i.e., the gene pool richness of a taxon.

In conclusion, the main critical result is that most populations do not occur in official reserves, as such, they are highly vulnerable and their future conservation is unclear. Moreover, most of the Nature Reserves in which the species occur cover a

TABLE 4 - OCCURRENCE OF *IRIS* SECTION *ONCOCYCLUS* WITHIN NATURE RESERVES IN ISRAEL

NATURE RESERVE NAME	District	Total area of NR (km^2)	Section Oncocyclus *Iris* occurrence
Um-Zuqqa	E Samaria	21.00	*Iris atrofusca*
Nahal Yitav	E Samaria	13.40	
Wadi Maquch	Judean Desert	23.50	
Nahal Prat	Judean Desert	8.60 ?	
Poleg	Sharon Plain	0.53	*Iris atropurpurea*
Kadima	Sharon Plain	0.008	
Bet-Hanan*	Philistean Plain	0.035	
Ashdod	Philistean Plain	0.87	
Nahal Misgav	E Upper Galilee	1.28	*Iris bismarkiana*
Nahal Qedesh	E Upper Galilee	1.52	
Nahal Dishon	E Upper Galilee	13.30	
Nahal Bet Ha-'emek	W Upper Galilee	2.53 (cult.)	
Nazareth*	C Lower Galilee	0.13	
Har Yona*	C Lower Galilee	0.05	
Giv'at Ha-more*	E Lower Galilee	0.41	
Ein Avazim	Hula Valley	0.06 (? cult.)	
Susita	S Golan Heights	10.00	*Iris haynei*
Ha'on cliffs	S Golan Heights	23.00	
Nahal Metzar	S Golan Heights	10.50	
Mt. Gilboa*	N Samariae	7.28	
Nahal Bezek	E Samaria	7.50	
Nahal Mali'ach	E Samaria	11.00	
Bashanit ridge	EC Golan Heights	10.37	*Iris hermona*
Yehudiyya forest	C Golan Heights	76.00	
Nahal El-Al	S Golan Heights	2.10	
Yerucham*	N Negev	0.56	*Iris hieruchamensis*
Mamshit (national park)	N Negev	——	
Har 'Amassa	EN Negev	11.00	*Iris loessicola*
Tel Krayot	EN Negev	7.00	
Margaliyot	E Upper Galilee	0.38	*Iris lortetii* var. *lortetii*
Ramim cliffs	E Upper Galilee	0.25	
Nahal Qedesh	E Upper Galilee	1.52	
Nahal Dishon	E Upper Galilee	13.30	
Eynot Hatzor*	Hula Valley	0.14	
Har Cabir	C Samaria	25.00	*Iris lortetii* var. *samariae*
Wadi Beidan	C Samaria	1.80	
Halutza sands	CN Negev	248.00	*Iris mariae*
Mashabim sands	CN Negev	13.00	
Shunra sands	CN Negev	24.00	

* Nature Reserves which were declared mostly because of the *Iris* occurren

very small area. For some taxa, the entire worldwide protected area is of 1-2 km^2. These reserves are conserving the existing populations but do not facilitate their future increase or spreading to adjacent areas. The very uniqueness of the *Oncocyclus* irises makes them particularly vulnerable. Should they become extinct, there is nothing anybody can do to bring them back.

A conservation program has been proposed, including *in-situ* and *ex-situ* activities. Most populations have been recorded in the field and a map of the sites drawn up. These have been submitted to the Israeli Nature Reserves Authority, in order to commence the legal process of declaring them as nature reserves. A detailed program to conserve the plants in nethouse and the seeds in a gene bank was also proposed. This conservation program is currently in its first stages. *Ex-situ* activities began during 1998. Seeds of all taxa were deposited in the seed-bank of the Herbarium of the Hebrew University (HUJ) and the University Botanical Gardens in Jerusalem. All taxa will be propagated in the nursery, in order to study the life cycle of each population, rates of germination, reproduction system, maturation of fruits and fertilization of seeds. These activities are included in the Israeli Endemic Plant Conservation Project, which is being carried out by the Jerusalem Botanical Gardens.

Compared with the total distribution area as far East as Caucasia, Turkmenia and Iran, the limited Levantine region contains a relatively large number of *Oncocyclus* species. Hence, attention must be given to *in-situ* conservation activities, in the neighbouring territories of the Levant, i.e., Syria, Lebanon and south Turkey. About fifteen additional taxa occur in these countries, including all taxa of the *I. susiana* L. aggregate that are not represented in the southern Levant. We hope that this information will draw positive attention to the whole section *Oncocyclus*, in order to protect and conserve its taxa in the wildness before they completely disappear.

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