Iris bismarckiana in Israel and Jordan – new findings and taxonomic remarks

Y. Sapir, A. Shmida and H.P.Comes

2001

Journal of Plant Sciences

49: 229-235

Israel Journal of Plant Sciences *Vol. 49* *2001* *pp. 229–235*

Iris bismarckiana in Israel and Jordan—New findings and taxonomic remarks

Yuval Sapir,[a,*] Avi Shmida,[a] and H. Peter Comes[b]
[a]*Rotem—Israel Plant Information Center, Department of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, Jerusalem, 91904, Israel*
[b]*Institut für Spezielle Botanik und Botanischer Garten, Johannes Gutenberg-Universität Mainz, Bentzelweg 7–9 Mainz, 55099, Germany*

(Received 19 February 2001 and in revised form 29 April 2001)

ABSTRACT

Iris bismarckiana (*Iris* section *Oncocyclus*) was found for the first time in the west Gilead in Jordan. This discovery was utilized to shed some light on the taxonomic relationships among the light-colored irises in the Levant. Morphometric quantitative analysis of the Jordanian population compared to *I. bismarckiana* allies in Israel (*I. bismarckiana* in the Galilee and *I. hermona* in the Golan) suggests that the Jordanian population is *I. bismarckiana*, despite the large distance from the main distribution area. Cluster analysis, based on the morphology, revealed that some of the populations of *I. bismarckiana* have closer affinities to *I. hermona* than to each other. Populations of *I. hermona* and *I. bismarckiana* in Jordan and Israel do not differ statistically from each other in morphological traits, and should not be treated as two independent species.

INTRODUCTION

The section *Oncocyclus* (Siems.) Baker of the genus *Iris* L. comprises 32 different species (Rix, 1997) that are distributed throughout the Fertile Crescent in Southwest Asia (Avishai, 1977). Taxonomic treatments of the section have never dealt with the phenotypic variation within and among populations, and were usually based on a single or a few "representative" specimens of each species. The number of species recognized in the section ranges from 16 (Dykes, 1913), 32 (Rix, 1997), 38 (Mathew, 1989), up to 65 (Avishai, 1977). Among the ten species present in Israel and Jordan, much taxonomic confusion exists with respect to species delimitation, and probably the only reliable taxa are Avishai and Zohary's (1980) aggregates (Sapir, 1999).

In Israel and Jordan there are ten species of section *Oncocyclus*, all of which are narrow geographic endemics (Feinbrun-Dothan, 1986; Rix, 1997). Avishai and Zohary (1980) divided the *Oncocyclus* species into seven aggregates, based mainly on floral morphology and named after the first species described in each aggregate. In the *Iberica* aggregate, all species have dark-purple to brownish heavy-dotted falls (outer petals), and pale standards (inner petals) with fine, purple to bluish veins or speckled dots and spots. The species of the *Iberica* aggregate are distributed over two major geographical regions: (1) the high mountains of Transcaucasia, eastern Turkey, and northwestern Iran; and (2) the hills and mountains surrounding the northern Jordan Valley and southern Antilebanon (Avishai and Zohary, 1980).

As a member of the *Iberica* aggregate, *Iris bismarckiana* Regel was described from rhizomes sent by M. Damman from Lebanon to Germany in 1890 (Dykes, 1913). Shortly afterwards, Foster (1893, cited in Dykes, 1913) described a new species, *Iris sari* var. *nazarensis*,

*Author to whom correspondence should be addressed. E-mail: sapir@vms.huji.ac.il

from the Nazareth area in Israel. Eleven years later, Sprengel (1904, cited in Feinbrun-Dothan, 1986) claimed that the type specimens of *I. bismarckiana* and *I. sari* var. *nazarensis* were grown from the same rhizome. In the same year (1893), the type locality of *I. sari* was re-discovered and a very rare form, similar to *I. bismarckiana*, was found (Dykes, 1913).

Dinsmore (1934) called the Nazareth iris "*Iris nazarena*" and described it as a discrete species, separate from *Iris bismarckiana*. He also described a new species from the Golan Heights, *Iris hermona* Dinsmore. Mouterde (1970) merged all taxa of the *Iberica* aggregate in the Levant into one species, *I. bismarckiana*. Avishai (1972), however, emphasized that *I. hermona* has some morphological characters that are clearly distinct from those of *I. bismarckiana*, especially rhizome form (stoloniferous in *I. bismarckiana* and compact in *I. hermona*; see also Dinsmore, 1934; Feinbrun-Dothan, 1986).

Until now, only dark-colored *Oncocyclus* species were known from Jordan, i.e., *I. atrofusca* Baker, *I. nigricans* Dinsmore, *I. petrana* Dinsmore (Feinbrun-Dothan, 1986; Rix, 1997), and *I. bostrensis* (Mathew, 1989; Rix, 1997). In March 1999 we found three populations of *I. bismarckiana* in the Gilead Mts. in Jordan. In this paper, we utilize the new finding to discuss the morphology of the populations in a geographical context. The results of the morphological analysis might shed light on the taxonomy of the *Iberica* aggregate species in Israel and Jordan.

METHODS AND RESULTS

Iris bismarckiana site in Jordan

The largest population was found at an altitude of 475–500 m on the stoney south-facing slope of Wadi Rajib (north of the village), irises grew on a stony slope under the limestone cliffs "Arak-el-Shams" and "Arak-el-Sa'ad". The population covered an area approx. 80 × 250 m, and no *I. bismarckiana* plants were found outside this patch.

The second population was located in the upper part of Wadi Rajib, near the village of Ein-a-Sahne at 605 m altitude. There, rhizomes were planted in the local cemetery, together with *I. mesopotamica* Dykes, under a huge sacred oak (*Quercus calliprinos* Webb). *I. bismarckiana* is easily transplanted due to its shallow subterranean rhizomes, approx. 1.5 cm deep (Y. Sapir, unpublished data). It is known as an ornamental flower often replanted in cemeteries, especially by Muslims (Avishai, 1979). The third population of *I. bismarckiana* was found about one kilometer east of the village of Rajib, along the road. Only three clones were found on a steep, north-facing slope.

We identified the population as *I. bismarckiana* based on the color pattern, following Feinbrun-Dothan (1986). Finding, for the first time, light-colored irises in Jordan prompted the question of species identity, considering the large distance from the main geographic distribution (see locations in Table 1). On the other hand, the habitat of the Jordanian population is strikingly similar to the habitat of *I. bismarckiana* in the northeastern Upper Galilee, i.e., steep rocky slopes with shallow patches of terra rossa soil.

Morphometric analysis

In order to clarify the identity of the Jordanian population and overall population relationships, a morphometric analysis was conducted based on field-collected data. The Rajib population, as well as five *I. bismarckiana* and two *I. hermona* populations chosen within the distribution area in Israel (Table 1), were scored for sixteen characters (Table 2). Ten of the characters were descriptors of floral morphology, while three described shape and size of leaves (one leaf, the second to depart from the stem, was measured in each individual). The remaining three characters were descriptors of stem

Table 1
Locations of *Iris bismarckiana* and *Iris hermona* populations measured

Location	Region	Species	Coordinates (Israel net)	Elevation (m.a.s.l.)	Sample size
Rajib	Jordan—Ajlun	*I. bismarckiana*	2150/1836	350	18
Givat Hamore	Lower Galilee	*I. bismarckiana*	1843/2244	480	30
Nazareth	Lower Galilee	*I. bismarckiana*	1823/2368	560	26
Yiftah	Upper Galilee	*I. bismarckiana*	2019/2823	430	18
Dishon Wadi	Upper Galilee	*I. bismarckiana*	1967/2753	400	11
Majdal Shams	Hermon	*I. bismarckiana*	2225/2982	1300	20
Keshet	Golan Heights	*I. hermona*	2256/2652	700	30
Mapalim	Golan Heights	*I. hermona*	2210/2660	550	30

Table 2
Description of characters recorded in *I. bismarckiana* and *I. hermona* populations, for character numbers appearing in Table 4

No.	Character	Description
1	Flower height	From fall bottom to standard top (in cm)
2	Flower diameter	At the height of the pollination tunnel (in cm)
3	Flower diameter / height	Ratio determines the flower shape (Feinbrun-Dothan, 1986)
4	Flower surface	Flower diameter × flower height (in cm^2)
5	Fall width	At its broadest place (in cm)
6	Standard width	At its broadest place (in cm)
7	Signal patch length	At its broadest place (in cm)
8	Signal patch width	At its broadest place (in cm)
9	Signal patch surface	Signal patch length × width (in cm^2)
10	Patch surface / fall width	Ratio determines the projection of the signal patch over the fall
11	Leaf arch	Categorical character, coded by 1 = erect, 2 = semi curved, and 3 = curved
12	Leaf width	At the point of deviation from stem (in cm)
13	Leaf height	From ground to the highest point (could be the peak of the curve) (in cm)
14	Stem height	From ground to fall bottom (in cm)
15	Stem gap	The ratio of the gap between leaves and flower, and stem height (stem height – leaf height)/stem height
16	Stem height/flower height	Ratio determines the size of the flower compared to stem height

architecture. All the characters chosen have previously been considered diagnostic for the *Oncocyclus* species in Israel and Jordan (Feinbrun-Dothan, 1986). Although rhizome stoloniferosity is considered as diagnostic (Dinsmore, 1934; Avishai, 1972; Feinbrun-Dothan, 1986) it has not been included in the present study because of the damage caused if rhizomes are dug out. Further details of measurement are given in Table 2. The population means for each character recorded are presented in Table 3. In addition, multiple comparisons of population means were performed using Scheffe's test (Zar, 1999), evaluated at a significance level of 0.05 (Table 4).

Table 4 indicates that the Jordanian Rajib population differs from those of *I. hermona* at Mapalim and Keshet (Golan Heights) in seven and nine characters, respectively. In contrast, there are no significant differences between the Rajib population and *I. bismarckiana* from Dishon Wadi (Upper Galilee), suggesting that the Jordanian population may be assigned to *I. bismarckiana* rather than to *I. hermona*. Six significant differences were found between the Rajib population and *I. bismarckiana* from Givat Hamore and Yiftah.

Cluster Analysis (CA; Kovach, 1999) was performed on the values of a Euclidean distance matrix derived from the mean values of all populations, and using Average Linkage between groups (populations) as clustering method (Fig. 1). Apparently, the Jordanian population from Rajib groups with the geographically distant *I. bismarckiana* population from Dishon, thereby forming a distinct cluster with likely congeners from Nazareth (Lower Galilee) and Majdal Shams (Hermon). Although these data support the classification of the Jordanian population as *I. bismarckiana*, it is also clear that two other populations of *I. bismarckiana* (Yiftah/ Upper Galilee and Givat Hamore/Lower Galilee) form a separate cluster with *I. hermona* from the Golan Heights (see cluster "II" in Fig. 1).

To gain more detailed insights into the multidimensional relationships among populations, a Principal Components Analysis (PCA; Kovach, 1999) was performed on the standardized character means of all populations, and mean component scores for each population were projected in two dimensions. The PCA plot (Fig. 2) provides results similar to the cluster analysis, with the first two components extracting 50.11% and 24.11% of the total variation, respectively. Again, the Jordanian population of Rajib is close to the Dishon population, and the two clusters of populations identified by the CA are separated clearly along the PCA first axis.

DISCUSSION

The results of the morphometric analysis presented here strongly suggest that *I. bismarckiana* is "paraphyletic" in the sense that some of its populations have closer phenetic affinities to other species, i.e., *I. hermona*, than to other populations within the species (Fig. 1). Trying to disentangle the reason(s) for this "paraphyletic" pattern observed is difficult. However, general explanations accounting for such a pattern are frequently pointed out (e.g., Avise, 1994), including (i) recent hybridization;

Table 3
Mean (± S.D.) of sixteen characters recorded for eight populations of *I. bismarckiana* and *I. hermona* from Israel and from Rajib, Jordan

Location	Keshet (*I. herm.*)	Mapalim (*I. herm.*)	Givat Hamore (*I. bism.*)	Yiftah (*I. bism.*)	Nazareth (*I. bism.*)	Dishon Wadi (*I. bism.*)	Majdal Shams (*I. bism.*)	Rajib (Jordan) (*I. bism.*)
Flower height	12.5 ± 1.5	11.1 ± 1.6	11.7 ± 1.7	11.3 ± 1.7	10.5 ± 1.1	9.0 ± 1.5	10.3 ± 1.0	9.5 ± 1.4
Flower diameter	10.2 ± 0.8	9.7 ± 1.0	9.6 ± 0.9	9.6 ± 1.0	8.7 ± 1.3	8.4 ± 1.0	9.3 ± 0.9	8.4 ± 1.2
Flower diameter/height	0.82 ± 0.09	0.88 ± 0.08	0.83 ± 0.12	0.87 ± 0.11	0.83 ± 0.08	0.95 ± 0.12	0.91 ± 0.1	0.87 ± 0.05
Flower surface	130 ± 23	109.8 ± 25	113.3 ± 23	110.6 ± 25	92.8 ± 22	77.6 ± 20	97.2 ± 15	82 ± 23
Fall width	6.6 ± 0.83	6.3 ± 0.93	6.7 ± 0.87	6.3 ± 0.72	5.8 ± 0.86	5.1 ± 0.71	5.8 ± 0.89	5.4 ± 0.84
Standard width	9.1 ± 0.86	7.7 ± 0.93	7.5 ± 0.57	7.4 ± 0.86	6.3 ± 1.07	5.5 ± 0.98	6.4 ± 0.79	6.1 ± 1.24
Signal patch length	1.6 ± 0.27	1.5 ± 0.25	1.5 ± 0.27	1.6 ± 0.24	1.2 ± 0.23	1.5 ± 0.3	1.6 ± 0.26	1.4 ± 0.31
Signal patch width	1.5 ± 0.36	1.5 ± 0.32	1.6 ± 0.16	2.0 ± 0.3	1.4 ± 0.23	1.5 ± 0.33	1.7 ± 0.4	1.3 ± 0.36
Signal patch surface	2.5 ± 1.05	2.3 ± 0.85	2.5 ± 0.59	3.3 ± 0.94	1.8 ± 0.63	2.4 ± 0.94	2.8 ± 1.01	2.0 ± 0.93
Patch surface/fall width	0.37 ± 0.13	0.37 ± 0.1	0.38 ± 0.08	0.52 ± 0.1	0.3 ± 0.08	0.46 ± 0.14	0.48 ± 0.16	0.38 ± 0.15
Leaf arch	1.5 ± 0.5	1.1 ± 0.38	1.6 ± 0.66	1.0 ± 0.24	1.3 ± 0.47	1.2 ± 0.47	1.3 ± 0.4	1.3 ± 0.49
Leaf width	1.5 ± 0.3	1.7 ± 0.31	1.5 ± 0.22	1.9 ± 0.44	1.6 ± 0.29	1.7 ± 0.35	1.4 ± 0.18	1.7 ± 0.35
Leaf height	33 ± 7.1	34 ± 4.9	27 ± 7.6	36 ± 7.5	26 ± 6.4	23 ± 4.9	18 ± 4.2	24 ± 7.9
Stem height	47 ± 9.6	54 ± 10	36 ± 7.8	41 ± 7.8	32 ± 6.5	26 ± 7.0	22 ± 5.3	23 ± 6.6
Stem gap	0.27 ± 0.1	0.36 ± 0.09	0.22 ± 0.14	0.12 ± 0.05	0.17 ± 0.13	0.07 ± 0.15	0.2 ± 0.09	0.05 ± 0.25
Stem height/flower height	0.27 ± 0.06	0.2 ± 0.04	0.33 ± 0.08	0.27 ± 0.03	0.34 ± 0.08	0.35 ± 0.07	0.47 ± 0.09	0.43 ± 0.12

Table 4
Multiple comparisons of population means (Scheffe's test) for sixteen characters recorded in *I. bismarckiana* and *I. hermona* populations. Character numbers are explained in Table 2. Asterisk (*) denotes significant ($p < 0.05$) difference of population means for that character; otherwise character differences are nonsignificant

	Keshet (*I. herm.*)	Mapalim (*I. herm.*)	Givat Hamore (*I. bism.*)	Yiftah (*I. bism.*)	Nazareth (*I. bism.*)	Dishon Wadi (*I. bism.*)	Majdal Shams (*I. bism.*)
Mapalim (*I. herm.*)	1 2 3 4 5 * 7 8 9 10 11 12 13 14 15 16						
Givat Hamore (*I. bism.*)	1 2 3 4 5 * 7 8 9 10 11 12 13 * 15 16	1 2 3 4 5 6 7 8 9 10 * 12 13 * 15 *					
Yiftah (*I. bism.*)	1 2 3 4 5 * 7 * 9 * 11 12 13 14 15 16	1 2 3 4 5 6 7 * 9 * 11 12 13 * * 16	1 2 3 4 5 6 7 8 9 10 * * * 14 15 16				
Nazareth (*I. bism.*)	* * 3 * 5 * * 8 9 10 11 12 * * 15 16	1 2 3 4 5 * * 8 9 10 11 12 * * * *	1 2 3 4 5 * * 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 * * * * 11 12 * 14 15 16			
Dishon Wadi (*I. bism.*)	* * 3 * * * 7 8 9 10 11 12 * * * 16	1 2 3 * * * 7 8 9 10 11 12 * * * *	* 2 3 * * * 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 * 7 8 9 10 11 12 * * 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16		
Majdal Shams (*I. bism.*)	* 2 3 * 5 * 7 8 9 10 11 12 * * 15 *	1 2 3 4 5 * 7 8 9 10 11 12 * * * *	1 2 3 4 5 * 7 8 9 10 11 12 * * 15 *	1 2 3 4 5 6 7 8 9 10 11 * * * 15 *	1 2 3 4 5 6 * 8 * * 11 12 * 14 15 *	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	
Rajib (Jordan) (*I. bism.*)	* * 3 * * * 7 8 9 10 11 12 * * * *	1 * 3 * 5 * 7 8 9 10 11 12 * * * *	* 2 3 * * * 7 8 9 10 11 12 13 * 15 *	1 2 3 4 5 * 7 * * 10 11 12 * * 15 *	1 2 3 4 5 6 7 8 9 10 11 12 13 14 * 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 * 16

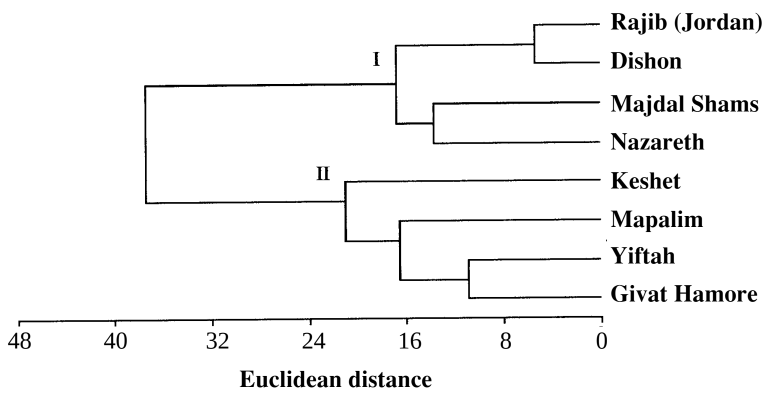

Fig. 1. Averaged Linkage dendrogram for eight populations of *I. bismarckiana* (Rajib, Dishon, Majdal Shams, Nazareth, Yiftah, and Givat Hamore) and *I. hermona* (Keshet and Mapalim) from Israel and Jordan based on sixteen morphological characters and Euclidean distances.

(ii) phenotypic convergence; or (iii) incorrect taxonomy.

Although high levels of interfertility among *Oncocyclus* species have been demonstrated by Avishai and Zohary (1980), we think it unlikely that the phenotypic similarity observed between *I. bismarckiana* (from Yiftah and Givat Hamore) and *I. hermona* is due to contemporary hybridization, because of the geographic isolation of the populations involved. Alternatively, it could be explained as resulting from phenotypic convergence due to similar environmental conditions. Thus, under a selection model, we would expect populations of close proximity to be more similar than widely separated ones because macroenvironmental habitat factors (and therefore selective forces) are likely to be more similar over short distances than over long distances (e.g., Ledig et al., 1997). Contrary to predictions, however, there is no clear geographical structure underlying our phenotypic data set. It appears unlikely, therefore, that phenotypic convergence could have brought about the paraphyletic pattern observed.

Our overall results suggest that the taxonomic status of *I. hermona* and *I. bismarkiana* (including the Jordanian population) as separate "morphospecies" needs revision, given that the population clusters identified by our morphometric analyses, on the basis of both floral and vegetative traits, are incongruent with current species categories. The only "reliable" and supposedly species-diagnostic character left is rhizome form, which is

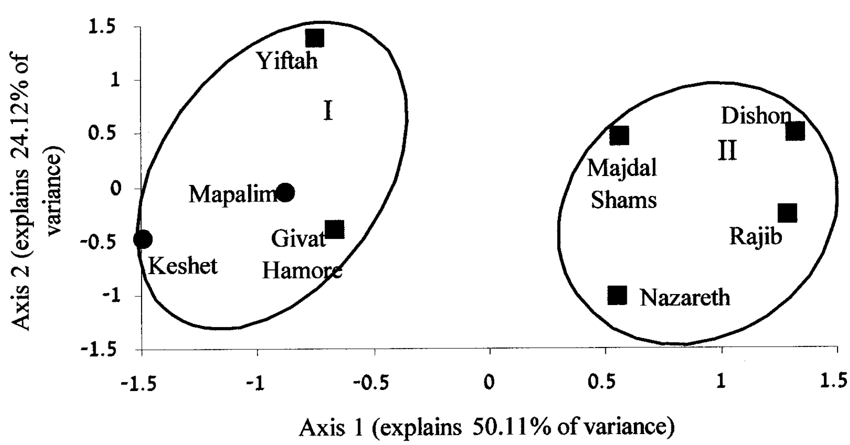

Fig. 2. Principal Components Analysis of populations of *I. bismarckiana* (squares) and *I. hermona* (circles) based on standardized population means for sixteen morphological characters. Circles indicate the two clusters identified by the Cluster Analysis.

stoloniferous in *I. bismarckiana* and compact in *I. hermona* (Dinsmore, 1934; Avishai, 1972; Feinbrun-Dothan, 1986). This character, however, could be strongly affected by habitat (Ginsburg, 1956). Consequently, with the data at hand, and in agreement with Mouterde (1970), we suggest that *I. bismarckiana* and *I. hermona* are best treated as one single species. Nonetheless, it will be necessary in the future to determine whether the two subsets of populations identified here form separate monophyletic entities (see clusters I and II, Fig. 2). Molecular markers, common garden experiments, and the inclusion of additional taxa from neighboring countries will help to provide such information and shed more light on species relationships and speciation trends among *Oncocyclus* irises in Israel and Jordan.

ACKNOWLEDGMENTS

We thank Gilad Peli and Haim Ben-David for the first indication of light-colored irises in Jordan, and Avraham Isdarechet and Ada Ben-Gera for their field assistance. Y.S. thanks Miriam Belmaker, Merav Katz, and Katja Tielboerger for their useful comments on the manuscript.

REFERENCES

Avise, J.C. 1994. Molecular markers, natural history, and evolution. Chapman & Hall, New York.

Avishai, M. 1972. *Iris hermona*. Teva-Va'aretz, 15: 36-38 (in Hebrew).

Avishai, M. 1977. Species relationships and cytogenetic affinities in section *Oncocyclus* of the genus *Iris*. Ph.D. thesis, Hebrew University, Jerusalem.

Avishai, M. 1979. Irises in Israel. SPNI, Tel Aviv (in Hebrew).

Avishai, M., Zohary, D. 1980. Genetic affinities among the *Oncocyclus* Irises. Bot. Gaz. 141(1): 107–115.

Dinsmore, J.E. 1934. Plantae Postianae et Dinsmoreanae, Fasc. 2. American University Press, Beirut.

Dykes, W.R. 1913. The genus *Iris*. Cambridge University Press, Cambridge.

Feinbrun-Dothan, N. 1986. Flora Palaestina. Part 4. Israel Academy of Sciences and Humanities, Jerusalem.

Ginsburg, Z. 1956. The natural growing-conditions of *Oncocyclus* irises in Israel. British Iris Society Year Book 1956: 51–63.

Kovach, W.L. 1999. MVSP—A MultiVariate Statistical Package for IBM-PC's, ver. 3.11. Kovach Computing Services, Pentraeth, Wales, U.K.

Ledig, F.T., Jacob-Cervantes, V., Hodgkiss, P.D., Eguiluz-Piedra T. 1997. Recent evolution and divergence among populations of a rare Mexican endemic, Chihuhahua spruce, following Holocene climatic warming. Evolution 51(6): 1815–1827.

Mathew, B. 1989. The iris (2nd ed.). Batsford, London.

Mouterde, P. 1970. Nouvelle flore du Liban et de la Syrie. Beirut.

Rix, M. 1997. Section *Oncocyclus*. In: The species group of the British Iris Society (eds.) A guide to species iris. Cambridge University Press, Cambridge.

Sapir, Y. 1999. Morphological variation in the populations of the royal irises (*Iris* sec. *Oncocyclus*) in Israel. M.Sc. thesis, Hebrew University, Jerusalem.

Zar, J.H. 1999. Biostatistical analysis. Prentice-Hall, Upper Saddle River, NJ.