Neriman Özhatay & Margaret A. T. Johnson

Some karyological remarks on Turkish *Allium* sect. *Allium, Bellevalia, Muscari,* and *Ornithogalum* subg. *Ornithogalum*

Abstract

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A tabular karyosystematic overview is presented of some Turkish genera in the *Liliaceae* s.l., including 84 new chromosome number records.

Introduction

Turkey is an important centre of plant diversity, being the meeting point of three major floristic regions. It has an extensive and varied flora of nearly 10,300 taxa, with a high level of endemism. According to the *Flora of Turkey* (Davis 1984), there are 388 native species representing 31 genera in the *Liliaceae* sensu lato, which are thus the ninth largest family in the Turkish flora. Since the *Flora of Turkey Supplement* (Davis 1988), a further 31 species have been added (Özhatay & al. 1994), which are either new records for Turkey, or new to science. The numbers are continuing to increase in this important Turkish family, where 35 % of species are endemic. A few *Liliaceae* genera and infrageneric groups have been selected for this survey, as follows:

Allium L. sect. *Allium.* – A recent taxonomic review of *Allium* sect. *Allium* (Mathew 1996) shows that out of 115 species in this section distributed throughout Europe (Mediterranean area) and Asia, 64 taxa (53 species), 40 % of them endemic, are found in Turkey, which represents almost 50 % of the total.

Bellevalia Lapeyr. – 20 species occur in Turkey, 9 of which are endemic (45 %), some of them having a very localized distribution.

Muscari Mill. sensu lato. – Of the 23 species, 13 are endemic (56 %).

Ornithogalum L. subg. *Ornithogalum.* – In this subgenus there are now 29 species, several new ones having recently been added to the flora by Speta (1989a, 1990, 1991a-e, 1992). There are 15 endemic species (51 %).

A tabular overview of all recognized Turkish taxa is presented, with chromosome data whenever known, which include 84 new records together with full literature data.

Material and methods

Material with numbers prefixed ISTE (Istanbul University), JOCD (Johnson, Cowley & Doherty), and JOHM (Johnson) was collected by us from wild populations in Turkey. Other prefixes indicate collectors' names, as follows: ARCH = J. C. Archibald, ARJJ = J. C. Archibald & J. Archibald, BAHY = R. Baines & G. Henry, DVSP = P. H. Davis, KOYM = M. Koyuncu, MASE = E. Markus, MAWS = B. Mathew. Full locality data for all the material studied are available in the Kew Living Collections database.

The new chromosome counts were all obtained using a standard root-tip squash method, as detailed previously (Johnson & Özhatay 1988, Johnson & al. 1991). Permanent slides are retained at the Department of Pharmaceutical Botany, University of Istanbul, and/or at the Jodrell Laboratory, Royal Botanic Gardens, Kew. Chromosome photographs were taken on a Zeiss photomicroscope III using Pan F film. Herbarium vouchers are kept at the Royal Botanic Gardens, Kew (K), and/or the Herbarium, Istanbul University (ISTE). Where possible, vouchers were made in the field, and again when the plants came into flower in cultivation at Kew. Many collections are complemented by transparency photographs of the plants in their wild habitat and also in cultivation at Kew. All species have been determined by Kew Herbarium staff in collaboration with N. Özhatay *(Allium)* and F. Garbari (some *Ornithogalum* material).

Results

Chromosome counts for all four genera or infrageneric groups are given in Table 1. Photographs of some representative somatic metaphase plates are shown in Fig. 1.

Allium sect. *Allium*. – The majority of species investigated to date are diploid, $2n$ = 16, with a karyotype consisting of large meta-, submeta- and acrocentric chromosomes (Fig. 1a). Species in this section are karyologically identifiable by interstitial secondary constrictions and the absence of distal satellites. Polyploidy at the $3x$, $4x$, $5x$ and $6x$ levels is found, and there are 4 records of B chromosomes.

Bellevalia. – Although closely related to *Muscari* (which has a basic number of x = 9), karyotypically *Bellevalia* is quite distinct, with large chromosomes and a basic number of x = 4 (Fig. 1b-c). Both tetraploids and octoploids occur, and recently a new hexaploid ($6x$) species was described from European Turkey, *B. edirnensis* (Özhatay & al. 1991b). Aneuploids have so far been recorded at the octoploid level only. Metacentric and telocentric B chromosomes are found, and both *B. paradoxa* and *B. pycnantha* have telocentric B's, confirming close affinity between these species.

Muscari. – The majority of *Muscari* species are diploid with $2n$ = 18 (Fig. 1d-h), although several populations of *M. neglectum* from European Turkey studied by Dalgiç (1991) were polyploid. To date, polyploidy in Anatolian material is uncommon, with very few records. Until recently there were no published reports of B chromosomes in the genus (Speta 1989b). Most of the species have a distinctive bimodal karyotype (Fig. 1 g-h).

Table 1: List of Turkish taxa of *Allium* sect. *Allium, Bellevalia, Muscari,* and *Ornithogalum* subg. *Ornithogalum,* together with both published and new (*) chromosome number records. – See text for collector abbreviations; ● = endemic species.

Allium (sect. *Allium*)	Collector + n°	2*n* =	References
affine Ledeb.		16	Tanker & Kuruku 1979
	ISTE 61661	16	Özhatay *
amethystinum Tausch		16	Özhatay 1984, 1990
ampeloprasum L.		40,48	Özhatay 1984, 1990
	ISTE 61718	32	Özhatay
● *anatolicum* Özhatay & B. Mathew	ISTE 58856	16	Özhatay *
● *armerioides* Boiss.		–	–
artvinense Grossh.		16	Özhatay 1986b
asperiflorum Grossh.		16	Özhatay 1986b
	ISTE 61648	16	Özhatay *
atroviolaceum Boiss.		16	Özhatay 1984, 1986b, 1990
	JOCD 43.90.180	24	Johnson *
	JOCD 37.90.143	32	Johnson *
aucheri Boiss.		16	Özhatay 1986b
● *baytopiorum* Kollmann & Özhatay	ISTE 43568	16	Özhatay *
bourgeaui Rech. f.			
subsp. *bourgeaui*	ISTE 45030	16	Özhatay *
subsp. *cycladicum* Bothmer	ISTE 44881	16	Özhatay *
calyptratum Boiss.		–	–
● *cappadocicum* Boiss.		16	Özhatay 1986b*
commutatum Guss.		–	–
curtum Boiss. & Gaill.	ISTE 61749	16	Özhatay *
	ISTE 61824	16,16,+4B	Özhatay *
dictyoprasum C. A. Mey. & Kunth		16	Özhatay 1986b
	MASE 673	16+1B	Özhatay *
	ISTE 51951	16	Özhatay *
● *eldivanense* Özhatay		16	Özhatay 1986a
● *enginii* Özhatay & B. Mathew	ISTE 61830	16	Özhatay *
erubescens K. Koch		–	–
● *fethiyense* Özhatay & B. Mathew	ISTE 58655	16	Özhatay *
fuscoviolaceum Fomin		16+1B	Özhatay 1986a
	KOYM 8738	16	Özhatay *
● *gorumsense* (Regel) Boiss.		–	–
gramineum K. Koch	BAHY 141	16	Özhatay *
guttatum Steven			
subsp. *dalmaticum* (Janch.) Stearn		32	Özhatay 1986a
subsp. *guttatum*		16	Özhatay 1986b
	ISTE 56954 A	32	Özhatay *
subsp. *sardoum* (Moris) Stearn		16	Özhatay 1984, 1990

Table 1 (continued).

Allium (sect. *Allium*)	Collector + n°	2*n* =	References
• *ilgazense* Özhatay		16	Özhatay 1986a
jubatum J. F. Macbr.		16	Özhatay 1986b
junceum Sm. subsp. *junceum.*	ISTE 43979	16	Özhatay *
• subsp. *tridentatum* Kollmann & al.	ISTE 60504	16	Özhatay *
karyeteinii Post	ISTE 61704	16	Özhatay *
longicuspis Regel		–	–
macrochaetum Boiss. & Hausskn.		16	Şiraneci 1992
• *nevsehirense* M. Koyuncu & Kollmann	BAHY 52	32	Özhatay *
	ISTE 60410	16	Özhatay *
• *oltense* Grossh.		16	Özhatay 1986b
phanerantherum Boiss. & Hausskn.			
subsp. *deciduum* Kollmann & M. Koyuncu		–	–
subsp. *phanerantherum*		–	–
ponticum Grossh.		32	Özhatay 1986b
proponticum Stearn & Özhatay			
• var. *parviflorum* Kollmann		–	–
• var. *proponticum*		16	Stearn & Özhatay 1977
		16	Özhatay 1990
pseudoampeloprasum Grossh.		16	Özhatay 1986b
pustulosum Boiss. & Hausskn.		–	–
• *reuterianum* Boiss.	ISTE 43993	16	Özhatay *
robertianum Kollmann		–	–
rollovii Grossh.		16	Özhatay 1986b
rotundum L.			
subsp. *jajlae* (Vved.) B.		16	Özhatay 1986b
Mathew	ISTE 54593	16	Özhatay *
	BAHY 11	32	Özhatay *
subsp. *rotundum*		16	Özhatay 1986b
		32	Özhatay 1984
	BAHY 18	40	Özhatay *
subsp. *waldsteinii* (G. Don)	BAHY 140	24	Özhatay *
K. Richt.	MAWS 10804	32	Özhatay *
	MAWS 10804	32	Özhatay *
• *sandrasicum* Kollmann & al.	ISTE 60506	16	Özhatay *
• *scabriflorum* Boiss.	ISTE 61853	16	Özhatay *
scorodoprasum L.		32	Özhatay 1984
• *sintenisii* Freyn		–	–
sosnowskyanum Grossh.		16	Özhatay 1986b
		16	Özhatay 1993

Table 1 (continued).

Allium (sect. *Allium*)	Collector + n°	2*n* =	References
sphaerocephalon L.			
subsp. *arvense* (Guss.) Arcang.		–	–
subsp. *sphaerocephalon*		16	Stearn & Özhatay 1977, Özhatay 1984, 1990
subsp. *trachypus* (Boiss. & Spruner) K. Richt.		–	–
stearnianum M. Koyuncu & al.			
● subsp. *stearnianum*		16	Özhatay 1986b
● subsp. *vanense* Kollmann & M. Koyuncu		–	–
stylosum O. Schwarz	KOYM 8560	16	Özhatay *
trachycoleum Wendelbo	ISTE 60451	48	Özhatay *
● *tuncelianum* (Kollmann) B. Mathew & Özhatay		16	Şraneci 1992
vineale L.		32	Özhatay 1984
● *vuralii* Kit Tan		–	–
Bellevalia			
● *anatolica* B. Mathew & Özhatay		8	Johnson 1994
● *clusiana* Griseb.		8	Bothmer & Wendelbo 1981
		8	Özhatay & al. 1991a
● *crassa* Wendelbo		–	–
dubia (Guss.) Roem. & Schult.		8	Özhatay & al. 1991a-b
● *edirnensis* Özhatay & B. Mathew		24	Özhatay & al.1991a-b
fominii Woronow		8	Özhatay & al. 1991a
● *forniculata* (Fomin) Deloney		8	Özhatay & al. 1991a
● *gracilis* Feinbrun		8+0-3B	Özhatay & al. 1991a
kurdistanica Feinbrun		16	Bothmer & Wendelbo 1981
latifolia Feinbrun		32	Özhatay & al. 1991a
longipes Post		–	–
longistyla (Miscz.) Grossh.		32, 33, 35	Özhatay & al. 1991a
macrobotrys Boiss.		–	–
● *modesta* Wendelbo		8	Özhatay & al. 1991a
paradoxa (Fisch. & C. A. Mey.) Boiss.		8, 16, 32	Özhatay & al. 1991a
	JOHM 300	8 + 3TB	Johnson *
pycnantha (K. Koch) Losinsk.		8,8+3TB,16,16+2TB	Özhatay & al. 1991a
● *rixii* Wendelbo		8	Özhatay & al. 1991a
sarmatica (Georgi) Woronow		8	Bothmer & Wendelbo 1981
		8,8+2B,8+3B,9+3B	Özhatay & al. 1991a
	ARJJ 6950	8+3MB	Johnson *
● *tauri* Feinbrun		8, 16	Bothmer & Wendelbo 1981
		16	Johnson *

Table 1 (continued).

Bellevalia	Collector + n°	2*n* =	References
trifoliata (Ten.) Kunth		8	Bothmer & Wendelbo 1981
		8	Özhatay & al. 1991a
Muscari s.l.			
• *anatolicum* Cowley & Özhatay		18,36	Johnson 1994
armeniacum Baker		18	Stuart 1970
		18	Karlén 1985
		18	Dalgiç 1991
	JOHM 182	18	Johnson *
	JOHM 67	18+2B	Johnson *
	JOHM 159	18+0-3B	Johnson *
	JOCD 53.90.229	36	Johnson *
• *aucheri* (Boiss.) Baker		18,36	Stuart 1970
	JOHM 205	18	Johnson *
	JOHM 87	36	Johnson *
• *azureum* Fenzl		18	Stuart 1970
• *bourgaei* Baker		18	Stuart 1970
	JOHM 343	18	Johnson *
caucasicum (Griseb.) Baker		18	Stuart 1970
	JOHM 202	18	Johnson *
• *coeleste* Fomin	JOHM 132	18	Johnson *
comosum (L.) Mill.		18	Stuart 1970
		18	Dalgiç 1991
	JOHM 330	18	Johnson *
• *discolor Boiss.*		18	Johnson 1994
inconstrictum Rech. f.		–	–
• *latifolium* Kirk		18,36+1,2B	Speta 1989b
longipes Boiss.		–	–
macrocarpum Sweet	JOHM 496	18	Johnson *
• *massayanum* Grunert		18	Davis & Mathew 1982
		18	Speta 1989 b
	ISTE 57075	18	Johnson *
• *mcbeathianum* Kit Tan		–	–
• *microstomum* Davis		18	Stuart 1970
• *mirum* Speta		18	Speta 1989b
• *muscarimi* Medik.		18	Stuart 1970
	JOHM 503	18	Johnson
neglectum Guss.		18	Stuart 1970
		28,45,54	Dalgiç 1991
	JOHM 225	18	Johnson *
	JOHM 237	36	Johnson *
	JOHM 241	36+1B	Johnson *
parviflorum Desf.		–	–
• *sandrasicum* Karlén		18	Karlén 1987
	JOHM 438	18	Johnson *

Table 1 (continued).

Muscari	Collector + n°	2*n* =	References
tenuiflorum Tausch		18	Stuart 1970
		18	Dalgiç 1991
	JOCD 89.90.369	18	Johnson *
weissii Freyn		18	Bentzer 1973
• sp.	JOCD 6.90.26	18	Johnson *
Ornithogalum (subg. *Ornithogalum*)			
• *aemulum* Schott & Kotschy		16	Speta 1991c
alatum Turrill		20	Speta 1991a
• *alpigenum* Stapf		18	Cullen & Ratter 1967
• *armeniacum* Baker		16	Cullen & Ratter 1967
		16	Dalgiç & Özhatay 1996
	JOHM 410	14	Johnson *
	JOCD 39.90.160	16	Johnson *
	JOCD 45.90.187	18	Johnson *
	JOCD 59.90.241	18+1B	Johnson *
	JOCD 64.90.285	20	Johnson *
	JOHM 467	20+1B	Johnson *
	JOHM 447	22 (or 18+4B)	Johnson *
comosum L.		14,16,18	Dalgiç & Özhatay 1996
	JOHM 335	16	Johnson *
euxinum Speta		18	Speta 1990
fimbriatum Willd.		12,35,36	Cullen & Ratter 1967
		12	Dalgiç & Özhatay 1996
aff. *fimbriatum*		13,20+1B	Johnson & al. 1991
• *improbum* Speta		18	Speta 1992
• *joschiae* Speta		18	Speta 1989a
• *kureanum* Speta		14	Speta 1991a
lanceolatum Labill.		20,22	Cullen & Ratter 1967
	JOCD 63.90.266	20	Johnson *
	JOHM 470	22	Johnson *
• *macrum* Speta		54	Speta 1991e
montanum Cyr.		14,18	Cullen & Ratter 1967
		14	Dalgiç & Özhatay 1996
	JOHM 518	18	Johnson *
	DVSP 39388	18+1-2B	Johnson *
• *mysum* Speta		16	Speta 1991d
• *nivale* Boiss.		–	–
oligophyllum E. D. Clarke sensu lato (incl. *O. balansae* and *O. luschanii*)		20,24	Cullen & Ratter 1967
		18	Dalgiç & Özhatay 1996
		16,20,24+2B,40,80	Johnson & al. 1991
		12	Johnson *
	JOHM 15	12+0-3B	Johnson *
	JOHM 19	18	Johnson *
	JOHM 133		

Table 1 (continued).

Ornithogalum (subg. *Ornithogalum*)	Collector + n°	2*n* =	References
• *balansae* Boiss.	JOHM 320	12	Johnson *
	JOHM 118	24	Johnson *
	JOHM 318	24+1B	Johnson *
• *luschanii* Stapf		44	Johnson & al. 1991
	JOHM 176	60	Johnson *
aff. *luschanii*		28	Johnson & al. 1991
orthophyllum Ten.		14	Dalgiç & Özhatay 1996
	JOHM 535	14	Johnson *
	JOCD 37.90.141	28	Johnson *
• *pascheanum* Speta		14	Speta 1991b
platyphyllum Boiss.		54	Cullen & Ratter 1967
	JOCD 20.90.84	16	Johnson *
	JOHM 103	18	Johnson *
	JOHM 179	27	Johnson *
• *reflexum* Freyn & Sint.		12	Speta 1991a
• *refractum* Schltdl.		28,54	Dalgiç & Özhatay 1996
sibthorpii Greuter		14,28,32	Dalgiç & Özhatay 1996
sigmoideum Freyn & Sint.		12,16,16+B,19,20	Cullen & Ratter 1967
		14	Johnson & al. 1991
	JOHM 378	14	Johnson *
ulophyllum Hand.-Mazz.		14,18	Cullen & Ratter 1967
	MAWS 11132	14 (or 12+2B)	Johnson *
	ARCH 6005	16+0-2B	Johnson *
• *uluense* Speta		20	Speta 1991c
umbellatum L.		44	Cullen & Ratter 1967
		36,45,54	Dalgiç & Özhatay 1996
	JOHM 167	16	Johnson *
wiedemannii Boiss.		14+1B	Cullen & Ratter 1967
		14+1B	Couderc & al. 1984
		12	Speta 1991 a
		12,12+1B,12+2B (or 14)	Johnson & al. 1991
	JOCD 1.90.1	18	Johnson *

Ornithogalum subg. *Ornithogalum*. – The karyotype (Fig. 1i) is very variable, both in chromosome size and structure. Meta-, submeta-, acro-, and telocentric chromosomes are found. Some interstitial secondary constrictions are seen, but distal satellites are rare. In this genus, there appear to be many different basic numbers, some polyploids, aneuploids, and also large B chromosomes. The latter are sometimes difficult to distinguish from A chromosomes.

Conclusions

A karyological summary is given in Table 2. Basic chromosome numbers are constant in *Allium*, *Bellevalia*, and *Muscari*, but not in *Ornithogalum*. Chromosome data are now available for 106 Turkish species out of a total number of 125.

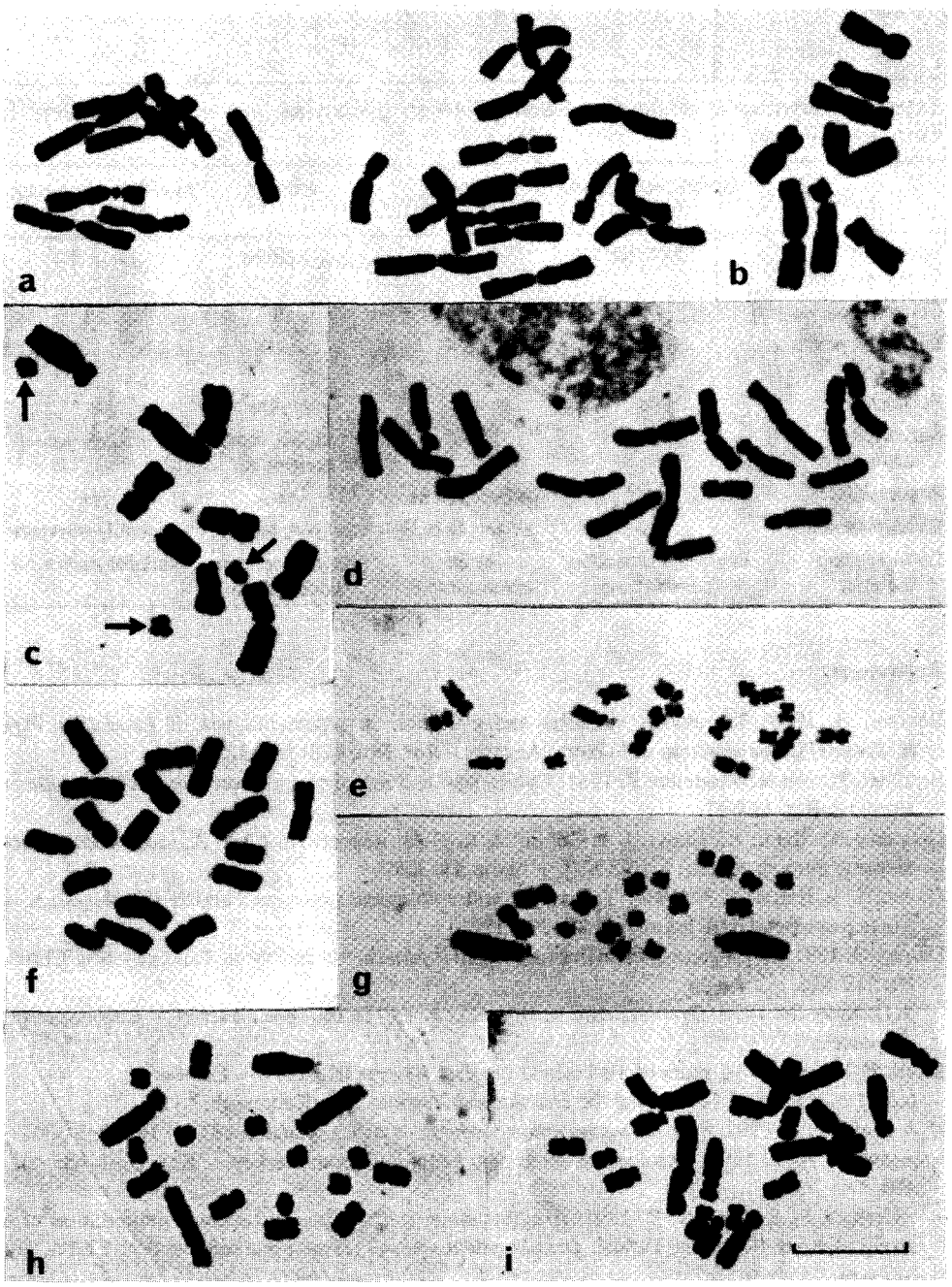

Fig. 1. Somatic metaphase plates of selected Turkish species of *Liliaceae*. – **a**, *Allium atroviolaceum*, $2n = 24$ (JOCD 45.90.184); **b**, *Bellevalia rixii*, $2n = 8$ (JOHM 269); **c**, *B. sarmatica*, $2n = 8 + 3$ metacentric B chromosomes (arrowed) (ARJJ 6950); **d**, *Muscari muscarimi*, $2n = 18$ (JOHM 503); **e**, *M.* sp., $2n = 18$ (JOCD 6.90.26); **f**, *M. coeleste*, $2n = 18$ (JOHM 132); **g**, *M. comosum*, $2n = 18$ (JOHM 330); **h**, *M. tenuiflorum*, $2n = 18$ (JOCD 82.90.369); **i**, *Ornithogalum lanceolatum*, $2n = 20$ (JOCD 63.90.268). – Scale bar = 10 μm.

Table 2: Karyological summary of some Turkish geophytes. – * = more frequent in European Turkey.

	Allium sect. *Allium*	*Bellevalia*	*Muscari*	*Ornithogalum* subg. *Ornithogalum*
Species n° (Endemism %)	53 (42%)	20 (45%)	23 (56%)	29 (51%)
Counted species (n°)	42	17	19	28
Basic chromosome number	$x = 8$	$x = 4$	$x = 9$	$x = 6,7,8,9,10,11,12$
Polyploidy	yes	yes	very rare *	yes *
Karyotype asymmetry	no	yes	yes, but some species no	usually yes
Aneuploidy	no	no, except $6x$	no	yes
B chromosomes	few	$2x$ and $4x$ only	very few	probably common
Distinguishing features	interstitial secondary constrictions	large chromosomes	distal secondary constrictions	variable karyotype

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Addresses of the authors:
Prof. Neriman Özhatay, Department of Pharmaceutical Botany, Faculty of Pharmacy, University of Istanbul, TR-34452 Istanbul, Turkey.
Ms Margaret A. T. Johnson, Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3DS, U.K.