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The Karyotype of Three *Limonium* Miller Species in the Family of Plumbaginaceae Conducted Using Image Analysis System

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Abstract: In this research, a karyological analysis on three naturally growing *Limonium* Miller species were made using Image Analysis System. The species studied are; *Limonium iconicum* (Boiss. and Heldr.) O. Kuntze, *L. lilacinum* (Boiss. and Bal.) Wagenitz and *L. globuliferum* (Boiss. and Heldr.) O. Kuntze. The chromosome numbers are determined as $2n = 34$ in *L. iconicum*, as $2n = 36$, in *L. lilacinum* and as $2n = 18$ in *L. globuliferum*. The chromosome lengths in these taxa varied between 1.44 to 6.10 μm . The karyotype formula of the species studied were; in *L. iconicum* $10m+5sm+2T$, in *L. lilacinum* $7m+10sm+1T$ and in *L. globuliferum* $4m+5sm$. The ideograms of each species were arranged according to the decrease in their length.

Key words: Chromosome number, karyomorphology, *Limonium*, Plumbaginaceae

INTRODUCTION

Plumbaginaceae is a cosmopolitan family distributed widely in the temperate zones of the Northern Hemisphere. It prefers arid or saline, often coastal, environments (Kubitzki, 1993; Lledó *et al.*, 2005).

Limonium Mill. genus is represented with approximately 400 taxa and 12 sections throughout the world (Febles and Pérez-Rodríguez, 2004). *Limonium* is represented with 21 taxa (five sections) in Turkey (Bokhari and Edmondson, 1982; Yildirimli and Koca, 2006).

Limonium species (*L. iconicum* and *L. lilacinum*) are labeled locally by the Turkish people as eşek kulağı and deve kulağı. Whereas the fresh leaves of this species are eaten by animals, the dried florescences are used as drog.

Previous studies on the chromosome numbers of the *Limonium* genus determined the chromosome number as $2n = 12, 14, 16, 17, 18, 24, 25, 26, 27, 28, 32, 33, 34, 35, 36, 42, 43, 51$ and 54 . The studies have proven that this genus has four different basic chromosome number ($x = 6, 7, 8$ and 9) (Michaelis, 1964; Febles, 1989; Borgen, 1969; Van Loon, 1974; Papatsoy and Phitos, 1975; Erben, 1978, 1979, 1993; Brullo and Pavone, 1981; Artelari and Kamari, 1986; Goldblatt, 1988; Artelari *et al.*, 1992; Ardevol Gonzales *et al.*, 1993; Arrigoni and Diana, 1993; Sáez *et al.*, 1998; Rosselló *et al.*, 1998; Goldblatt and Johnson, 2000; Palacios *et al.*, 2000; Lledó *et al.*, 2003; 2005). The main objectives of this study are to report new counts for three species of *Limonium* collected in Turkey and to analyses in detail the karyotypes of these three Turkish species using Image Analysis System.

MATERIALS AND METHODS

Seed material was collected in Turkey in 2005 (Table 1). Vouchers have been deposited at the herbaria of Afyonkarahisar Kocatepe University, Department of Biology.

Mitotic chromosome preparations were prepared from root meristems obtained from germinating seeds. Root tips were pretreated for 16 h in α -monobromonaphthalene at 4°C , fixed in 3:1 absolute alcohol-glacial acetic acid, then the root tips were hydrolyzed with 1 N HCl for 3 min at 60°C overnight and stained with 2% aceto-orcein for 2 h at room temperature. Stained root tips were squashed with a drop of 45% acetic acid and permanent slides were made by mounting with Depex. We examined slides under Olympus BX-50 Photomicroscope using an oil immersion objective (100 X). Photographs were taken using the same microscope. The ideogram was taken only of five well spread metaphase plates and measurements were made on enlarged micrographs. The classification of chromosomes, the length of long and short arm, arm ratio, centromeric index and relative chromosomal length were measured using Software Image Analyses (BsPro200) loaded on a personal computer. The classification of chromosomes into median (m), submedian (sm), subterminal (st) and

Table 1: The localities of studied specimens in *Limonium*

Taxon	Chromosome		
	No. (2n)	Locality	Voucher
<i>Limonium iconicum</i>	34	Afyonkarahisar	Kala 1531
<i>Limonium lilacinum</i>	36	Afyonkarahisar	Kala 1309
<i>Limonium globuliferum</i>	18	Afyonkarahisar	Kala 1530

terminal point (T) was based on the analysis of metaphase chromosomes (Levan *et al.*, 1964). Ideograms of these taxa were arranged in decreasing length.

RESULTS AND DISCUSSION

The karyomorphological features reported here have not been reported in previous studies on the species of *Limonium iconicum*, *L. lilacinum* and *L. globuliferum*. The karyological data of all species are given in Table 2 and Fig. 1-3. The number of somatic chromosomes is $2n = 34$ in *Limonium iconicum*, $2n = 36$ in *Limonium lilacinum* and $2n = 18$ in *Limonium globuliferum*. The basic chromosome number is $x = 9$, 17 and 18. The karyotype formulas are different in these three *Limonium* species. One pair of satellite in metaphase chromosomes is identified in *Limonium iconicum* and *Limonium lilacinum*. In this research no polyploidy is observed.

Section: *Limonium*: *Limonium iconicum* (Boiss. and Heldr.) O. Kuntze is found in Afyonkarahisar: around the salty area in Heybeli hot spring, at the altitude of 1000 m. on 25.07.2006, Kala 1531. It had a somatic chromosome number of $2n = 34$ (Fig. 1). The Karyotype formula, chromosome morphology total, arm ratio and centromeric index are shown in Table 2. At mitotic metaphase phase, ten pairs of median (m), five pairs of submedian (sm) and two pairs of terminal point (T) chromosomes are observed. The chromosome lengths varied between 1.44 to 4.67 μm . The total haploid chromosome length is measured as 42.51 μm . One pair of satellite in metaphase chromosomes is identified. The ideogram of this species, endemic to Turkey, is given in Fig. 4.

Section: *Sphaerostachys* Boiss: *Limonium lilacinum* (Boiss. and Bal.) Wag. is found in Afyonkarahisar: Çay, in the salty grass areas in the surroundings of Lake Eber, at the altitude of 950 m. on the 20.07.2005, Kala 1309. $2n = 36$ is the somatic chromosome number of this species (Fig. 2). The karyotype formula, chromosome morphology, arm ratio and centromeric index are summarized in Table 2. At the mitotic metaphase phase seven pairs of median (m), ten pairs of submedian (sm) and one pair of terminal point (T) chromosomes are observed. The chromosome lengths are between 1.53 to 2.76 μm . The total haploid chromosome length is measured as 48.23 μm . One pair of satellite in metaphase chromosomes is identified in this species endemic to Turkey. The ideogram is given in Fig. 4.

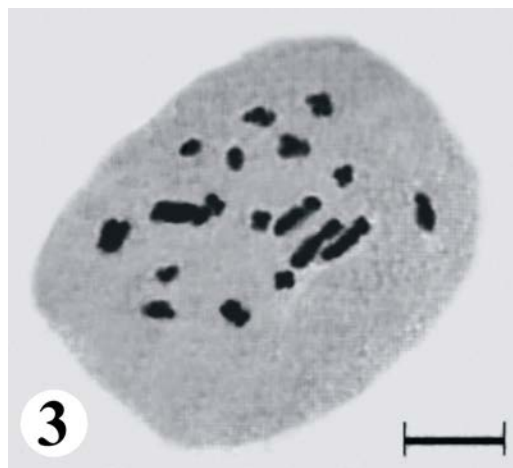
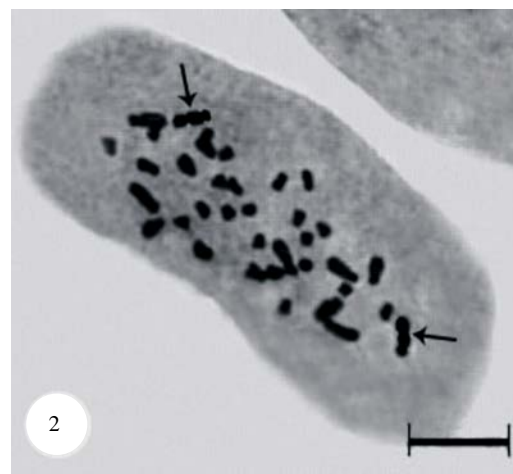
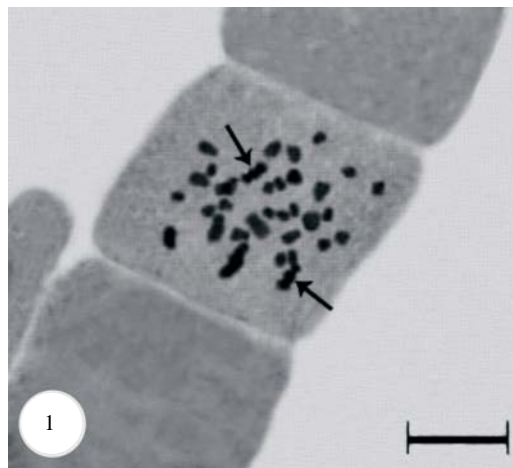


Fig. 1-3: (1) *Limonium iconicum* ($2n = 34$), (2). *L. lilacinum* ($2n = 36$) and (3). *L. globuliferum* ($2n = 18$). Scale Bar: 10 μm

Table 2: Karyotype details in taxa of *Limonium*

Taxon	Chromosome No. (2n)	Chromosome sizes (µm)	AR	CI	THC (µm)	M	SM	T	X
<i>Limonium iconicum</i> *	34	1.44-4.67	1.96	1.95	42.51	10	5	2	17
<i>Limonium lilacinum</i> *	36	1.53-2.76	1.92	1.90	48.23	7	10	1	18
<i>Limonium globuliferum</i>	18	1.86-6.10	1.87	3.76	29.61	4	5	-	9

AR: arm ratio; CI: Centromeric index; THC: Total length of haploid complement; M: Median; SM: Submedian; T: Terminal point; X: Basic chromosome number, * one pair of satellites in the chromosome pairs is marked with an asterisk

Section: *Sphaerostachys* Boiss: *Limonium globuliferum* (Boiss. and Heldr.) O. Kuntze has been located in Afyonkarahisar: around the salty area of Heybeli hot spring at the altitude of 1000 m, on the 25.07.2006, Kala 1530. The somatic chromosome number of this species is $2n = 18$ (Fig. 3). The karyotype formula, chromosome morphology, arm ratio and centromeric index of this species are shown in Table 2. At the mitotic metaphase stage four pairs of median (m), five pairs of submedian (sm) chromosomes are observed. The chromosome length varied from 1.86 to 6.10 µm. Total haploid chromosome length is measured as 29.61 µm. The ideogram of this species is given in Fig. 4.

The results of the present study are the first identifying the chromosome numbers and morphologies of the species *Limonium iconicum*, *L. lilacinum* and *L. globuliferum*. The diploid chromosome numbers are determined as $2n = 34$ for *L. iconicum*, as $2n = 36$ for *L. lilacinum* and as $2n = 18$ for *L. globuliferum*. The chromosome numbers identified is in line with previous studies on specimens from different localities (Erben, 1978, 1979, 1993; Brullo and Pavone, 1981; Artelari and Kamari, 1986; Goldblatt, 1988; Artelari *et al.*, 1992; Ardevol Gonzales *et al.*, 1993; Sáez *et al.*, 1998; Rosselló *et al.*, 1998; Goldblatt and Johnson, 2000; Lledó *et al.*, 2003, 2005). Table 3 shows previous counts in some taxa of *Limonium*.

Limonium genus diverges into two sections according to Turkish flora enlistments (*Limonium* and *Sphaerostachys*). The species in the present study have proven three different somatic chromosome and basic chromosome numbers.

L. iconicum species is endemic to Turkey. The diploid chromosome number is $2n = 34$ and the basic chromosome number is defined as $x = 17$. This taxon has the largest arm ratio (1.96) and the length of the smallest chromosome number is (1.44 µm). The karyotype formula of this species is $10m+5sm+2T$. In metaphase chromosomes a pair of satellite is determined.

L. lilacinum species is also endemic to Turkey. $2n = 36$ is diploid chromosome number of this species and the basic chromosome number is $x = 18$. It has the largest haploid chromosome length (48.23 µm) of this species; but at the same time it also has the smallest centromeric index (1.90). The karyotype formula is $7m+10sm+1T$. A pair of satellite is determined in the metaphase chromosomes of this species.

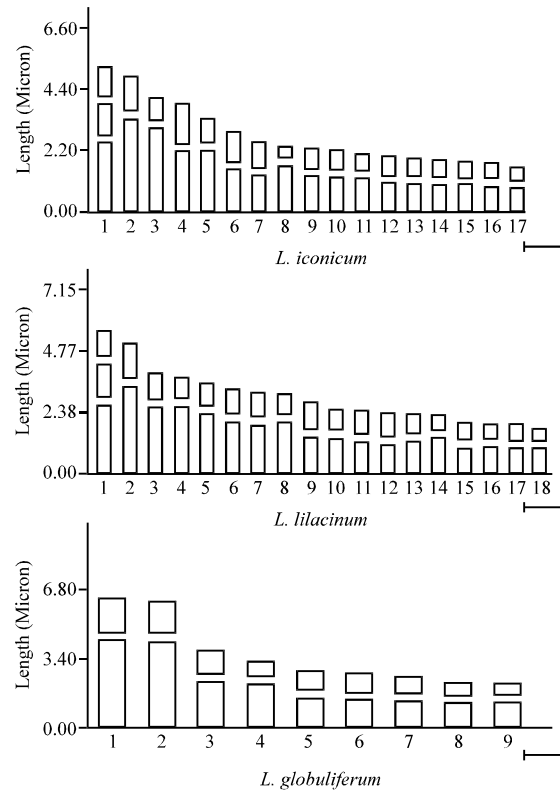


Fig. 4: Ideograms of *Limonium* species. Scale bar: 10 µm

In the Karyological literature review on *Limonium* genus taxa no satellite has been reported. However, in the present karyological study, a double pair of satellite chromosomes is determined in the mitotic metaphase chromosomes of *L. iconicum* and *L. lilacinum* species.

Contrary to *L. lilacinum* and *L. iconicum*, *L. globuliferum* species is not endemic to Turkey. It has a diploid chromosome number of $2n = 18$. The basic chromosome number is $x = 9$ and has the largest centromeric index (3.76) and chromosome length (6.10 µm) among the species of the present study. This taxon; nevertheless, has the smallest arm ratio (1.87) and total haploid chromosome length (29.61 µm). The Karyotype formula of this taxon is $4m+5sm$ and there are not any terminal point metaphase chromosomes contrary to the other species.

Regarding this genus in the literature, the chromosome number of only four taxa is reported on the Turkish flora (Papatsou and Phitos, 1975; Erben, 1978;

Davis *et al.*, 1988; Artelari *et al.*, 1992; Güner, 2000). Cytological studies and their results on the *Limonium* taxa are given in Table 3. Erben (1978, 1979) noted that within section *Limonium*, diploid species show two basic chromosome numbers ($n = 8$ and $n = 9$) and postulated that the complement of the polyploidy arose through several combinations, involving reduced and unreduced gametes. Hence, triploid ($2n = 24, 25, 26$ and 27) and tetraploid ($2n = 34, 35$ and 36) taxa combine genomes of the two basic cytotypes (Palacios *et al.*, 2000).

Myriolepis section, which found in *Limonium* genus, separated from *Limonium* genus and constituted a new genus (Lledó *et al.*, 2003). According to the literature, *L. diffusum* and *L. ferulaceum*, previously in section *Myriolepis*, the diploid chromosome numbers were defined as $2n = 16$ (Erben, 1978, 1979). However the basic chromosome number of *Limonium* subgenus (e.g., *L. cymuliferum*) were defined as $x = 8$ and $x = 9$. *L. ferulaceum* species' chromosome are more or less equal and consists of median metaphase chromosomes, but in *L. diffusum* species, the chromosome lengths are not equal. However, *L. sinuatum* (subgenus *Pteroclados*) has the same chromosome number and their karyotypes consist completely of subterminal chromosome pairs and are declared to be of equal size. In the same literature, *Siphonantha* and *Polyarthrion* sections have diploid chromosome number $2n = 18$ (Lledó *et al.*, 2003). In our research only in *Limonium globuliferum* out of the three *Limonium* species diploid chromosome number is observed as $2n = 18$. Hence, *Siphonantha* and *Polyarthrion* sections' somatic chromosome numbers are compatible with the literature. The karyotype formula of *Limonium* species differs with the literature. This fact may stem from diversity in the locality.

In the karyological studies on *Pteroclados* section, endemic to Canary Islands, nine species and one subspecies of *Limonium* genus in the *Nobiles* subsection, all taxa are reported to have $2n = 14$ somatic chromosome numbers. The basic chromosome number was reported as $x = 7$ (Febles and Pérez-Rodríguez, 2004). The karyotype formulas are reported generally as $7m$ chromosome pairs (except *L. bourgeai* and *L. puberulum*). *L. bourgeai* and *L. puberulum* karyotype formulas are mentioned as $6m+1sm$. In this study, the somatic chromosome numbers of *Limonium* species diverge from the above-mentioned literature in regard to the number and morphology of the chromosomes.

Erben and Arán introduced *Limonium mateoi* species to literature in 2005 and defined its somatic chromosome number as $2n = 18$ in line with our finding on the chromosome number of *L. globuliferum*.

The chromosome numbers 16 plant taxa endemic the North Cyprus was defined in 2006 by Yıldız and Gücel. *Limonium albidum* (Guss.) Pignatti subsp. *cypricum*

Table 3: Previous counts in some taxa of *Limonium*

Taxon	2n	Authors
<i>L. graecum</i> var. <i>hyssopifolium</i>	42	Papatsou and Phitos (1975)
<i>L. sinuatum</i>	16	Erben (1978, 1979)
<i>L. virgatum</i>	27	Erben (1978, 1979)
<i>L. diffusum</i>	16	Erben (1978, 1979)
<i>L. ferulaceum</i>	16	Erben 1978, 1979)
<i>L. cymuliferum</i>	16	Erben (1978, 1979)
<i>L. bellidifolium</i>	18	Artelari <i>et al.</i> (1992)
<i>L. narbonense</i>	36	Palacios <i>et al.</i> (2000)
<i>L. vulgare</i>	36	Palacios <i>et al.</i> (2000)
<i>L. camposanum</i>	27	Palacios <i>et al.</i> (2000)
<i>L. gymnesicum</i>	27	Palacios <i>et al.</i> (2000)
<i>L. girardianum</i>	26	Palacios <i>et al.</i> (2000)
<i>L. delicatulum</i>	25	Palacios <i>et al.</i> (2000)
<i>L. cavanillesii</i>	27	Palacios <i>et al.</i> (2000)
<i>L. anguste-bracteatum</i>	26	Palacios <i>et al.</i> (2000)
<i>L. rigualii</i>	27	Palacios <i>et al.</i> (2000)
<i>L. cossonianum</i>	16	Palacios <i>et al.</i> (2000)
<i>L. furfuraceum</i>	18	Palacios <i>et al.</i> (2000), Lledó <i>et al.</i> (2005)
<i>L. tenuicaule</i>	18	Palacios <i>et al.</i> (2000)
<i>L. minutum</i>	18	Palacios <i>et al.</i> (2000)
<i>L. dichotomum</i>	18	Palacios <i>et al.</i> (2000)
<i>L. caesium</i>	18	Palacios <i>et al.</i> (2000)
<i>L. globatum</i>	12	Palacios <i>et al.</i> (2000)
<i>L. echioides</i>	18	Palacios <i>et al.</i> (2000)
<i>L. lobatum</i>	12	Erben (1979)
<i>L. arborescens</i>	14	Michaelis (1964)
<i>L. bourgeai</i>	14	Borgen (1970), Ortega and Navarro (1977)
<i>L. brassicifolium</i> subsp. <i>brassicifolium</i>	14	Michaelis (1964), Borgen (1970)
<i>L. brassicifolium</i> subsp. <i>macropterum</i>	14	Larsen (1960)
<i>L. fruticans</i>	14	Larsen 1958 (1960), Borgen (1970), Gagnieu <i>et al.</i> (1973)
<i>L. imbricatum</i>	14	Febles (1989)
<i>L. macrophyllum</i>	14	Larsen (1958, 1960), Borgen (1970)
<i>L. perezii</i>	14	Borgen (1970)
<i>L. puberulum</i>	14	Larsen (1958, 1960), Michaelis (1964) Van Loon (1974)
<i>L. spectabile</i>	14	Michaelis (1964)
<i>L. sventenii</i>	14	Borgen (1970), Febles (1989)
<i>L. pectinatum</i>	12	Larsen (1958, 1960), Borgen (1969)
<i>L. papillatum</i>	12	Borgen (1970)
<i>L. ovalifolium</i> subsp. <i>canariense</i>	24	Borgen (1970)
<i>L. tuberculatum</i>	32	Michaelis (1964), Borgen (1970)
<i>L. thiniense</i>	26	Lledó <i>et al.</i> (2005)
<i>L. echioides</i>	18	Lledó <i>et al.</i> (2005)
<i>L. cossonianum</i>	16	Lledó <i>et al.</i> (2005)
<i>L. estevei</i>	16	Lledó <i>et al.</i> (2005)
<i>L. carthaginense</i>	18	Lledó <i>et al.</i> (2005)
<i>L. leonardi-llorensii</i>	26	Sáez <i>et al.</i> (1998)
<i>L. marisoliai</i>	27	Sáez <i>et al.</i> (1998)
<i>L. calcarae</i>	18	Brullo and Pavone (1981)
<i>L. syracusanum</i>	18	Brullo and Pavone (1981)
<i>L. bocconeii</i>	18	Brullo and Pavone (1981)
<i>L. tenuiculum</i>	18	Brullo and Pavone (1981)
<i>L. lopadusanum</i>	18	Brullo and Pavone (1981)
<i>L. panormitanum</i>	18	Brullo and Pavone (1981)
<i>L. minutiflorum</i>	26	Brullo and Pavone (1981)
<i>L. cosyrense</i>	27	Brullo and Pavone (1981)
<i>L. pignattii</i>	27	Brullo and Pavone (1981)
<i>L. lojacioni</i>	32	Brullo and Pavone (1981)
<i>L. intermedium</i>	32	Brullo and Pavone (1981)
<i>L. ionicum</i>	35	Brullo and Pavone (1981)
<i>L. serotinum</i>	36	Brullo and Pavone (1981)
<i>L. mazarae</i>	36	Brullo and Pavone (1981)
<i>L. secundiranium</i>	36	Brullo and Pavone (1981)
<i>L. hyblaeum</i>	36	Brullo and Pavone (1981)
<i>L. lilacium</i>	36	Present study
<i>L. ionicum</i>	34	Present study
<i>L. globuliferum</i>	18	Present study

Meikle is among these taxa. The somatic chromosome number of *L. albidum* is $2n = 18$ just like *L. globuliferum* in the present study (Yidiz and Guçel, 2006).

These findings of the present study are in regard to the somatic chromosome number of the species studies inline with the literature. However, it diverges from previous literature in regard to chromosome morphology and chromosome lengths. This shows that there are cytological differences to be determined regarding genus *Limonium*. It further will shed light to similar studies on the karyology of the same genus.

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REFERENCES

- Ardevol-Gonzales, J.F., L. Borgen and P.L. Pérez De Paz, 1993. Checklist of chromosome numbers counted in Canarian vascular plants. *Sommerfeltia*, 18: 51-59.
- Arrigoni, P.V. and S. Diana, 1993. Contribution à la connaissance du genre *Limonium* en Corse. *Candollea*, 48: 631- 677.
- Artelari, R. and G. Kamari, 1986. A karyological study of ten *Limonium* species (Plumbaginaceae) endemic in the Ionian area, Greece. *Willdenowia*, 15: 497-513.
- Artelari, R. and G. Kamari *et al.*, 1992. In: Mediterranean chromosome number reports-2. *Flora Mediterranea*, 2: 229-232.
- Bokhari, M. and J.R. Edmondson, 1982. *Limonium* Miller. In: Davis, P.H. (Ed.). *Flora of Turkey and the East Aegean Islands*, Edinburgh University Press, Edinburgh, 7: 465-476.
- Borgen, L., 1969. Chromosome numbers of vascular plants from the Canary Islands, with special reference to the occurrence of polyploidy. *Nytt. Mag. Bot.*, 16: 81-121.
- Borgen, L., 1970. Chromosome numbers of Macaronesian flowering plants. *Nytt. Mag. Bot.*, 17: 145-161.
- Brullo, S. and P. Pavone, 1981. Chromosome numbers in the Sicilian species of *Limonium* Miller (Plumbaginaceae). *Actas III Congr. Optima. Anales Jard. Bot. Madrid.*, 37: 535-555.
- Davis, P.H., R.R. Mill and K. Tan, 1988. *Flora of Turkey and East Aegean Islands (Supplement)* Vol. 10, Edinburgh University Press, Edinburgh.
- Erben, M., 1978. Die gattung *Limonium* in südwest mediterranean Raum. *Mitt. Bot. Staatssamml. München.*, 14: 361-631.
- Erben, M., 1979. Karyotype differentiation and its consequences in Mediterranean *Limonium*. *Webbia*, 34: 409-417.
- Erben, M., 1993. *Limonium* Mill. (nom. cons.). En *Castroviejo colaboradores Flora Ibérica. Plantas vasculares de la Peninsula Ibérica a Islas Baleares. Vol. 3. Real Jardín Botánica de Madrid. CSIC. Fareso, Madrid*, pp: 2-143.
- Febles, R., 1989. Estudios en la Flora Macaronésica: Algunos números de cromosomas. VI. *Bot. Macaronésica*, 17: 57-76.
- Febles, R. and E.Y. Pérez-Rodríguez, 2004. Análisis cariotípico de *Limonium* Mill. Sección *Pteroclados* Boiss. subsección *Nobiles* Boiss. (Plumbaginaceae). *Bot. Macaronésica*, 25: 79-94.
- Gagnieu, A., R. Linder and V. Voggenreiter, 1973. Caryotypes de la Flore Insularia de Tenerife. *Monog. Biol. Canar.*, 4: 126-133.
- Goldblatt, P., 1988. Index to plants chromosome numbers 1984-85. *Monographs in Systematic Botany. Vol. 23. Missouri Botanical Garden St. Louis.*
- Goldblatt, P. and D.E. Johnson, 2000. Index to plants chromosome numbers 1996-97. *Monographs in Systematic Botany. Vol. 81. Missouri Botanical Garden St. Louis.*
- Güner, A., 2000. *Limonium* Miller. In: *Flora of Turkey and the East Aegean Islands*, Güner, A., N. Özhatay, T. Ekim and K.H.C. Başer (Eds.). Vol. 11. Edinburgh University Press, Edinburgh.
- Kubitzki, K., 1993. Plumbaginaceae. In: *The Families and Genera of Vascular Plants*, Kubitzki, K., J.G. Rohwer and V. Bittrich (Eds.). Springer, Berlin. Germany, 2: 523-530.
- Larsen, K., 1958. Preliminary note on the cytology of the endemic canarian element. *Bot. Tidsskr.*, 54: 167-169.
- Larsen, K., 1960. Cytological and experimental studies on the flowering plants of the Canary Islands. *Biol. Skr. Dan. Vid. Selsk.*, 11: 1-60.
- Levan, A., K. Fredga and A.A. Sandberg, 1964. Nomenclature for centromeric position on chromosomes. *Hereditas*, 52: 201-220.
- Lledó, M.D., M. Erben and M.B. Crespo, 2003. *Myriolepis*, a new genus segregated from *Limonium* (Plumbaginaceae). *Taxon*, 52: 67-73.
- Lledó, M.D., M.B. Crespo, M.F. Fay and M.W. Chase, 2005. Molecular phylogenetics of *Limonium* and related genera (Plumbaginaceae): Biogeographical and systematic implications. *Am. J. Bot.*, 92: 1189-1198.

- Michaelis, G., 1964. Chromosomenzahlen einiger kanarischer endemismen. *Planta*, 62: 194.
- Ortega, J. and B. Navarro, 1977. Estudios en la Flora Macaronésica: Algunos números de cromosomas. *Bot. Macaronésica*, 4: 69-76.
- Palacios, C., J.A. Rosselló and F. González-Candelas, 2000. Study of the evolutionary relationships among *Limonium* species (Plumbaginaceae) using nuclear and cytoplasmic molecular markers. *Mol. Phylogenet. Evol.*, 14: 232-249.
- Papatsou, S. and D. Phitos, 1975. Two new taxa from the Eastern Aegean. *Notes R.B.G. Edinb.*, 34: 203-204.
- Rosselló, J.A., L. Sáez and A.C. Carvalho, 1998. *Limonium carvalhoi* (Plumbaginaceae), a new endemic species from the Balearic Islands. *Anales Jard. Bot. Madrid*, 56: 23-31.
- Sáez, L., A.C. Carvalho and J.A. Rosselló, 1998. *Limonium marisoliai* L. Llorens (Plumbaginaceae) Revisited. *Anales Jard. Bot. Madrid*, 56: 33-41.
- Van Loon, J.C., 1974. A cytological investigation of Flowering plants from the Canary Islands. *Acta Bot. Neerl.*, 23: 113-124.
- Yidiz, K. and S. Guce, 2006. Chromosome numbers of 16 endemic plant taxa from Northern Cyprus. *Turk. J. Bot.*, 30: 181-192.
- Yildirimli, S. and A.D. Koca, 2006. A new species *Limonium adilgunerii* Yildirimli and A. Dogru-Koca (Plumbaginaceae) from edge of Tuzgolu, Inner Anatolia, Turkey. *Ot. Sist. Bot. Dergisi*, 13: 11-16.