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Chromosome numbers of plants collected during *Iter Mediterraneum V* in Morocco

Abstract

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They represent 111 taxa belonging to 79 genera of 25 families. Twelve taxa have not previously been studied. In seven taxa the chromosome number found differs from previous reports.

Keywords: Chromosome number, karyology, cytotaxonomy, cytogenetics, Morocco, North Africa.

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Introduction

The OPTIMA expeditions (*Itinera Mediterranea*) constitute a good opportunity for improving the karyological knowledge of taxa distributed in geographical areas little known in the Mediterranean region. The chromosome number of many gatherings collected during different expeditions was counted and published in several papers (Luque & Díaz Lifante 1991; Díaz Lifante & al. 1992; Vogt & Aparicio 1999; Vogt & Oberprieler 2012). During the fifth OPTIMA expedition in Morocco in June 1992 (*Iter Mediterraneum V*), 2366 gatherings were collected, belonging to 1418 taxa. Seeds from 143 gatherings were germinated and chromosome number counted. These specimens belong to 111 different taxa, 79 genera and 25 families.

Material and Methods

In Table 1 the geographic origin of the plants here studied is indicated. Vouchers are kept in the Herbarium of the Departamento de Biología Vegetal y Ecología of the University of Seville (SEV).

Seeds were taken from the herbarium material and germinated in Petri dishes with filter paper moisturized with distillate water at room temperature in autumn 1992. Metaphase root plates were treated with 0.002 M-hydroxyquinoline for 4 hours, then fixed in Farmer's fluid (Löve & Löve 1975) and kept at 4 ºC. Alcoholic hydrochloric acid carmine solu-

tion (Snow 1963) was used for staining roots for 24-48 hours. Plates were squashed and mounted in 45 % glacial acetic acid. Photographs of metaphase plates for some taxa were obtained with a Zeiss Axioscope photomicroscope.

Results

The diploid chromosome numbers found are indicated in Table 2 in which families, genera and species are arranged alphabetically. The number of the gathering given in the *Iter V* collection is indicated for each plant. The previous chromosome counts for each taxa are referred by the cytogenetic databases where they are included. For simplicity, in Table 2 these databases are represented by one or two letters as follows: A, ANTHOS (2013); B, Bolkhovskikh & al. (1969); BI, BSBI (2013); Ch, CHROBASE (2013); Cr, CROMOCAT (2013); I, IPCN (2013) (see References section). Taxa marked with an asterisk are counted presumably for the first time in this study.

Discussion

The results here included are complementary with the accounts already published by Vogt & Oberprieler (2012) on plants collected during the fifth *Iter Mediterraneum*. According to the bibliographic references consulted, the counts made in 91 taxa agree with previous numbers reported by different authors. In 25 of these taxa the somatic chromosome number found confirms the range of ploidy levels known to date. The counts obtained in three taxa amplify the ploidy level range and those found in seven taxa are not in agreement with previous reports. For 16 taxa the counts here presented seem to be the first accounts on Moroccan plants. For 12 taxa these are presumably the first accounts

Some comments for 64 taxa are following in relation to the chromosome numbers here presented which are deviating from previous studies or constitute a new count or are remarkable for other reasons. Taxa for each family are arranged alphabetically.

Alliaceae

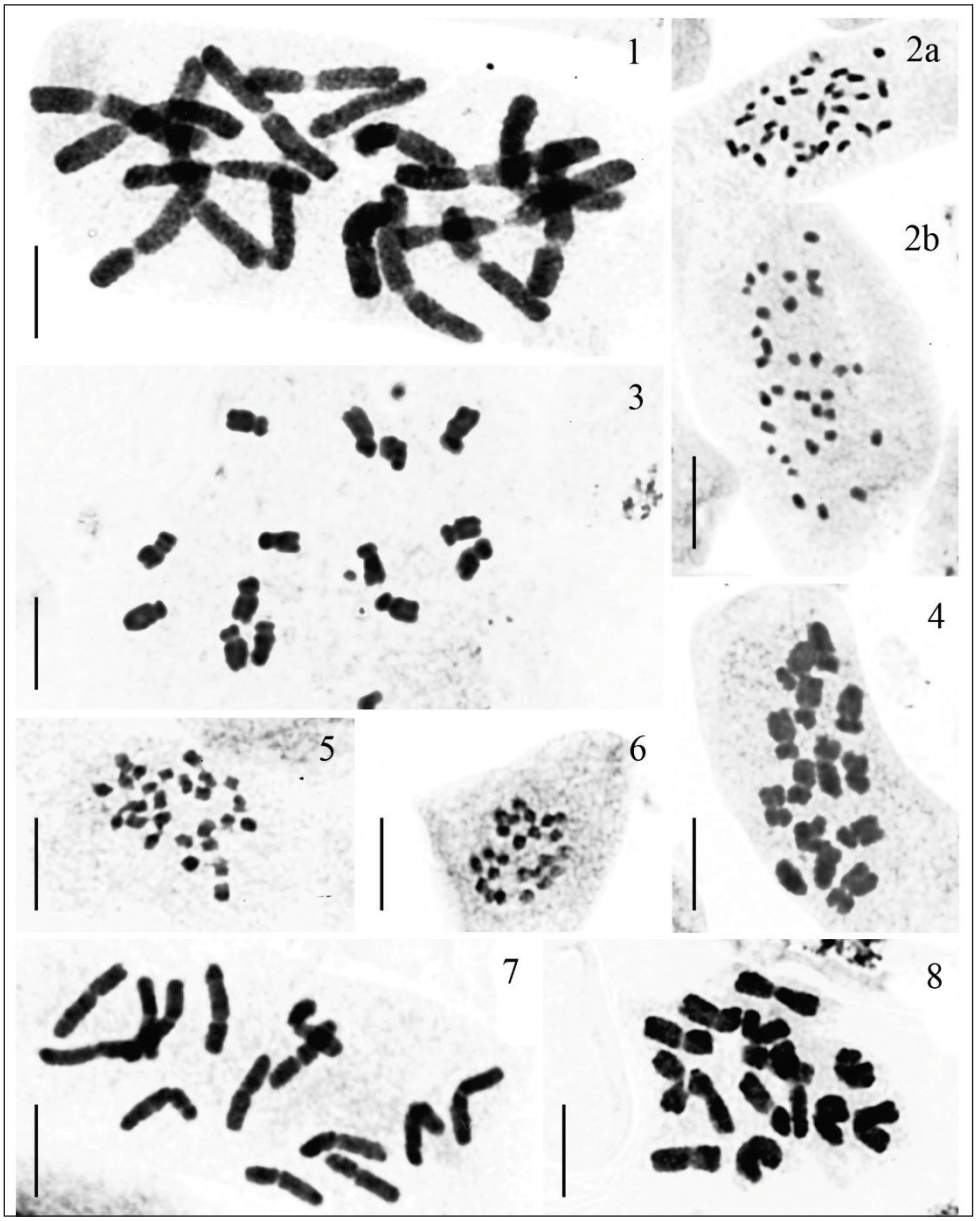
Allium pallens Lam. subsp. *pallens* *2n*=16 (fig. 1)

The chromosome number found for the first time in plants from two locations of Morocco supports the distribution of diploids in populations from the Iberian Peninsula, N Africa and Anatolia, as Fiorini & Raffaelli (1996) suggested, whereas the 4x level distributes by the central Mediterranean area.

Brassicaceae

Alyssum simplex Rudolphi (= *A. parviflorum* Fisch.) *2n*=32

This tetraploid level has also been found by Ghaffari & Chariat-Panahi (1985) and Vogt & Oberprieler (2009, 2012: gathering nº 3.91) in plants from Iran and Morocco, respectively, whereas the diploids (*2n*=16) have been found in Portugal (Queirós 1973), Italy (Raimondo



Figures 1-8. Somatic metaphases. 1: *Allium pallens* Lam. subsp. *pallens* (3.83), 2n=16. 2a, 2b: *Ononis mitissima* L. (54.1808), 2n=30-32. 3: *Vicia lecomtei* Humbert & Maire subsp. *lecomtei* (29.1285), 2n=14. 4: *Vicia pubescens* (DC.) Link (43.1475), 2n= 14. 5: *Geranium purpureum* Vill. (25.892bis), 2n=26. 6: *Luzula forsteri* (Sm.) DC. (60.2065), 2n=24. 7: *Hordeum murinum* subsp. *glaucum* (Steud.) Tzvelev (7.322), 2n=14. 8: *Patzkea patula* (Desf.) H. Scholz (10.455), 2n= 14. Scale bar for all the figures: 5 μm.

& al. 1983), Spain (Löve & Kjellqvist 1974a, Luque & Díaz Lifante 1991) and Greece (Runemark 2000).

Diplotaxis tenuisiliqua Delile *2n*=18

This is, presumably, the first count made for this north African endemism.

Jonopsidium prolongoi (Boiss.) Batt. *2n*=36

The count here included differs from *n*=11 by Fernández Casas (1975) and *2n*= 22 by Chiarugi (1945, sec. Bolkhovskikh & al. 1969). Nevertheless *2n*=36 has also been found by Luque & Díaz Lifante (1991) in plants from Sierra de la Sagra (SE Spain). This population is located at a high altitude, 1400-1700 m, as the Moroccan population here studied, at 1765-1900 m.

Lepidium heterophyllum Benth. subsp. *riphanum* (Emb. & Maire) J.M. Monts. Martí *2n*=16

This seems to be the first time that the somatic chromosome number has been counted in this Rif endemic subspecies. It agrees with the counts from N European and Portuguese plants attributed to the species without subspecific designation (ANTHOS 2013; Bolkovskikh & al. 1969; CROMOCAT 2013; IPCN 2013).

Lepidium hirtum (L.) Sm. subsp. *dhayense* (Munby) Thell. *2n*=32

The account here presented for this north African endemism was obtained in plants from the Middle Atlas growing at 1400 m. The octoploid level (2n=32) found disagrees with the 2n=16 given by Favarger & al. (1979) in plants from several populations of High Atlas at 3350 m altitude. So far, all accounts on this W Mediterranean species (Bolkhovskikh & al. 1969; Morales Torres & al. 1988) yelded diploid and tetraploid level (*2n*=8 and *2n*=16).

Malcolmia triloba (L.) Sprengel subsp. *broussonetii* (DC.) Asensi & Díaz Garretas *2n*=20

This is the first count for the subspecies. It differs from the *2n*=24 found by Diosdado & al. (1994) in plants from Sevilla (Spain) without indication of subspecies.

Psychine stylosa Desf. *2n*=30

In this endemic north African species, the gametic number *n*=15 has been found also in Moroccan plants identified as the var. *maroccana* Murb. (Marrakech, Gómez Campo 1980) and var. *typica* Maire (Fès, Ruíz de Clavijo 1991), but it disagrees with that of *2n*=16 found by Arista & Ortiz (1994) in plants from Taza (Morocco).

Sisymbrium erysimoides Desf. *2n*=14

This is the third count in this species, which is in accordance with that found by Jonsell (1976) in plants from tropical Africa and by Díaz Lifante & al. (1992) in plants from Israel.

Cariophyllaceae

Arenaria pomelii Munby *2n*=20

The somatic chromosome number found in this western Mediterranean species agrees with

the only previous count, *n*=10, by Aparicio (1993) in plants of Sierra de Grazalema (S Spain).

Arenaria serpyllifolia L. *2n*=40

The somatic chromosome number *2n*=40 has been found in plants of two locations (Table 1). The polymorphic species *A. serpyllifolia* shows two ploidy levels, with *2n*=20 and *2n*=40, both found in Moroccan plants, by Favarger & al. (1979) and Galland (1988) respectively, although other rare counts are recorded in cytogenetic databases. According Verlaque & al. (1995) the tetraploid level *2n*=40 occurs in the Eurasian and cosmopolitan subsp. *serpyllifolia*.

Cerastium brachypetalum Pers. subsp. *brachypetalum* *2n*=72

The number *2n*=72 found does not agree with the *n*=38, 44-45, 45±1 counts for plants from Moroccan mountains given by Favarger & al. (1979), Galland (1988) and Çelebioglu & Favarger (1993). Nevertheless it is in accordance with the numbers *n*=36 and *2n*=72 indicated by Pogan & al. (1986) for this species in Polish plants.

Cerastium pumilum Curtis *2n*=54

This is the first time that *2n*=54 has been found in this species for which previous counts indicate *2n*=72, 90, 95 (Table 2).

Cerastium ramosissimum Boiss. *2n*=54

The number *2n*=54 agrees with the gametic number given by Favarger & al. (1979) in Moroccan and Spanish plants and with the somatic number reported by Luque & Díaz Lifante (1991) in plants from Israel. It differs from 2n=44-46 indicated by Sollner (1954) in this species.

Cerastium semidecandrum L. *2n*=36

In this species the most frequent count is *2n*=36 (Table 2), which agrees with that here found in Moroccan plants.

Minuartia hybrida (Vill.) Schischkin *2n*=42

This is a new chromosome number to add to the diverse somatic and gametic numbers found in this species (Table 2).

Polycarpon tetraphyllum (L.) L. subsp. *tetraphyllum* *2n*=16

In this study two different numbers, *2n*=16 and *2n*=48, have been found in plants from Taza and Alhoceima regions, respectively. Several previous counts indicating 4x, 6x and 8x ploidy levels are recorded in the literature (Table 2). The first count here given agrees with the only previous diploid *2n*=16 indicated by Dalgaard (1986) in plants from Madeira. The second with the hexaploid level found by Runemark (1996) in plants from Greece.

Scleranthus polycarpos L. *2n*=44

Galland (1988) for Moroccan plants from High Atlas, and Fernandes & Leitão (1971) for Portuguese plants, reported *n*=22 and *2n*=44 in this subspecies, which are corroborated by the counts here given for plants from two populations at high altitude (Table 1).

Silene mekinensis Coss. *2n*=24

It seems to be the second record for this species, the first for Moroccan plants, which is in accordance with that reported by Blackburn (1928, sec. Bolkhovskikh & al. 1969).

Silene martyi Emb. & Maire *2n*=24

As far as the authors are aware, this is the first karyologic study for this species. It corroborates the more frequent chromosome number of genus *Silene*.

Silene vulgaris (Moench) Garke subsp. *vulgaris* *2n*=48 (fig. 2)

The most frequent somatic chromosome for this taxon is *2n*=24 although *2n*=48 has also been recorted in the literature (Table 2) for plants of Portugal, Finland and Turkey.

Chenopodiaceae

Chenopodium opulifolium W.D.J. Koch & Ziz *2n*=18

The result obtained in this study is in agreement with the *2n*=18 of Kawatani & Ohno (1956) and *n*=9 of Crompton & Bassett (1976). Nevertheless *2n*=36 and the most frequent *2n*=54 are also reported for the same species in the literature (Table 2). It seems to be the first count in Moroccan plants.

Cistaceae

Cistus ladanifer L. subsp. *mauritianus* Pau & Sennen *2n*=18

The somatic number *2n*=18 constitutes the first count in this subspecies, as far as the authors are aware. It agrees with the number found in the species for different authors (Table 2).

Cyperaceae

Carex pendula Huds. *2n*=40

The somatic number here presented deviates from the most frequent *2n*=58 as well as from *2n*=60, 62 also previously cited (Table 2).

Dipsacaceae

Lomeliosa stellata (L.) Raf. (= *Scabiosa stellata* L.) *2n*=18

The count *2n*=18 obtained in plants from Taineste (Taza) meets with that found by Vogt & Oberprieler (2012) in plants of this species belonging to the gathering 25.900 of the *Iter V*, collected near of Taza city. Nevertheless other different somatic numbers are reported in the literature (Table 2).

Euphorbiaceae

Euphorbia dracunculoides Lam. subsp. *inconspicua* (Ball) Maire *2n*=40

It seems to be the first count in this subspecies of *Euphorbia dracunculoides*. It agrees with the *2n*=40 indicated in the species without designation of subspecies for western Mediter-

ranean plants from Morocco by Vicens & Molero (1992) and Humphries & al. (1978). However the latter authors also reported *2n*=16 from Biskra (Algeria).

Mercurialis annua L. *2n*=48

Plants of gathering 22.825 have been identified as *M. annua* L. in accordance to characters indicated by Güemes (1997). Nevertheless the hexaploid level found (*2n*=48) does not correspond with the expected diploid level of this species (Güemes 1997; Krähenbühl & al. 2002). In Morocco *2n*=48 has been found in plants identified as *M. ambigua* L. fil. from Rabat (El Alaoui-Faris & al. 2009) and from Ketama (Vogt & Oberprieler 2012, gathering nº 43.1476 of *Iter V*).

Fabaceae

Lotus longisiliquosus R. Roem. *2n*=28

This account seems to be the first in the species according to the databases consulted (Table 2).

Onobrychis humilis (Loefl.) G. López subsp. *jahandiezii* (Sirj.) Greuter & Burdet *2n*=14

This is the first karyologic study for this Moroccan endemic subspecies, obtained in plants from two different locations. It is in accordance with counts by Ruíz de Clavijo (1993) and Elena Roselló & al. (1984) who indicated *n*=7 and *2n*=14, respectively, in Spanish plants identified as *O. peduncularis* (Cav.) DC (= *O. humilis* (Loefl.) G. López), but it disagrees with the *n*=16 found by Humphries & al. (1978) in Moroccan plants from High Atlas at 1700 m.

Ononis mitissima L. *2n*=30-32 (fig. 2)

Many former counts indicate *2n*=30 for this species (Table 2). In plants here studied from two locations 30-32 chromosomes have been counted in somatic mitosis. As it can be observed in the two cells photographed (fig. 2), an accurate count is really difficult. The large difference in size among chromosomes allows interpreting the smallest chromosomes as chromosomes B or satellites released from the chromosomes.

Vicia lecomtei Humb. & Maire subsp. *lecomtei* *2n*=14 (fig. 3)

According to the databases consulted (Table 2), this is, presumably, the first count for this Moroccan endemic species.

Geraniaceae

Erodium malacoides (L.) L´Hèr subsp. *brevirrostris* (Maire & Samuels.) Guittonn. *2n*=36

It seems to be the first count in this subspecies of *Erodium malacoides*. It disagrees with the *2n*=40 indicated by many authors for the species without designation of subspecies (ANTHOS 2013; Bolkovskikh & al. 1969; CROMOCAT 2013; IPCN 2013).

Geranium purpureum Vill. *2n*=26 (fig. 5)

In this species two different somatic chromosome numbers have been indicated: *2n*=32 (many counts, see Table 2) and *2n*=64 (Luque & Díaz Lifante 1991) in plants from SE

Spain, but never *2n*=26. Therefore it would be desirable a research on the cytotaxonomic nature of these plants collected around Jbel Tazzeka.

Lamiaceae

Salvia barrelieri Etl. *2n*=32

The only existing report in the species is *2n*=38 (Benoist 1937, sec. Bolkhovskikh & al. 1969).

Linaceae

Linum tenue Desf. *2n*=20

This somatic number agrees with the only count found in this species by Pastor & al. (1990) who indicated *2n*=20 for Spanish plants from Fuenteheridos (Huelva province). It seems to be the first karyological study in Moroccan plants.

Poaceae

Anisantha diandra (Roth) Tutin (= *Bromus diandrus* Roth.) *2n*=56

Many numbers representing different ploidy leves (4x, 6x, 8x, 10x, 16x) can be found in the species (Table 2). The number *2n*=56 represents the hexaploid level, which is the more frequent somatic number, and confirms the cytogenetic hypothesis for the species proposed by Oja & Laarmann (2002).

Anisantha sterilis (L.) Nevski (= *Bromus sterilis* L.) *2n*=14

Two ploidy leves have been found in Mediterranean plants, diploid (*2n*=14) and tetraploid (*2n*=28) (Table 2). The new count for Moroccan plants represents another diploid population that confirms the hypothesis proposed by Oja & Laarmann (2002) on the diploid nature for *A. sterilis* within the complex *A. sterilis, A. diandrus* and *A. rigidus*. They found an autopolyploid nature for the tetraploid cytotypes (*2n*=28) based in the isoenzymatic pattern found and proposed to recognize this cytorace as *A. sterilis* with which it shares the shape of the scar of rachilla segments in the floret.

Anisantha tectorum (L.) Nevski (= *Bromus tectorum* L.) *2n*=14

This chromosome number is in agreement with other reports (Table 2). This diploid level was found in Morocco by Galland (1988) and Humphries & al. (1978) in the High Atlas, but these latter authors also found tetraploids (2n=28) in two populations at similar altitude than diploids, also from High Atlas. Another tetraploid counts were found in Spanish plants from Extremadura region (Devesa & al. 1990a, 1990b), where also plants with *2n*=14 were registered (Devesa & al. 1991).

Aristida adscensionis subsp. *coerulescens* (Desf.) Auquier & J. Dubign. *2n*=22

The record here presented seems to be the first for Moroccan plants. It is in agreement with previous counts in plants identified as *Aristida adscensionis* L. subsp. *coerulescens* (Desf.) Bourreil & Trouin ex Auquier et J. Vuvig. by Ferchichi & al. (1994), Peruzzi & Cesca

(2004) and Talavera (1978) in plants from Tunisia, Italy (Calabria), and Spain (Murcia), respectively.

Melica humilis Boiss. *2n*=18

The count here found for plants from two locations agrees with the only report found for Moroccan plants by Favarger & al. (1979, as *M. cupani* Guss.).

Melica minuta L. subsp. *minuta* *2n*=18

This is the first report for Moroccan plants, corresponding to the diploid level cited for the species. Diploid and tetraploid levels have been reported by many authors in Iberian and Balearic plants of this species (Table 2).

Patzkea patula (Desf.) H. Scholz *2n*=14 (fig. 7)

As far as the authors are aware this count is the second obtained for Mediterranean plants. The first was reported by Devesa & al. (1990a, as *Festuca triflora* Desf.) in Spanish plants from Extremadura.

Piptatherum coerulescens (Desf.) P. Beauv. *2n*=24

The only count reported in the literature consulted (Table 2) is that of Kerguelen (1975, as *Oryzopsis coerulescens* (Desf.) Hackel) who indicated also *2n*=24 in French plants.

Stipa capensis Thunb. *2n*=36

This count is in accordance with the most frequent chromosome numbers reported for Mediterranean plants (Iberian Peninsula, Balearic Islands and Tunisia) (Table 2), which corresponds with a tetraploid level. For Morocco the count here presented agrees with that by Scholz & al. (1998) for plants from Figuig and Monts des Beni-Snassen. The diploid level (*2n*=18) was indicated in the species only by Borgen (1970) in Macaronesian plants.

Vulpia geniculata (L.) Link *2n*=14

This is the second count for Moroccan plants, which agrees with that given by Galland (1988) in Moroccan plants from de Hight Atlas (Oukaimenden) at 2680 m altitude, and with previous reports for other Mediterranean plants (Table 2).

Polygonaceae

Rumex papilio Coss. & Balansa *2n*=18

This chromosome number is in accordance with previous reports in the species by Baltisberger & Charpin (1989) and Vogt & Oberprieler (2012 as var. *quadrivalvis* Maire) for Moroccan plants, respectively from High Atlas and Meknès region (*Iter Mediterranean V*, gathering nº 3.88).

Portulacaeae

Montia fontana L. subsp. *amporitana* Sennen *2n*=20

This is the first karyological study for this subspecies in Moroccan plants which agrees with

other counts given for the same subspecies in plants from Spain (Löve & Kjellqvist 1974a; Luque & Díaz Lifante 1991) and Greece (Runemark 1996).

Primulaceae

Anagallis foemina Mill. *2n*=20, 40

Two different chromosome numbers *2n*=20 and *2n*=40 have been counted in plants collected in three locations. However only *2n*=40 has been indicated for this species in the literature (Table 2). The diploid number *2n*=20 has not been found either in *A. arvensis*, species to which *A. foemina* has been sometimes subordinated as subspecies, although recent evidence molecular has pointed out as different species (Manns & Anderberg 2007).

Ranunculaceae

Ranunculus macrophyllus Desf. *2n*=16

This seems to be the first report for the chromosome number for Morocco. It agrees with the numerous previous counts for Western Mediterranean plants (Table 2).

Ranunculus ophioglossifolius Vill. *2n*=16

This count is in accordance to previous reports for plants from Portugal, Spain Italy and Bulgaria (Table 2). It seems to be the first account for Moroccan plants.

Ranunculus parviflorus L. *2n*=28

This count corresponds to the tetraploid level as stated by Diosdado & Pastor (1993). It is in accordance to previous reports (Table 2), and it seems to be the first time that it is counted for Moroccan plants.

Ranunculus trilobus Desf. *2n*=48

The chromosome number found corresponds to the hexaploid level and it is in accordance with that indicated by Valdés & Parra (1997) in Moroccan plants from Guercif (Taza region).

Resedaceae

Reseda lanceolata subsp. *constricta* (Lange) Valdés Berm. *2n*=24

The present count is the first for this subspecies. It agrees with several reports in the species for Spanish plants (Fernández Casas & Ruíz Rejón 1974; Valdés 1978; González Aguilera & Ruíz Rejón 1978; González Aguilera & al. 1980; González Aguilera & Peralta 1984).

Rosaceae

Sanguisorba verrucosa (G. Don) Ces. *2n*=28

This count was obtained in plants from two populations. It agrees with the first one reported by Valdés & Parra (1997) in plants from Chechaoune and with those indicated for Spanish plants from Balearic Islands (Dahlgren & al. 1971) and Granada (Luque & Díaz Lifante 1991) as *S. minor* subsp. *magnolii* (Spach) Briq.

Rubiaceae

Galium murale (L.) All. *2n*=44

The present count is the first for Moroccan plants. The same chromosome number has been reported by Dahlgren & al. (1971), Queirós (1986) and Díaz Lifante & al. (1992) for plants from Balearic Islands, Portugal and Israel, respectively.

Galium setaceum Lam. *2n*=44

Presumably this is the first count in Moroccan plants, which corresponds with the tetraploid level. Two somatic chromosome numbers have been reported in the literature. The diploid *2n*=22 was indicated by Dahlgren & al. (1971) for plants from the Balearic Islands. However in plants from Creta *2n*=22 and *2n*=44 were reported by Ehrendorfer (1982) and Montmollin (1986), respectively.

Scrophulariaceae

Chaenorhinum villosum Lange subsp. *granatense* (Willk.) Valdés *2n*=14

There are two previous counts for this species, *2n*=12 by Viano (1973) in Iberian plants, and 2*n*=14 by Vogt & Oberprieler (1994) in plants from Morocco. The only previous count for the subspecies found in literature is that of Löve & Kjellqvist (1974b), given for Spanish plants.

Linaria tristis (L.) Mill. subsp. *pectinata* (Pau & Font Quer) Maire *2n*=12

The same chromosome number was indicated in the species without subspecific indication by Valdés (1969) and Aparicio (1993) for Iberian plants and by Quézel (1957), Favarger & al. (1979), Galland (1988) and Vogt & Oberprieler (1994) for Moroccan plants. This is presumably the first account for this subspecies in Morocco.

Misopates orontium (L.) Raf. *2n*=16

This chromosome number is in agreement with numerous previous reports (Table 2). Vogt & Oberprieler (2012) have indicated the same number in plants collected during the *Iter V* in Taineste (Taza region, gathering 39.1329), also at high altitude.

Scrophularia arguta Aiton *2n*=36

This somatic chromosome number disagrees with the only counts found in the literature, *n*=20+B and *2n*=40+B, for Macaronesian plants (Dalgaard 1979).

Scrophularia lyrata Willd. *2n*=58

This count constitutes the first record for Moroccan plants. It agrees with previous counts by Grau (1976, 1979) in plants from Sardinia and by Fernandes & al. (1977) in plants from Portugal.

Veronica verna L. *2n*=18

This is the first time that the somatic number *2n*=18 has been found in this species, in which only *2n*=16 was reported by several authors in plants of the North and East of Europe (Table 2).

Valerianaceae

Valerianella microcarpa Loisel. *2n*=16

This somatic chromosome number here included agrees with those reported in plants from the South of France (Kliphuis & Wieffering 1972), Italy (Detlev 1972) and Balearic Islands (Dahlgren & al. 1971). It seems to be the first count for Moroccan plants.

Table 1. Origin of the plants studied. Geographic localities have been numbered consecutively. Collectors: A. Acchal, F. Conti, M. Fennane, S.L. Jury, M. Lisci, P. Mazzola, Ch. Oberprieler, S. Peccenini, F.M. Raimondo, M. Rejdali, E. Rico, G.J. Stark, H. t'Hart, B. Valdés, R. Vogt, R.G. Wilson.

1 Khémisset (Kénitra): c. 12 km from Rabat on road to Meknès, forêt de la Maâmora, 34º2'N 6º42'W, *Quercus suber* forest, 80 m, 09.06.1992.

2 Khémisset (Meknès): c. 45 km E of Meknès, 2 km W of Oued Beht on Rabat to Meknès road, 33º52´N 5º57´W, open rocky area with *Pinus halepensis*, 150 m, 09.06.1992.

3 Khémisset (Meknès): c. 42 km E of Meknès, 1 km E of Oued Beht on Rabat to Meknès road, 33º53´N 5º55´W, degraded *Tetraclinis articulata* woodland with planted *Pinus halepensis*, 220 m, 09.06.1992.

4 Ifrane (Meknès): c. 15 km from El Hajeb or road to Ifrane, forêt de Jaaba, 33º36´N 5º17´W, *Quercus canariensis* wood, 1400 m, 09.06.1992.

5 Midelt (Ksar-Es-Souk = Errachidia): Outskirt of Midelt on track to Cirque du Jaffar, Jbel Ayachi, 32º40´N 4º46´W, 1500 m, 10.06.1992.

6 Midelt (Ksar-Es-Souk = Errachidia): c. 15 km from Midelt, near village on road to Cirque du Jaffat, Jbbel Ayachii, 32º38´N 4º46´W, 1700 m, 10.06.1992.

7 Midelt (Ksar-Es-Souk = Errachidia): By forest house above Midelt on road to Cirque du Jaffar, 32º35´N 4º51´W, W & S facing slopes above road and below house, 1850 m, 10.06.1992.

8 Ifrane (Meknès): c. 22 km to Ain-Leuh from Azrou-Midelt road, 33º25´N 5º12´W, *Quercus ilex* subsp. *ballota*, *Viburnum tinus* woodland, 1450 m, 11.06.1992.

9 Ifrane (Meknès): c. 17 km from Ain-Leuh from Azrou-Midelt road, 33º23´N 5º14´W, shrub in *Quercus ilex* subsp. *ballota* wood and with some *Viburnum tinus*, *Cedrus libani* subsp. *atlantica* and *Ilex aquifolium*, 1585 m, 11.06.1992.

10 Ifrane (Meknès): c. 11 km from Azrou on road to Ain-Leuh, 33º22´N 5º15´W, *Quercus ilex* subsp. *ballota* woodland with open grassy clearing, 1550 m, 11.06.1992.

11 Ifrane (Meknès): c. 4 km from Ain-Leuh on road to Tiouririne and Azrou, 33º20´N 5º21´W, among rocky outcrops in cultivated area, 1150 m, 04.06.1992.

12 Ifrane (Meknès): c. 7 km from Azrou by road to Midelt, 33º16´N 5º12´W, FLNM559315, *Cedrus libani* subsp. *atlantica* forest sourrounded by *Quercus ilex* subsp. *ballota* scrubland, 1650 m, 12.06.1992.

13 Ifrane (Meknès): c. 19 km from Azrou by road to Midelt, 33º19´N 5º7´W, on *Cedrus libani* subsp. *atlantica* forest, 1900-2000 m, 12.06.1992.

14 Taza: c. 19 km from Taza, 46 km W from Guercif, 34º5´N 3º50´W, basic marls with wheat, 520 m, 14.06.1992.

15 Taza: c. 52 km from Taza, 13 km W from Guercif, 34º2´N 3º27´W, semi-arid, stony area, planted area with *Schinus molle* and *Eucaliptus*, 520 m, 14.06.1992.

16 Nador: c. 55 km from Nador on road to Guercif, 34º48´N 3º11´W, limestone slopes heavily grazed, 500 m, 14.06.1992.

17 Taza: c. 4 km from village of Ain Zorah on road from Saka, 34º38´N 3º31´W, limestone gorge, 890 m, 14.06.1992.

18 Taza: c. 11 km from Taza on minor road S to Jbel Tazekka, 34º9´N 4º1´W, FLNM628395, hillsides and bank of river, 745 m, 15.06.1992.

19 Taza: c. 18 km from Taza along minor road to Gouffe de Friouato and Djbel Tazekka, 34º8´N 4º2´W, limestone rocks under *Quercus ilex* subsp. *ballota*, 1200 m, 15.06.1992.

20 Taza: c. 42 km from Taza on minor road, 34º3´N 4º12´W, 1200 m, 15.06.1992.

21 Taza: c. 6 km SE of Sidi Abdallah (town from Fes-Taza road) along minor road to Bab Boudir, 34º9´N 4º19´W, limestone gorge, W facing slopes and cliffs, with *Olea europaea* and *Ceratonia siliqua*, 340 m, 15.06.1992.

22 Taza: Arround Summit of Jbel Tazekka, 34º5´N 4º11´W, schistose, 1900 m, 16.06.1992.

23 Taza: c. 6 km up track on Jbel Tazekka, 3 km from summit, 34º5´N 4º11´W, schistose, 1780 m, 16.06.1992.

24 Taza: c. 27 km from Taza, along minor road to Bab Boudir, 34º6´N 4º5´W, 1400 m, 16.06.1992.

25 Taza: c. 13 km SSW of Taza, 23 km from Taza, on minor road to Bab Boudir, 34º7´N 4º3´W, 1420 m, 16.06.1992.

26 Taza: c. 37 km from Taza on road to Nador, S of Dar-Caïd-Medboh, 34º26´N 3º54´W, steep open mudstone and marls hills, 900 m, 17.06.1992.

27 Taza: c. 14 km E from Boured, on road to Taza, 34º44´N 4º1´W, FLNM626460, slatey mudstones, 1350 m, 17.06.1992.

28 Taza: c. 2 km E of Ajdir, 16 km E of Boured, on road to Taza, 34º45´N 3º59´W, 860 m, 17.06.1992.

29 Taza: Col du Nador, about 10 km from Aknoul on road to Boured, 34º43´N 3º56´W, 1340 m, 17.06.1992.

30 Taza: Western outskirts of Taineste, c. 40 km due NNW of Taza, 4º34´N 4º8´W, 1100 m, 18.06.1992.

31 Taza: Junction of road from Tahar Souk, Boured and Taineste, c. 50 km NNW of Taza, 34º39´N 4º13´W, dry roadside banks and fields margins, 855 m, 18.06.1992.

32 Taounate (Fes): Ikaouen, c. 40 km N from Taounate on road to Targuist, 34º48´N 4º38´W, 1000 m, 19.06.1992.

33 Al Hoceima (Fes): c. 15 km SW of Issaguen (= Ketama) along road to Taounate and Fes, 34º53´N 4º38´W, 1000 m, 19.06.1992.

34 Al Hoceima: c. 4 km along track to Jbel Tidirhine, 1 km SW of Tleta Ketama and 9 km from Issaguen (= Ketama), 34º43´N 4º36´W, *Quercus ilex* subsp. *ballota* woodland with stream above village, 1500 m, 20.06.1992.

35 Al Hoceima: c. 15 km along track below summit of Jbel Tidirhine, 34º52´N 4º31´W, 2000 m, 20.06.1992.

36 Al Hoceima: c. 5 km from Tleta Ketama along track to Jbel Tidirhine, aux Eaux et Forêst house, 34º53´N 4º35´W, fields of *Cannabis sativa*, 1550 m, 20.06.1992.

37 Chefchaouen (Kénitra): c. 21 km from Ouazzane on road to Souk El Arba du Gharb, 34º47´N 5º45´W, 140 m, 23.06.1992.

38 Chefchaouen (Tétouan): c. 5 km up track to Jbel Tizirane, start of track 72 km from Chefchaouen on road to Issaguen (= Ketama), 14 km from Bab Berred, 35º2´N 4º56´W, 1700 m, 24.06.1992.

39 Chefchaouen (Tétouan): c. 71 km from Chefchaouen on road to Issaguen (= Ketama), 13 km from Bab Berred, 35º1´N 4º59´W, ponds and sourrounding fields, 1450 m, 25.06.1992.

40 Chefchaouen (Tétouan): c. 20 km from Chefchaouen on route to Jbel Tassaout, 35º17´N 5º14´W, N-facing limestone cliffs, 350 m, 25.06.1992.

41 Chefchaouen (Tétouan): Jbel Tassaout, c. 44 km from Chefchaouen on route to Jbel Tassaout, 14 km above Talambote, 35º15´N 5º5´W, limestones, forests of *Abies marocana*, 1600 m, 25.06.1992.

42 Chefchaouen (Tétouan): Jbel Tassaout, c. 40 km from Chefchaouen on route to Jbel Tassaout. 10 km above Talambote, 35º16´N 5º8´W, mixed forest of *Quercus ilex* subsp. *ballota* and *Q. alpestris*, 1565 m, 25.06.1992.

43 Chefchaouen (Tétouan): Jbel Talassemtane, c. 38 km from Chefchaouen, 14 km above Bab Taza on track to Jbel Talamssemtane, 35º9´N 5º12´W, mixed forest of *Abies maroccana* and *Cedrus libani* subsp. *atlantica*, on limestones, 1765-1900 m, 26.06.1992.

Table 2. Somatic chromosome numbers found in the taxa studied. The localities have been numbered as in Table 1. The number of the gathering in the *Iter Mediterraneum* V is given for each count. The haploid or diploid chromosome number of previous counts recorded in cytogenetic databases are included. A, ANTHOS (2013); B, Bolkovskih & al. (1969); BI: BSBI (2013); Ch, CHROBASE (2013); Cr, CROMOCAT (2013); I, IPCN (2013). *: First count for the species or subspecies.

				Previous counts		
Taxon	Nº locality	Nº gathering	*2n*	*n*	*2n*	Databases
Alliaceae						
Allium ampeloprasum L.	3	3.103	32	16, 24	16, 24, 32, 40, 48, 56, 80	A B Ch Cr I
Allium pallens Lam. subsp. *pallens*	3	3.83	16 (fig. 1)	-	16, 24, 32, 40	B Ch Cr I
	37	54.1789	16			
Apiaceae						
Ammoides pusilla (Brot.) Breistr.	14	19.760	12	6	12	A Cr
Ridolfia segetum Moris	15	20.809	22	11	22, 22+2B	A B Cr I
Brassicaceae						
Alyssum simplex Rudolphi	7	9.409	32	8, 24	16, 32	A Cr I
Arabidopsis thaliana (L.) Heynh.	22	29.1310	10	5	10	A B Cr I
	38	57.1865	10			
Biscutella didyma L.	4	4.209	16	8	16	B I
	11	13.560	16			I
	30	39.1314	16	8		
Biscutella frutescens Coss.	10	12.513	18	9	18	B I
Cardamine hirsuta L.	10	12.519	16	8, 16	16, 32, 64	A Cr I
	22	29.1307	16			
Crambe filiformis Jacq.	28	36.1223	30	15	30	B I
Diplotaxis tenuisiliqua Delile	2	2.63	18	-	-	*
Eruca vesicaria subsp. *sativa* (Mill.) Thell.	6	7.335	22	11	22	I
Jonopsidium prolongoi (Boiss.) Batt.	41	60.1992	36	11	22, 36	A I
	43	64.2202	36			
Lepidium heterophyllum Benth. subsp. *riphanum* (Emb. & Maire) J.M. Monts. Martí	38	57.1827	16	-	-	*
Lepidium hirtum subsp. *dhayense* (Munby) Thell.	4	4.204	32	-	16	I
Malcolmia triloba (L.) Sprengel subsp. *broussonetii* (DC.) Asensi & Díaz Garretas	1	1.34	20	-	-	*
Notoceras bicorne (Aiton) Amo	15	20.814	22	11	22	A B I
Psychine stylosa Desf.	14	19.771	30	15	16, 30	A Ch Cr I
	26	34.1166	30			
Sisymbrium erysimoides Desf.	21	28.1006	14	-	14	Cr I
Sisymbrium irio L.	6	7.316	14	7	14	A B Cr I
Teesdalia nudicaulis (L.) R. Br.	38	57.1863	36	18	36	A B Cr I
Cariophyllaceae						
Arenaria pomelii Munby	22	29.1281	20	10	-	A I
Arenaria serpyllifolia L.	22	29.1279	40	10, 20	20, 22, 30, 40, 44	A B Cr I
	41	60.2016	40			

Table 2. Continued

Taxon	Nº locality	Nº gathering	2n	Previous counts n	Previous counts 2n	Databases
Cerastium brachypetalum Pers. subsp. *brachypetalum*	4	4.228	72	36, 38, 39, 44-45, 46	52, 72, c78, 90	B Cr I
subsp. roeseri (Boiss. & Heldr.) Nyman	8	10.488	72			
Cerastium pumilum Curtis	22	29.1046	54	36	72, 90, 95	A B Cr I
	22	29.1309	54			
Cerastium ramosissimum Boiss.	12	14.599	54	27	44-46, 54	A I
Cerastium semidecandrum L. (= *C. pentandrum* L.)	12	14.588	36	-	18, 36, 37	A B Cr I
Minuartia hybrida (Vill.) Schischkin	19	26.932	42	11, 12, 21, 22, 23, 24, 25, 35, 46	20, 22, 24, 45, 46, 48, 70	A Cr I
Moehringia pentandra Gay	4	4.237	48	-	48	A B Cr I
	41	60.1998	48			
Petrorhagia dubia (Raf.) G. López & Romo	20	27.990	30	-	30	A B I
Polycarpon tetraphyllum subsp. *tetraphyllum* (L.) L.	17	23.860	16	16, 24, 32	16, 32, 48, 54, c.64	A B Cr I
	33	43.1500	48			
Scleranthus polycarpos L.	34	44.1529	44	22	44	Cr I
	38	57.1846	44			
Silene gallica L.	20	27.987	24	12	24	A B Ch Cr I
	32	42.1415	24			
	33	43.1463	24			
Silene inaperta L. subsp. *inaperta*	3	3.132	24	12	24	A B Cr I
Silene martyi Emb. & Maire	31	41.1398	24	-	-	*
Silene mekinensis Coss.	10	12.523	24	-	24	B
Silene patula Desf. subsp. *patula*	23	30.1077bis	24	12	24	I
Silene vulgaris (Moench) Garke subsp. *vulgaris*	27	35.1214	48	24	24, 48	A B BI Cr I
Spergula pentandra L.	35	45.1556	18	-	18	A Cr I
Chenopodiaceae						
Chenopodium murale L.	21	28.1025	18	9	18	A B Cr I
Chenopodium opulifolium W.D.J. Koch & Ziz	3	3.130	18	9, 27	18, 36, 54	A B Cr I
Cistaceae						
Cistus ladanifer subsp. *mauritianus* Pau & Sennen	32	42.1409	18	-	-	*
Cistus salviifolius L.	18	25.894	18	9	18	A Cr I
Helianthemum anthemoides (Desf.) Grosser	24	32.1098	20	10	20	B Ch I
Tuberaria macrosepala (Boiss.) Willk.	20	27.984	36	18	-	A I
Cyperaceae						
Carex pendula Huds.	32	42.1434	40	-	58**,** 60, 62	A B BI Ch Cr I
Dipsacaceae						
Lomeliosa stellata (L.) Raf.	30	39.1348	18	9	16, 18, 26, 27, 28	A Cr I
Euphorbiaceae						
Euphorbia characias L.	41	60.2002	20	10	20	A B Cr I

Table 2. Continued

Taxon	Nº locality	Nº gathering	*2n*	*n*	*2n*	Databases
Euphorbia dracunculoides Lam. subsp. *inconspicua* (Ball) Maire	17	23.871	40	-	-	*
Euphorbia medicaginea Boiss.	3	3.134	16	8	16	A I
Mercurialis annua L.	16	22.825	48	-	16, 32, 48, 64	A B Ch Cr I
Fabaceae						
Lathyrus nissolia L.	42	61.2072	14	-	14	A B Cr I
Lotus longisiliquosus R. de Roemer	26	34.1155	28	-	-	*
Medicago lupulina L.	4	4.193	16	8	16, 32	A B Cr I
Onobrychis humilis (Loefl.) G. López subsp. *jahandiezii* (Sirj.) Greuter & Burdet	24	32.1104	14	-	-	*
	25	33.1115	14			
Ononis mitissima L.	36	51.1674	30-32	15	30	Ch Cr I
	37	54.1808	30-32 (fig. 2)			
Ononis sicula Guss.	3	3.126	32	-	32	A Cr I
Scorpiurus sulcatus L.	25	33.1112	28	-	28	A B I
Tetragonolobus conjugatus subsp. *requienii* (Sanguinetti) E. Domínguez & E.F. Galiano	37	54.1804	14	7	14	A I
Vicia lecomtei Humb. & Maire subsp. *lecomtei*	22	29.1285	14 (fig. 3)	-	-	*
Vicia pubescens (DC.) Link	33	43.1475	14 (fig. 4)	-	14	A Ch I
Vicia vicioides (Desf.) Cout.	19	26.931	14	-	14	A I
Geraniaceae						
Erodium guttatum (Desf.) Willd.	5	6.279	18	-	18, 20	B, I
Erodium malacoides subsp. *brevirrostris* (Maire & Samuels.) Guittonneau	14	19.752	36	-	-	*
Geranium purpureum Vill.	18	25.892bis	26 (fig. 5)	-	32, 64	A B Ch I
Juncaceae						
Luzula forsteri (Sm.) DC.	41	60.2065	24 (fig. 6)	12	24	A B Cr I
Lamiaceae						
Salvia barrelieri Etl.	31	41.1397	32	-	38	B
Liliaceae						
Muscari comosum (L.) Mill.	27	35.1217	18	9+1B, 27	18, 19, 36	A B Ch Cr I
Linaceae						
Linum tenue Desf.	2	2.55	20	10	20	A Mo
Poaceae						
Aegilops geniculata Roth	18	25.911	28	14	28	A Cr I
	26	34.1170	28			
Anisantha diandra (Roth) Tutin	34	44.1526	56	21, 28	28, 42, 56, 70, 112	A Cr I
Anisantha rubens (L.) Nevski	14	19.784	28	14	28	A Cr I
Anisantha sterilis (L.)	8	10.456	14	7	14, 28	A B Cr I
Anisantha tectorum (L.)	22	29.1278bis	14	7, 14	14	A B Cr I
Aristida adscensionis L. subsp. *coerulescens* (Desf.) Auquier & J. Dubign.	3	3.102	22	11	22	A Ch I

Table 2. Continued

Taxon	Nº locality	Nº gathering	Previous counts *2n*	*n*	*2n*	Databases
Briza minor L.	32	42.1435	10	5	10	A B Cr I
Echinaria capitata (L.) Desf.	43	64.2274	18	9	18	A Cr I
Hordeum murinum subsp. *glaucum* (Steud.) Tzvelev	6	7.322	14 (fig. 7)	-	14	I
Melica humilis Boiss.	2	2.58	18	9	18	A I
	29	37.1251	18			
Melica minuta L. subsp. *minuta*	28	36.1236	18	9, 18	18, 36	A B Cr I
Narduroides salzmanii (Boiss.) Rouy	34	44.1531	14	-	14	A Cr I
Patzkea patula (Desf.) H. Scholz	8	10.455	14 (fig. 8)	7	14	B I
Piptatherum coerulescens (Desf.) P. Beauv.	33	43.1487	24	-	24	Cr I
Polypogon monspeliensis (L.) Desf.	26	34.1172	28	7, 14, 21	28, 35	A B Cr I
Stipa capensis Thunb.	2	2.56	36	18	18, 36	A Ch I
	14	19.770	36			
Vulpia bromoides (L.) S. F. Gray	22	29.1038	14	7	14	A Ch
	34	44.1535	14			
Vulpia geniculata (L.) Link	38	57.1882	14	7	14	A B Cr I
Polygonaceae						
Rumex papilio Coss. & Balansa	3	28.1000	18	-	18	B I
Portulacaeae						
Montia fontana L. subsp. *amporitana* Sennen	34	44.1525	20	-	20	A Cr I
	39	58.1942	20			
Primulaceae						
Anagallis foemina Mill.	2	2.75	20	20	40	B Cr I
	17	23.850	20			
	26	34.1167	40			B Cr I
Asterolinon linum-stellatum (L.) Duby	20	27.989	20	-	20	A Cr I
Ranunculaceae						
Ranunculus macrophyllus Desf.	32	42.1400	16	8	16	A Cr I
	36	48.1643	16			
Ranunculus ophioglossifolius Vill.	32	42.1448	16	8	16	A B BI Ch Cr I
	39	58.1936	16			
Ranunculus parviflorus L.	19	26.925	28	14	28	A B BI Ch Cr I
Ranunculus trilobus Desf.	32	42.1442	48	24	32, 48	A B Ch I
Resedaceae						
Reseda lanceolata subsp. *constricta* (Lange) Valdés Berm.	27	35.1187	24	-	-	*
Rosaceae						
Sanguisorba verrucosa (G. Don) Ces.	4	4.163	28	-	28	A B I
	13	16.637	28			
Rubiaceae						
Cruciata pedemontana (Bellardi) Ehrend.	22	29.1311	22	-	22	B
Galium murale (L.) All.	18	25.909	44	-	44	A B Cr I

Table 2. Continued

Taxon	Nº locality	Nº gathering	Previous counts			Databases
			2n	*n*	*2n*	
Galium setaceum Lam.	2	2.77	44	-	22, 44	A B I
Valantia hispida L.	40	59.1986	18	-	18	A B Cr I
Scrophulariaceae						
Chaenorhinum villosum Lange subsp. *granatense* (Willk.) Valdés	28	36.1230	14	-	14	A I
Linaria tristis subsp. *pectinata* (Pau & Font Quer) Maire	40	59.1984	12	-	-	*
	43	64.2259	12			
Misopates orontium (L.) Raf.	4	4.227	16	8	16	A B Ch Cr I
Scrophularia arguta Aiton	2	2.70	36	20+B	40+B	I
Scrophularia lyrata Willd.	10	12.526	58	29	58	A Ch I
Veronica verna L.	12	14.580	18	8	16, 16+1B	B BI Cr I
Valerianaceae						
Centranthus calcitrapa (L.) Dufr. subsp. *calcitrapae*	41	60.1994	32	16	32	A B Cr I
	43	64.2273	32			
Centranthus macrosiphon Boiss.	21	28.1013	32	16	32	A B Ch I
	32	42.1406	32			
	40	57.1900	32			
Fedia pallescens (Maire) Mathez	9	11.494	32	-	32	I
Valerianella microcarpa Loisel.	4	4.238	16	8	16	A Ch Cr
	22	29.1031	16			

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