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Chromosome numbers of plant species from the Canary Islands

Matthias Baltisberger and Alex Widmer

Plant Ecological Genetics, Institute of Integrative Biology, CH-8092 Zürich;
e-mail: balti@ethz.ch

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Abstract

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Chromosome numbers are reported for 66 taxa (101 populations) of flowering plants representing 22 families from the Canary Islands. The chromosome numbers of *Kleinia aizoides* (Asteraceae, 2n = 20) and *Polycarpaea nivea* (Caryophyllaceae, 2n = 18) are given for the first time. Chromosome numbers of another 17 taxa are recorded for the first time from Canarian material. Karyotypes are presented for nine species (six endemic), and phytogeographic and for part of the species systematic aspects are discussed. For *Bidens aurea*, we provide evidence suggesting that this species might consist of more than one taxon.

Key words: Cytology, flowering plants, karyotypes, Macaronesia, phytogeography.

Introduction

Chromosome data are fundamental characters of plant species and relevant to plant systematics and evolution (Stace 2000). The basic data are chromosome numbers, but the size, morphology, and staining characteristics of chromosomes may also be important (Stace 2000). The most obvious morphological characters are chromosome size and position of the centromere (also called primary constriction). The occurence and position of secondary constrictions give additional morphological information. The description of chromosome morphology has proved a powerful method to characterise plant genomes.

Although modern biosystematic investigations are mainly based on molecular methods, chromosome data still provide essential information, which may for example help in interpreting results from molecular studies (Crawford et al. 2005; Hörandl et al. 2005). Cytological data (besides morphological characters) have aided or even made possible taxonomic decisions, e.g. in tracing the origin of hybrids in *Tragopogon* (Ownbey and McCollum 1954), *Spartina* (Marchant 1968), *Cardamine* (Urbanska 1977), *Fallopia* (Bailey and Stace 1992), or the cereal *Triticum aestivum* (wheat; Lilienfield 1951).

Despite its taxonomic relevance, the chromosome number is only known for about 25% of all angiosperms (Bennett 1998). Additionally, many reported chromosome numbers are uncertain because they are based on plants from a single population or even on a single individual, or the reported chromosome counts are not well documented (e.g. lacking indications of the site or no voucher specimens). This makes the data rather useless, especially in taxonomically difficult groups, in which chromosome numbers are often variable. Three main conditions must be fulfilled for chromosome numbers to be useful (Stace 2000): the investigated plants should originate from known wild localities, voucher specimens must be deposited in a designated herbarium, and counts have to be based on several plants in each population. Where possible, several populations from different geographic regions of the distribution area of a given taxon should be investigated. Of special interest are regions from the borders of the distribution area, isolated areas (such as islands), or areas where the taxon has been introduced and seems to spread into native vegetation.

The flora of the Canary Islands is highly diverse and comprises numerous endemic species and some endemic genera (Bramwell and Richardson 1973; Kunkel 1993), but for centuries a large number of alien plant species have been introduced. Many of them are expanding their ranges in the Canary Islands or hybridize with members of the native flora. The flora has long been of special interest to botanists, and several studies on the cytology of Canarian plants have been undertaken to date (e.g. Mendoza-Heuer 1974; Humphries 1975; Dalgaard 1991; Ardevol Gonzales et al. 1993). Nevertheless chromosome numbers and/or ploidy levels of many Canarian taxa are not or not sufficiently known.

Here, we report new cytological results from three excursions to the Canary Islands: in March 1995, both authors visited the islands Tenerife, Gran Canaria, La Gomera, and El Hierro; in November 1996, M. Soliva travelled to Gran Canaria, and in March 1998, M. Baltisberger and M. Ring sampled on Fuerteventura. Besides reporting the chromosome numbers for 66 taxa and karyotypes for nine taxa, we compare our results with published data, and we discuss phytogeographic or systematic aspects for part of the species.

Methods

To fulfill the three conditions for useful cytological investigations according to Stace (2000), all cytologically investigated plants originated from known wild localities, and voucher specimens were deposited in the herbarium Z/ZT (ETH and University of Zurich). For 20 of the 66 investigated taxa, several populations were sampled, and counts were made on several individuals per population in 97 out of 101 populations (Tab. 1).

Live plants, fruits or seeds of interesting plant species were sampled randomly within the respective populations. Whenever possible, at least six living plants were dug out, or seeds or fruits of six plant individuals were collected. On one trip (M. Soliva on Gran Canaria in November 1996) about one kilogram of soil was collected. Plants sampled alive and seedborn plants were grown in the greenhouse of our institute; the soil sample was spread out and kept wet, and seedlings emerging from the seed bank were cultivated.

All cytological investigations were carried out on root tips. These were pre-treated with colchicine (0.05%) for up to 2 hours, then fixed in ethanol/acetic acid (3:1), and

Tab. 1. List of the investigated plant species, sorted by families (in alphabetical order) and alphabetically within families, with the islands on which populations were sampled, the year of collection, the voucher number (Z/ZT herbarium of ETH and University of Zurich), the number (N) of individuals investigated, the chromosome number (2n), and the results of a comparison with literature data (Lit.), coded as:

* chromosome number reported for the first time
\+ number recorded for the first time for material from the Canary Islands
C confirming the chromosome number reported in literature
V confirming one of various chromosome numbers reported in literature

Taxon	Island	Year	Voucher	N	2n	Lit.
Amaryllidaceae						
01 *Pancratium maritimum* L.	Fuerteventura	1998	13883	6	22	V+
Apiaceae						
02 *Astydamia latifolia* (L.f.) Baill.	Fuerteventura	1998	13432	6	22	C
03 *Crithmum maritimum* L.	Tenerife	1995	13138	6	20	C
Asclepiadaceae						
04 *Periploca laevigata* Ait.	Tenerife	1995	13032	6	22	C
Asteraceae						
05 *Andryala pinnatifida* Ait.	Tenerife	1995	13026	6	18	C
06 *Argyranthemum frutescens* (L.) Sch.Bip. ssp. *foeniculaceum* (Pit. et Pr.) Humphr.	La Gomera	1995	13008	5	18	C
07 *Argyranthemum gracile* Sch.Bip.	Tenerife	1995	13060	1	18	C
08 *Argyranthemum tenerifae* Humphr.	Tenerife	1995	13030	6	18	C
09 *Bidens aurea* (Ait.) Sherff	Tenerife	1995	13010	6	72	V +
	Tenerife	1995	13025	6	72	
10 *Bidens pilosa* L.	La Gomera	1995	13001	6	72	V
	El Hierro	1995	13054	6	72	
	Gran Canaria	1995	13057	6	72	
	Tenerife	1995	13058	6	72	
	Tenerife	1995	13064	6	72	
	El Hierro	1995	13072	6	72	
	Gran Canaria	1996	13296	9	72	
	Fuerteventura	1998	13437	6	72	
11 *Calendula arvensis* L.	La Gomera	1995	13004	6	44	V
	El Hierro	1995	13112	6	44	
12 *Carlina salicifolia* (L.fil.) Cav.	Tenerife	1995	13482	6	20	C
13 *Conyza bonariensis* (L.) Cronq.	Tenerife	1995	13119	6	54	C
	Tenerife	1995	13120	6	54	
	El Hierro	1995	13121	6	54	

Tab. 1. (continued)

Taxon		Island	Year	Voucher	N	2n	Lit.
14	*Cotula australis* (Sieb. ex Spreng.) Hook.fil.	Tenerife	1995	13028	6	36	C +
15	*Dittrichia viscosa* (L.) W.Greuter	Gran Canaria	1996	13298	1	18	C
16	*Kleinia aizoides* DC.	Adeje, Tenerife	1995	no voucher	6	20	*
		Corralejo, Fuerteventura	1998	no voucher	1	20	
17	*Kleinia neerifolia* Haw.	Agujilva, La Gomera	1995	no voucher	6	20	C
		Frontera, El Hierro	1995	no voucher	6	20	
		Gran Canaria	1996	13395	5	20	
		Tarajalejo, Fuerteventura	1998	no voucher	4	20	
18	*Launaea arborescens* (Batt.) Murb.	La Gomera	1995	13007	8	14	C
		Tenerife	1995	13274	6	14	
		Gran Canaria	1995	13278	6	14	
		Fuerteventura	1998	13425	9	14	
19	*Pericallis cruenta* (L'Hér.) Bolle	Tenerife	1995	13031	8	60	C
20	*Pericallis lanata* (L'Hér.) Bolle	Tenerife	1995	13035	9	60	C
21	*Pericallis murrayi* (Bornm.) B.Nord.	El Hierro	1995	13018	6	60	C
22	*Pericallis steetzii* (Bolle) B.Nord.	La Gomera	1995	13005	5	60	C
23	*Schizogyne sericea* (L.fil.) Sch.Bip.	Tenerife	1995	13027	6	18	C
		Tenerife	1995	13810	4	18	
24	*Urospermum picroides* (L.) Scop.	El Hierro	1995	13019	6	10	C+
		Gran Canaria	1996	13300	2	10	
Boraginaceae							
25	*Cynoglossum creticum* Mill.	Gran Canaria	1995	13014	6	24	C
26	*Echium aculeatum* Poir.	La Gomera	1995	13009	5	16	C
		Tenerife	1995	13155	2	16	
Brassicaceae							
27	*Cakile maritima* Scop.	Fuerteventura	1998	13424	6	18	C
28	*Matthiola fruticulosa* (L.) Maire	Fuerteventura	1998	13434	6	12	C
Caryophyllaceae							
29	*Polycarpaea nivea* (Ait.) Webb	Fuerteventura	1998	13428	6	18	*
30	*Silene vulgaris* (Moench) Garcke ssp. *macrocarpa* Turrill	El Hierro	1995	13053	6	48	C+
		Gran Canaria	1995	13056	6	48	
		Tenerife	1995	13066	6	48	
		El Hierro	1995	13071	6	48	

Tab. 1. (continued)

Taxon	Island	Year	Voucher	N	2n	Lit.
Dipsacaceae						
31 *Pterocephalus lasiospermus* Link ex Buch	Tenerife	1995	13388	6	18	C
Euphorbiaceae						
32 *Euphorbia atropurpurea* (Brouss.) Webb et Berth.	Tenerife	1995	13023	6	20	C
33 *Euphorbia paralias* L.	Fuerteventura	1998	13422	7	16	C
34 *Ricinus communis* L.	Tenerife	1995	13141	6	20	C+
Fabaceae						
35 *Lotus lancerottensis* Webb	Fuerteventura	1998	13430	8	14	C
36 *Medicago laciniata* (L.) Miller	Fuerteventura	1998	13436	5	16	C
37 *Medicago soleirolii* Duby	Gran Canaria	1996	13389	2	16	C+
38 *Ononis natrix* L.						
ssp. *ramosissima* (Desf.) Batt.	Fuerteventura	1998	13440	6	30	V+
39 *Psoralea bituminosa* L.	Gran Canaria	1995	13273	6	20	C+
	El Hierro	1995	13275	3	20	
Geraniaceae						
40 *Erodium chium* (L.) Willd.	El Hierro	1995	13022	6	40	C
Lamiaceae						
41 *Marrubium vulgare* L.	El Hierro	1995	13017	6	34	C
42 *Micromeria benthamii* Webb ex Berth.	Gran Canaria	1996	13295	3	30	C
43 *Salvia canariensis* L.	Gran Canaria	1995	13013	4	22	C
	Gran Canaria	1996	13297	6	22	
44 *Salvia leucantha* Cav.	Tenerife	1995	13024	5	22	C+
45 *Stachys ocymastrum* (L.) Briq.	El Hierro	1995	13021	6	18	C
Liliaceae						
46 *Allium subvillosum* Salzm. ex Schultes & Schultes fil.	El Hierro	1995	13015	12	28	C
47 *Androcymbium psammophilum* Svent.	Fuerteventura	1998	13429	3	18	C
Papaveraceae						
48 *Eschscholtzia californica* Cham.	El Hierro	1995	13055	6	12	C+
Plantaginaceae						
49 *Plantago afra* L.	Gran Canaria	1996	13391	1	12	C
	Fuerteventura	1998	13427	8	12	
50 *Plantago aschersonii* Bolle	Fuerteventura	1998	13439	15	20	C

Tab. 1. (continued)

Taxon	Island	Year	Voucher	N	2n	Lit.
Poaceae						
51 *Brachypodium distachyon* (L.) Beauv.	El Hierro	1995	13069	6	20	V+
	Gran Canaria	1996	13399	5	20	
52 *Cynosurus echinatus* L.	Gran Canaria	1995	13153	6	14	C+
53 *Hordeum murinum* Briq.						
ssp. *leporinum* (Link) Arcangeli	Tenerife	1995	13063	4	28	C
	El Hierro	1995	13113	6	28	
54 *Lamarckia aurea* (L.) Moench	Gran Canaria	1996	13394	6	14	C
55 *Polypogon monspeliensis* (L.) Desf.	Tenerife	1995	13051	6	28	C
56 *Setaria verticillata* (L.) Beauv.	Tenerife	1995	13033	6	18	V+
	Tenerife	1995	13052	6	18	
	Fuerteventura	1998	13426	9	18	
57 *Stipa capensis* Thunb.	Gran Canaria	1996	13394	3	36	C
Polygonaceae						
58 *Polygonum maritimum* L.	Fuerteventura	1998	13433	10	20	C
59 *Rumex lunaria* L.	Gran Canaria	1995	13152	6	36	C
	El Hierro	1995	13276	6	36	
60 *Rumex vesicarius* L.	Fuerteventura	1998	13435	3	18	C
Ranunculaceae						
61 *Ranunculus cortusifolius* Willd.	La Gomera	1995	13006	4	16	C
	Gran Canaria	1995	13011	4	16	
	El Hierro	1995	13154	4	16	
Rubiaceae						
62 *Galium aparine* L.	La Gomera	1995	13002	6	66	V+
	El Hierro	1995	13020	6	66	
Sapindaceae						
63 *Cardiospermum grandiflorum* Sw.	La Gomera	1995	13003	6	22	C+
Scrophulariaceae						
64 *Misopates orontium* (L.) Rafin.	Gran Canaria	1996	13393	2	16	C
65 *Scrophularia glabrata* Ait.	Tenerife	1995	13029	6	58	C
Solanaceae						
66 *Datura stramonium* L.	Gran Canaria	1995	13142	6	24	V+

stained and squashed in lacto-propionic orcein (Dyer 1963). Five to ten metaphases were counted for each individual to determine the chromosome number. The numbers of investigated individuals and the results obtained for each population are presented in Table 1. Families are arranged in alphabetical order, and species in alphabetical order within families. Nomenclature mostly follows Hohenester and Welss (1993) or Gobierno de Canarias (2003). Literature concerning numbers was checked using the series "Index to plant chromosome numbers" (Moore 1973, 1974, 1977; Goldblatt 1981, 1984, 1985, 1988; Goldblatt and Johnson 1990, 1991, 1994, 1996, 1998, 2000, 2003), as well as Federov (1974) and Ardevol Gonzales et al. (1993).

For some species, karyotypes are discussed using the terminology for chromosome morphology proposed by Levan et al. (1964). The chromosomes are named according to the position of the centromers, which is expressed with the arm ratio, "long arm to short arm". The following terms are used: metacentric (arm ratio 1.0–1.7), submetacentric (arm ratio 1.7–3.0), subtelocentric (arm ratio 3.0–7.0), and acrocentric (arm ratio more than 7.0).

Results and discussion

All chromosome counts are summarized in Table 1. Results are discussed for interesting species separately following the order of the table together with phytogeographic and systematic aspects. When chromosome numbers simply confirm indications in literature (cf. Tab. 1), they are not discussed further in the text. An overall interpretation is given at the end as well as in Table 2.

01 *Pancratium maritimum* L. is widespread in the Mediterranean region and probably introduced to the Canary Islands where it only occurs in litorals of Fuerteventura (Hansen and Sunding 1985) but the related *P. canariense* Ker. grows on all islands. In literature two chromosome numbers are given for *P. maritimum* viz. 2n = 20 and 2n = 22. The first chromosome count on plants of *P. maritimum* from the Canary Islands showed the number 2n = 22 confirming the more frequent indication in literature as well as all indications for *P. canariense*.

02 *Astydamia latifolia* (L.f.) Baill. occurs in the litoral in Northwest Africa and on all Canary Islands.

03 *Crithmum maritimum* L. grows on maritime rocks (rarely on sand or shingle) of the northern Atlantic, Mediterranean and Black Sea and occurs on all Canary Islands except Lanzarote.

04 *Periploca laevigata* Ait. is a shrub often twining at apex. It occurs in the Mediterranean region, North Africa, and on all Canary Islands.

05 *Andryala pinnatifida* Ait. is considered to be an endemic species of the Canary Islands (Gobierno de Canarias 2003), although it has also been reported from northwestern Africa (Hohenester and Welss 1993). It is indicated for all islands but the occurence on La Palma, Lanzarote and Fuerteventura is doubtful (Hohenester and Welss 1993; Gobierno de Canarias 2003).

The genus ***Argyranthemum*** with its about 20 species (and 16 subspecies) is an endemic genus to Macaronesia (Kunkel 1993). All taxa (species and especially subspecies) have distribution areas which are restricted to one or few islands, no taxon occuring on all islands (Hohenester and Welss 1993; Gobierno de Canarias 2003). The taxa are all diploid with 2n = 2x = 18 chromosomes (Ardevol Gonzales et al. 1993).

06 *Argyranthemum frutescens* (L.) Sch.Bip. ssp. *foeniculaceum* (Pit. et Pr.) Humphr: The complex of *Argyranthemum frutescens* consists of seven subspecies and occurs on all islands except Fuerteventura but the respective subspecies have more restricted areas growing on a single island (four subspecies) or on two (one subspecies) or three islands (one subspecies), only subspecies *frutescens* occurs on five islands. *A. frutescens* ssp. *foeniculaceum* grows only on La Gomera. The karyotype consists of 14 meta- to submetacentric and 4 subtelocentric and satellited chromosomes (Fig. 1A). The same karyotype is given by Humphries (1975).

07 *Argyranthemum gracile* Sch.Bip. grows only on Tenerife. Only one plant survived and has been investigated. It showed the same karyotype of 14 meta- to submetacentric and 4 subtelocentric and satellited chromosomes (Fig. 1B) as indicated by Humphries (1975) as well as in *A. frutescens* ssp. *foeniculaceum* (see above) and in other taxa of the genus (Humphries 1975).

08 *Argyranthemum tenerifae* Humphr. grows only on Tenerife, as *A. gracile*. It has the same karyotype of 14 meta- to submetacentric and 4 subtelocentric and satellited chromosomes (Fig. 1C) as indicated by Humphries (1975) as well as in *A. frutescens* ssp. *foeniculaceum* and *A. gracile* (see above) and in other taxa of the genus (Humphries 1975).

09 *Bidens aurea* (Ait.) Sherff originates from central America and has been introduced in many parts of the world, e.g. in South Europe and in nearly all Canary Islands. Hohenester and Welss (1993) do not indicate it only for Fuerteventura, but Hansen and Sunding (1985) and Gobierno de Canarias (2003) also mention no occurrence on Lanzarote. There are four indications in the literature, all reporting different chromosome numbers for *B. aurea*: Powel and Turner (1963) give the chromosome number n = 24 (2n = 48), Fernandez and Queiros (1971) found 2n = 72, McVaugh (1984) indicates n = 23 and n = ca. 35 (2n = 46 and c. 70, respectively), and Montes et al. (1993) give n = 33 or 2n = 60 and 66–68. All plants sampled for this study at two sites in Tenerife showed 2n = 72 chromosomes. This number corresponds with the number published by Fernandez and Queiros (1971), and the same number has been found in several other species of the genus *Bidens* (e.g. *B. pilosa* see below). This is the first record of a chromosome number for *B. aurea* from the Canary Islands.

Bidens aurea is said to have yellow ligules with purplish lines (Tutin 1976; Hohenester and Welss 1993), but all plants from both sites in Tenerife (in nature as well as in the greenhouse) had white to whitish ligules with purplish lines. The colour of the ligules changed to yellowish when the flowers were dried and mounted as herbarium specimens. They then looked similar to the faded flowers of a yellow-flowered *Ranunculus* (Fig. 2). Consequently, the question arose if *B. aurea* can really have yellow flowers or whether flowers on live plants are always white, and thus whether the indications in the literature of the yellow ligules are based on the "faded" colour of herbarium specimens. We checked the 18 specimens of *B. aurea* within the herbarium Z/ZT. Seven

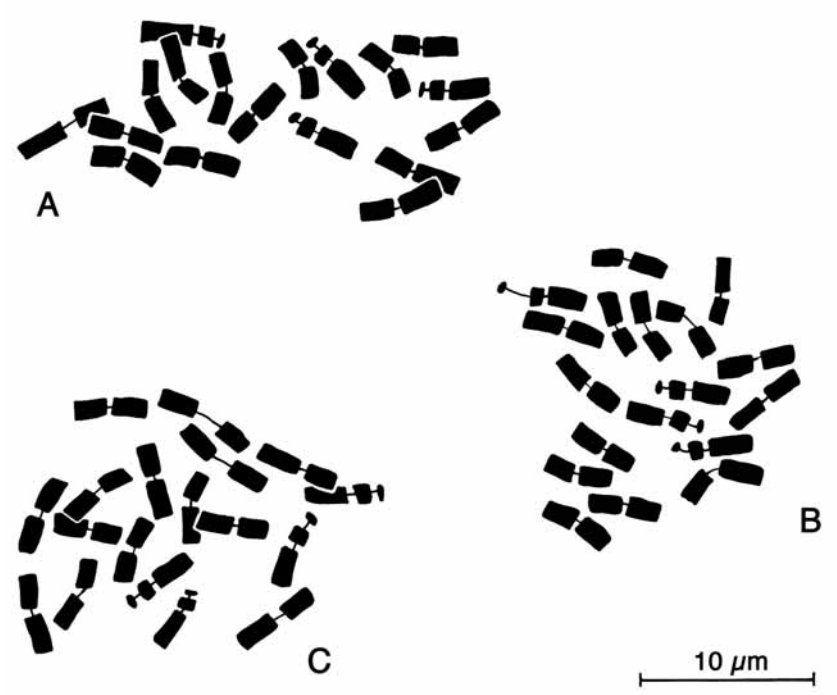

Fig. 1. Somatic metaphases of *Argyranthemum* spp. (2n = 18). – A. *Argyranthemum frutescens* ssp. *foeniculaceum*. – B. *Argyranthemum gracile*. – C. *Argyranthemum tenerifae*.

have no flowers, four have deep yellow ligules, and seven proved to show this colour of faded yellow or yellowish white. The four specimens with deep yellow flowers were originally determined as *B. heterophylla* Ortega, a species listed as a synonym of *B. aurea* by Sherff (1937). It is also remarkable that the herbarium specimens of other yellow flowered species of *Bidens* (e.g. *B. andicola* H.B.K. and *B. angustissima* H.B.K.) in the herbarium Z/ZT still have deep yellow flowers (partly after more than 100 years!). So it seems that at least in some taxa of *Bidens* the colour is well preserved even in herbarium specimens, and *B. aurea* probably consists of more than one taxon, one with yellow ligules (staying yellow in dry status) and another with white ligules (turning yellowish when dry).

10 *Bidens pilosa* L. originates from South America and has spread all over the world. It also occurs on all Canary Islands. Three different chromosome numbers (representing three ploidy levels) are given for *B. pilosa* viz. 24, 48 and 72. We investigated plants from five islands. All plants from all eight sites proved to have 2n = 72 chromosomes which is the most frequent number given in literature for this species.

11 *Calendula arvensis* L. is a very variable species but no variants seem to have any taxonomic value. It occurs in the Mediterranean area as well as on the atlantic islands

Fig. 2. Dried flowers from herbarium specimens, all flowers yellowish. Left: *Bidens aurea* with originally white flowers; middle and right: *Ranunculus* sp. with originally yellow flowers.

including all Canary Islands. Several chromosome numbers are reported in literature, viz. 2n = 14, 18, 36, 42 and 44. The chromosome number 2n = 44 found in all plants from both sites from the Canary Islands confirms the most frequent indication in literature.

12 ***Carlina salicifolia*** **(L.fil.) Cav**. is endemic to Macaronesia and grows on Madeira and on all Canary Islands (Meusel and Kästner 1994) but the occurance on La Palma is doubtful (Hohenester and Welss 1993). The karyotype consists of 8 metacentric and 12 submeta- to subtelocentric chromosomes, two of the latter bearing satellites (Fig. 3A). The same karyotype is given by Febles Hernandez (1984).

13 ***Conyza bonariensis*** **(L.) Cronq**. originates from tropical and subtropical America. It grows on cultivated ground and waste places and has been introduced and naturalized in many parts of the world (e.g. Mediterranean area). It now occurs on all Canary Islands.

14 ***Cotula australis*** **(Sieb. ex Spreng.) Hook.fil.** is a small annual species that has been introduced from South Africa or Australia into several parts of the world. It is naturalized e.g. in Portugal as well as on most Canary Islands (all except Fuerteventura and Lanzarote). This is the first chromosome count on plants from the Canary Islands.

15 ***Dittrichia viscosa*** **(L.) W.Greuter** is a Mediterranean species and occurs on all Canary Islands. Only one seedling survived and only one plant has therefore been investigated.

16 ***Kleinia aizoides*** **DC**. originates from South Africa. It has been naturalized in the Azores and also occurs on La Palma (Hansen and Sunding 1985; Hohenester and Welss

1993; Gobierno de Canarias 2003). It has very narrow leaves while the native *K. neerifolia* (see below) has broader and more flat leaves. We found very narrow leaved *Kleinia* on Tenerife (several dozen plants of different age) and on Fuerteventura (only two small plants). As it is easily and clearly distinct from the rather common broadleaved *K. neerifolia*, we suppose it could be *K. aizoides*. Both species are succulent plants, and as no plants were flowering we did not sample any herbarium specimens but living plants.

The chromosome number of *Kleinia aizoides* was not known up to now. The plants from both islands have as all *Kleinia* species 2n = 20 chromosomes. The chromosomes are rather big. The karyotype is very symmetric, all chromosomes being metacentric and similar in size (Fig. 3B).

17 *Kleinia neerifolia* Haw. is endemic to the Canary Islands. It is a broadleaved rather common species and occurs on all islands. The chromosome number is given in literature for plants from La Gomera, Tenerife and Gran Canaria. We investigated plants from four different islands (El Hierro, La Gomera, Gran Canaria, Fuerteventura). The chromosomes are rather big. As in *K. aizoides*, the karyotype is very symmetric, with metacentric chromosomes of similar size (Fig. 3C).

18 *Launaea arborescens* (Batt.) Murb. forms spiny dwarf shrubs and occurs in southeast Spain, in northwest Africa and on Atlantic islands including all Canary Islands (except El Hierro).

19–22 *Pericallis* is an endemic genus to Macaronesia. All species are restricted to one or few islands, and no taxon occurs on all islands. Twelve species occur on the Canary Islands. Nine of them have an area restricted to one single respective island. In earlier times *Pericallis* was mostly included within *Senecio* but Nordenstam (1978) re-established it as a separate genus, which seems to be widely accepted now.

***P. cruenta* (L'Hér.) Bolle** occurs on four islands (El Hierro, La Gomera, Tenerife and Gran Canaria), whereas ***P. lanata* (L'Hér.) Bolle** occurs only on Tenerife, ***P. murrayi* (Bornm.) B.Nord.** only on El Hierro, and ***P. steetzii* (Bolle) B.Nord**. only on la Gomera (Hohenester and Welss 1993; Gobierno de Canarias 2003). Indications in literature give 60 chromosomes for all taxa (Ardevol Gonzales et al. 1993).

23 *Schizogyne sericea* (L.fil.) Sch.Bip. is a rather frequent shrub in coastal regions of all Canary Islands. The genus *Schizogyne* comprises two species and is an endemic genus to the Canary Islands.

24 *Urospermum picroides* (L.) Scop. is a Mediterranean species and occurs on all Canary Islands. This is the first chromosome count on plants from the Canary Islands.

25 *Cynoglossum creticum* Mill. is a Mediterranean species and occurs on many Macaronesian islands viz. Azores, Madeira and on four Canary Islands (La Palma, La Gomera, Tenerife, Gran Canaria).

26 *Echium aculeatum* Poir. is endemic to the Canary Islands, where it occurs on El Hierro, La Gomera and Tenerife. The genus *Echium* has one of its centers of diversity on the Canary Islands with 30 species and subspecies, out of which 24 are endemic to a single island. With its occurrence on three islands, *E. aculeatum* is therefore compara-

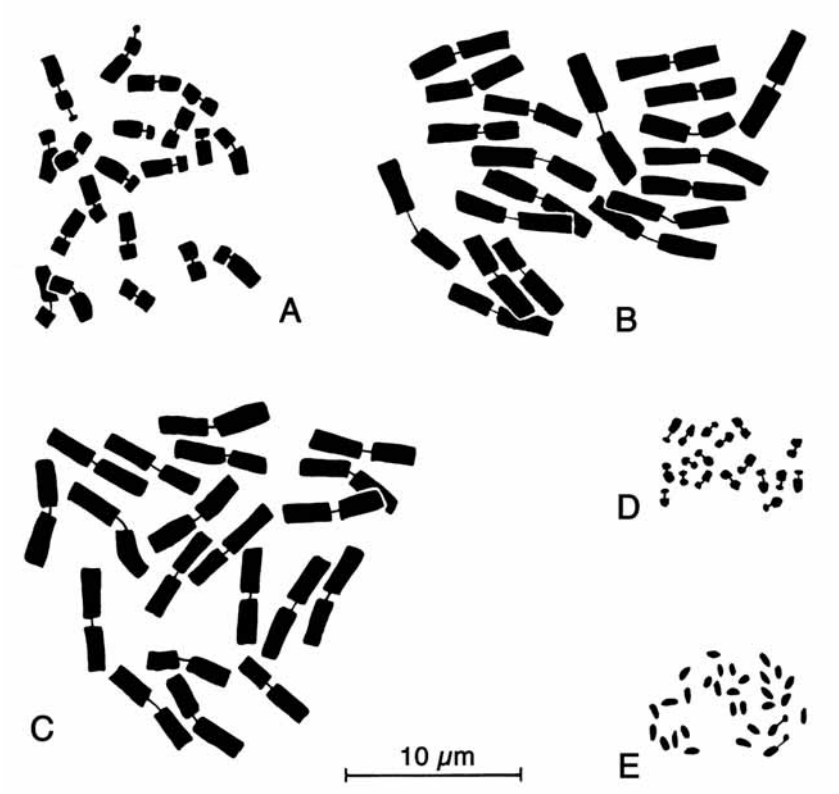

Fig. 3. Somatic metaphases. – A. *Carlina salicifolia* (2n = 20). – B. *Kleinia aizoides* (Tenerife; 2n = 20). – C. *Kleinia neerifolia* (El Hierro; 2n = 20). – D. *Polycarpaea nivea* (2n = 18). – E. *Ononis natrix* ssp. *ramosissima* (2n = 30).

tively widespread. The basic chromosome number of the genus *Echium* seems to be x = 8. Most of the taxa are diploid with 2n = 16, but triplod and tetraploid plants also occur.

27 *Cakile maritima* Scop. grows on coasts of Europe as well as of Madeira and of the eastern Canary Islands (Tenerife, Gran Canaria, Lanzarote, Fuerteventura).

28 *Matthiola fruticulosa* (L.) Maire is a Mediterranean species and occurs on Tenerife, Gran Canaria, Lanzarote and Fuerteventura. We investigated plants from Jandia (Fuerteventura). The plants sampled in the natural site match perfectly with the variety *Matthiola fruticulosa* var. *bolleana* (Webb ex Christ) Sund. which grows only in Jandia. They typically showed very short stems and fruits hidden within the leaves. But this habit changed drastically in culture, where plants developed conspicuous stems up to 25 cm high and rather elongated and lax infructescences.

29 *Polycarpaea nivea* (Ait.) Webb occurs in Northwest Africa and on all Canary Islands except for La Gomera. The chromosome number of this species was not known

up to now. The chromosomes are small (Fig. 3D), and with 2n = 18 the number corresponds with the number of other species of *Polycarpaea*.

30 *Silene vulgaris* (Moench) Garcke ssp. *macrocarpa* Turrill belongs to *S. vulgaris*, a widespread taxon in Europe, northern Africa, and temperate Asia. It is very variable, and many infraspecific taxa have been described at various taxonomic levels. Most of the subspecies are diploid with 2n = 24 chromosomes but *S. vulgaris* subsp. *macrocarpa* Turrill (Baltisberger and Aeschimann 1988) and probably also *S. vulgaris* ssp. *commutata* (Guss.) Hayek (Baltisberger and Widmer 2004) are tetraploid with 48 chromosomes.

S. vulgaris subsp. *macrocarpa* is probably distributed throughout all Mediterranean countries (Greuter et al. 1984). On the Canary Islands, *S. vulgaris* is mostly represented by ssp. *commutata* (Hohenester and Welss 1993) but ssp. *angustifolia* Hayek on El Hierro, ssp. *macrocarpa* on El Hierro, and ssp. *vulgaris* on El Hierro and La Gomera are also indicated (Gobierno de Canarias 2003). *S. vulgaris* subsp. *macrocarpa* has stolons, rather large leaves, mostly a more or less green calyx with obscure veins (or nearly veinless), sometimes pinkish petals, and capsules more than 1 cm. Most of these characters were fulfilled by the Canarian plants from Tenerife, Gan Canaria and El Hierro, but they showed rather fleshy roots instead of stolons. The plants investigated proved to be tetraploid, which is the first chromosome count on tetraploid *S. vulgaris* s.l. from the Canary Islands. According to morphological characters and the ploidy level, the investigated plants represent *S. vulgaris* ssp. *macrocarpa*, which is therefore more widely distributed and more frequent on the Canary Islands than thought before.

31 *Pterocephalus lasiospermus* Link ex Buch is a dwarf shrub and an endemic species only occuring on Tenerife. It mostly grows at higher altitude (2000–2500 m).

32 *Euphorbia atropurpurea* (Brouss.) Webb et Berth. is endemic to Tenerife and mostly grows together with *Kleinia neerifolia* showing a similar habit due to the habitat.

33 *Euphorbia paralias* L. grows on sandy sea-shores in western and southern Europe as well as on Madeira and on most of the Canarian Islands (except the most western islands El Hierro and La Palma).

34 *Ricinus communis* L. originates in tropical Africa but it is widely cultivated for ornament and for the oil obtained from the seeds. It is naturalized in South Europe, the Mediterranean area as well as on the Azores, on Madeira and on all Canary Islands. This is the first chromosome count on plants from the Canary Islands.

35 *Lotus lancerottensis* Webb is endemic to Fuerteventura and Lanzarote.

36 *Medicago laciniata* (L.) Miller originates in North Africa and Asia Minor and is widely naturalized in the Mediterranean area as well as on Madeira and all Canary Islands.

37 *Medicago soleirolii* Duby originates from the western part of the Mediterranean area (Lesins and Lesins 1979) and was probably introduced and naturalized in Gran Canaria and Lanzarote. This is the first chromosome count on plants from the Canary Islands.

38 *Ononis natrix* L. ssp. *ramosissima* (Desf.) Batt. occurs in the western part of the Mediterranean area and on four Canary Islands (Tenerife, Gran Canaria, Fuerteventura, Lanzarote). This subspecies usually grows near the coast, which was also the case with the plants investigated from Fuerteventura. Due to the habitat, these plants from the dunes were dwarf and very compact. But the habit changed in culture where the plants grew erect and much branched with a rather lax habit.

In literature two chromosome numbers are given viz. 2n = 30 and 2n = 32 for *Ononis natrix* s.l. as well as for different subspecies including ssp. *ramosissima*. This taxon is cytologically investigated for the first time on Canarian plants, its chromosomes are small and the centromeres are not visible (Fig. 3E). Only the chromosomes of one pair each have a long and a short arm and a conspicuous centromeric constriction. Each of the four arms of these two chromosomes could therefore easily be interpreted as a single chromosome without centromeric constriction (similar to the other chromosomes). This would explain the number 2n = 32. Valdes et al. (1977) give 2n = 30 for *O. natrix* ssp. *hispanica* (L.fil.) Cout., and on the photograph of a metaphase one of these chromosomes with conspicuous centromere can be recognized. A similar case (but for *O. spinosa L.*) is discussed by Ball (1968) and Baltisberger (1987).

39 *Psoralea bituminosa* L. is a Mediterranean species and occurs on all Canary Islands (Hohenester and Welss 1993). It is not listed on the web (Gobierno de Canarias 2003) but as it is rather frequent it probably has been forgotten. This is the first chromosome count on plants from the Canary Islands.

40 *Erodium chium* (L.) Willd. is a Mediterranean species and occurs on Madeira as well as on all Canary Islands.

41 *Marrubium vulgare* L. is a widespread species on waste places in Europe, western Asia and the Mediterranean area and occurs on all Canary Islands.

42 *Micromeria benthamii* Webb ex Berth. is a Canarian endemic occuring only on Gran Canaria. Most species of *Micromeria* (and all of the Canary Islands) grow on rocks or in other dry habitats. All 23 species and subspecies occuring on the Canary Islands are endemic taxa, 20 of them growing on one single respective island.

43 *Salvia canariensis* L. is endemic to the Canary Islands and occurs on all of them.

44 *Salvia leucantha* Cav. was introduced from Mexico as an ornamental plant and is a naturalized on Madeira and on four of the Canary Islands (La Palma, La Gomera, Tenerife, Gran Canaria). This is the first chromosome count on plants from the Canary Islands.

45 *Stachys ocymastrum* (L.) Briq. is a West Mediterranean annual species and occurs on all Canary Islands as well as on Madeira.

46 *Allium subvillosum* Salzm. ex Schultes & Schultes fil. has ciliate leaves. There is one *Allium* species with ciliate leaves indicated in Hohenester and Welss (1993) named *A. subhirsutum* L. but *A. subvillosum* (also with ciliate leaves) is not included while in the list on the web (Gobierno de Canarias 2003) both species are indicated all over the Canary Islands. According to Stearn (1980) the two species differ in the length of the

stamens. In *A. subvillosum* the stamens have rather long filaments and are slightly shorter to slightly longer than the perianth, but in *A. subhirsutum* they have shorter filaments and are up to 2/3 as long as the perianth. The investigated plants from El Hierro have stamens, which are longer than the perianth and belong therefore to *A. subvillosum*. This species also grows in the western part of the Mediterranean area.

The chromosomes are rather big. With its 28 chromosomes, *Allium subvillosum* is thought to be a tetraploid species based on the common basic chromosome number x = 7. But Jamilena et al. (1990) argued on a detailed analysis of the karyotype that *A. subvillosum* is probably a derived diploid with the exceptional basic chromosome number x = 14 and an asymmetric karyotype. This is supported by the karyotype found in the Canarian plants (Fig. 4A) which consists of 2 metacentric (chromosomes marked with a in Fig. 4A), 2 meta- to submetacentric (chromosomes marked with b), 4 submetacentric (chromosomes marked with c), 2 submeta- to subtelocentric (chromosomes marked with d), and 18 subtelocentric chromosomes, 4 of the latter bearing satellites (satellited chromosomes marked with e). Similar karyotypes have been given by Pastor (1982, but only with 2 satellited chromosomes) and Dalgaard (1991, without satellited chromosomes). Jamilena et al. (1990) indicate a variable number of satellites going up to 6, so the number of satellites seems to be variable.

47 *Androcymbium psammophilum* Svent. is treated at the subspecies level and named *A. gramineum* (Cav.) McBr. ssp. *psammophilum* (Svent.) Kunk. in Hohenester and Welss (1993). Based on allozymic and morphological investigations by Pedrola-Montfort and Caujape-Castells (1994), it is clearly distinct from *A. gramineum* and should be treated as a separate species. It is an endemic species to Fuerteventura and Lanzarote, and only two populations are known both in dunes on the beach, one on each of the two islands (Pedrola-Montfort and Caujape-Castells 1998). The few plants detected and sampled on Fuerteventura in 1998 do not originate from the dunes but grew on a ruderal site near a dilapidated building in the village of Corralejo.

48 *Eschscholtzia californica* Cham. originates from the southwestern United States and is widely cultivated for ornament, and therefore naturalized in many regions of the world. It occurs on the Azores, on Madeira and also on the Canary Islands (except La Gomera and Fuerteventura). This is the first chromosome count on plants from the Canary Islands.

49 *Plantago afra* L. is a Mediterranean annual species and occurs on dry, often sandy places on all Canary Islands.

50 *Plantago aschersonii* Bolle is an annual species growing in dry, often sandy places, mostly in the coastal region of all Canary Islands. It is endemic to the Canary Islands (Hohenester and Welss 1993) but nevertheless it is not mentioned in Hansen and Sunding (1985) as well as on the web list (Gobierno de Canarias 2003). *P. aschersonii* belongs to the group of *P. coronopus* L. (Pilger 1937). This group is rather difficult due to considerable variation within taxa in correlation to ecology and geography (Chater and Cartier 1976).

Most of the taxa of the genus *Plantago* have the basic chromosome number x = 6 except the group of *P. coronopus* with x = 5. Diploids with 2n = 2x = 10, tetraploids with 2n = 4x = 20 and hexaploids with 2n = 6x = 30 chromosomes are known within this group. The plants investigated from Fuerteventura proved to be tetraploid, confirming

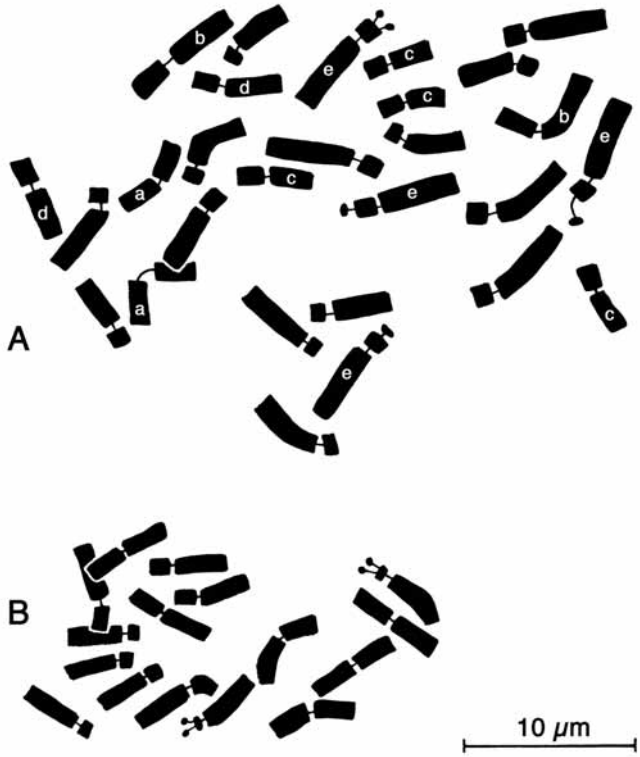

Fig. 4. Somatic metaphases. – A. *Allium subvillosum* (2n = 28; **a** metacentric, **b** meta- to submetacentric, **c** submetacentric, **d** submeta- to subtelocentric, **e** subtelocentric with satellites). – B. *Ranunculus cortusifolius* (Gran Canaria; 2n = 16).

the numbers found by Larsen (1960) as well as by Rahn (in Löve 1966). Note that the plants investigated by Larsen (1960) were not determined unequivocally by this author, but their morphological description matches very well with *P. aschersonii*, and no other tetraploid species from the group of *P. coronopus* occurs on the Canary Islands.

51 *Brachypodium distachyon* (L.) Beauv. is a widespread annual species growing in dry, usually open habitats in the Mediterranean area as well as on all Canary Islands. It is morphologically and cytologically isolated within the genus *Brachypodium* and therefore often excluded and then named *Trachynia distachya* (L.) Link (Hohenester and Welss 1993). The basic chromosome number in *B. distachyon* is x = 5, and diploid, tetraploid, and hexaploid plants are known (compilation see Baltisberger and Leuchtmann 1991). Plants from the Canary Islands are investigated for the first time, they all proved to be tetraploid with 2n = 4x = 20 chromosomes.

52 *Cynosurus echinatus* L. is a frequent and widespread species of the Mediterranean area and occurs on all Canary Islands except for Fuerteventura.

53 *Hordeum murinum* Briq. ssp. *leporinum* (Link) Arcangeli belongs to the widespread *Hordeum murinum* which occurs in whole Europe except the very North and is very frequent in the Mediterranean area. It is usually divided into several subspecies that are diploid or tetraploid. On the Canary Islands, two subspecies occur, the diploid ssp. *glaucum* (Steud.) Tzv. on Tenerife and Gran Canaria (and probably on Lanzarote), and the tetraploid ssp. *leporinum* on all islands. The investigated plants belong to ssp. *leporinum* and confirm the tetraploid level of this subspecies.

54 *Lamarckia aurea* (L.) Moench is a Mediterranean species and occurs also on all Canary Islands.

55 *Polypogon monspeliensis* (L.) Desf. is a widespread tetraploid species. It grows on all Canary Islands except on El Hierro.

56 *Setaria verticillata* (L.) Beauv. has retrorsely barbed bristles. In Hansen and Sunding (1985), Hohenester and Welss (1993) and Gobierno de Canarias (2003), the name *Setaria adhaerens* (Forsk.) Chiov. is used for the *Setaria* with retrorsely barbed bristles but according to Clayton (1980) this taxon has to be included in *S. verticillata.* It grows on all Canary Islands except on El Hierro. Three ploidy levels are indicated for *S. verticillata* in literature, viz. diploid with 2n = 18, tetraploid with 2n = 36, and hexaploid with 2n = 54. Plants from the Canary Islands were investigated for the first time; with 18 chromosomes they all proved to be diploid.

57 *Stipa capensis* Thunb. occurs on all Canary Islands as well as in the Mediterranean area and in South Africa.

58 *Polygonum maritimum* L. grows in maritime sand and shingle of the northern Atlantic, Mediterranean and Black Sea and occurs on all Canary Islands except El Hierro and La Gomera.

59 *Rumex lunaria* L. is a Canarian endemic growing on all Canary Islands but it has been planted for hedges in the Mediterranean area and naturalized in South Italy, Sicilia and Sardegna.

60 *Rumex vesicarius* L. is an annual originating in North Africa and Southwest Asia also occuring on all Canary Islands.

61 *Ranunculus cortusifolius* Willd. grows in shady and wet places (often in forests) and is a Macaronesian endemic occurring on the Azores, Madeira as well as on all Canary Islands. The chromosome number 2n = 16 confirms the indications in literature, the investigated plants originating from Madeira, Tenerife, Gran Canaria, La Palma, and Lanzarote. Plants from La Gomera and El Hierro are investigated for the first time, now lacking only investigations on plants from Fuerteventura. The karyotype consists of 6 metacentric, 8 submeta- to subtelocentric and 2 acrocentric chromosomes, the latter with satellites (Fig. 4B). The same karyotype is given by Goepfert (1974), Dalgaard (1985), and Baltisberger et al. (1990).

As *Ranunculus cortusifolius* grows in similar habitats and looks like *R. creticus* L. (an endemic species from Crete), it was suggested that these two species are closely

related (Bramwell and Richardson 1973; Goepfert 1976). But molecular data suggest that the two species are not as closely related (Paun et al. 2005). They join the same clade but they are each nested within a group of species from more or less the same phytogeographical region (western, respectively eastern Mediterranean). The similar habit is probably an independent adaptation to the shaded habitat. Nevertheless, the two species are more or less related since both species show similar karyotypes (compilation of literature see Baltisberger and Widmer 2005) and, based on data of chloroplast DNA, Johansson (1998) found a strongly supported monophyletic group with *R. cortusifolius* and *R. creticus* as well as some other species.

62 *Galium aparine* L. is a very variable cosmopolitan weed and also occurs on all Canary Islands. The most common basic chromosome number in the genus *Galium* is x = 11 (van Loon 1987). In *G. aparine*, diploid, tetraploid, hexaploid, and octoploid as well as aneuploid plants are known. The hexaploid level with 2n = 66 is the most common ploidy level, which is confirmed by all the investigated plants. This is the first chromosome count on plants from the Canary Islands.

63 *Cardiospermum grandiflorum* Sw. is a species from tropical America and Africa and naturalized on Madeira as well as on four Canary Islands (La Palma, La Gomera, Tenerife, Gran Canaria). The chromosome number found in the plants from La Gomera corresponds with the indication for plants from Madeira by Dalgaard (1986). This is the first chromosome count on plants from the Canary Islands.

64 *Misopates orontium* (L.) Rafin. is an annual species and grows on cultivated ground and in other open habitats on all Canary Islands.

65 *Scrophularia glabrata* Ait. is an endemic species growing in gravels and screes on La Palma and Tenerife. Several chromosome numbers are given in literature viz. 2n = 56, 2n =58, and rarely 2n = 60. The chromosomes are rather small and often clump together which might contribute to the different numbers indicated. The investigated plants from Tenerife showed 2n = 58 chromosomes, which is one of the two frequently indicated numbers.

66 *Datura stramonium* L. originates from America but is naturalized in many parts of the world. It is a tall annual and grows on cultivated ground, waste places and other open habitats but in some regions it is very irregular in its appearances. It is recorded for most of the Canary Islands (except Lanzarote). *D. stramonium* mostly has 24 chromosomes but 2n = 48 is also once reported. The investigated plants showed 2n = 24 chromosomes confirming the most frequently reported number. This is the first chromosome count on plants from the Canary Islands.

Final remark

Given the long history of botanical investigations on the Canary Islands, one could expect that plant species for which no chromosome counts have previously been reported, would be difficult to find and would have to be searched for specifically. But this is not the case (Tab. 2). Among the 66 investigated species, two species were cytologically completely unknown, and 17 other species have never been investigated on

Tab. 2. Categories of results concerning chromosome numbers. Numbers in bold refer to species for which karyotypes are given in addition to the chromosome number.

Categories of result (chromosome numbers)	Species (numbers as in Table 1)		
	Endemic	Native	Introduced
Number not reported previously		29	**16**
New determination for Canary Islands		24, 30, **38**, 39, 51, 52, 56, 62	01, 09, 14, 34, 37, 44, 48, 63, 66
Confirmation of number previously reported for Canary Islands	05, **06**, **07**, **08**, **12**, **17**, 19, 20, 21, 22, 23, 26, 31, 32, 35, 42, 43, 47, 50, 59, **61**, 65	02, 03, 04, 11, 15, 18, 25, 27, 28, 33, 40, 41, 45, **46**, 49, 53, 54, 55, 57, 58, 60, 64	10, 13, 36

Canarian material. These 19 species have either been introduced to the Canary Islands or are native species that also occur elsewhere, but does not include endemic taxa. The chromosome numbers of 47 species confirm earlier data in literature, all including investigations on Canarian plants, in some cases only on material from the Canary Islands (endemics!). Twenty-two of these species are endemics to the Canary Islands or at least to Macaronesia. As no endemic was investigated for the first time, endemics have obviously been well investigated in the past, better than the widely distributed or introduced species.

The distinction between native and introduced species is often not clear. Many species have a Mediterranean origin but now are very common and frequent on all Canary Islands, and this often since long times. If and when these species were introduced by humans is often unclear (e.g. *Brachypodium distachyon* or *Rumex vesicarius*). We declare species as introduced when it seems clear that this introduction was man-made and relatively recent. But some of the species treated as "native" may also have been introduced.

Our results suggest that cytological data are still often lacking for more or less common and widely distributed species as these are obviously less attractive for botanists than endemics. Nevertheless, cytological data are needed also for these common species.

Zusammenfassung

Die Chromosomenzahlen von 66 Taxa (101 Populationen) von Blütenpflanzen der Kanarischen Inseln aus 22 verschiedenen Familien werden präsentiert. Die Chromosomenzahlen von *Kleinia aizoides* (Asteraceae, 2n = 20) und *Polycarpaea nivea* (Caryophyllaceae, 2n = 18) wurden zum ersten Mal untersucht. Die Zahlen von weiteren 17 Taxa werden zum ersten Mal von kanarischen Herkünften mitgeteilt. Die Karyotypen von 9 Arten (6 davon endemisch) werden angegeben und pflanzengeographische und einige systematische Aspekte werden diskutiert. Zudem präsentieren wir Argumente, dass *Bidens aurea* möglicherweise mehr als ein Taxon umfasst.

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