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KARYOLOGICAL SYSTEMATICS OF *GENISTA IFNIENSIS* A. CABALLERO, *GENISTA TRICUSPIDATA* DESF., AND RELATED SPECIES (*GENISTEAE - FABACEAE*)

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Abstract: A karyological analysis of two species endemic to Northwestern Africa (*Genista ifniensis* A. Caballero and *G. tricuspidata* Desf.) showed that both species have the chromosome number 2n = 48. A comparison was also made with karyological data already available for the other taxa of sects. *Scorpioides* Spach and *Voglera* (Gaertn., Mey. & Schreb.) Spach.

Introduction

The genus *Genista* has a mainly Mediterranean distribution with two main centers: a western center (Southern Spain and Northwestern Africa), and an eastern one (Southern Balkan Peninsula, East Mediterranean). Other species are spread through the Central Mediterranean (Sicily, Sardinia), while few taxa reach Central - Northern Europe, such as *G. tinctoria* L., *G. pilosa* L., *G. germanica* L., *G. anglica* L. (Gibbs, 1966).

Karyological studies were carried out on many European species. Particularly, western species have been accurately analysed, both from the Iberian Peninsula (Sañudo 1979), and Southern France (Verlaque 1988); eastern species have been studied as well (see e. g. Cusma Velari & Feoli Chiapella 1991 and Kuzmanov 1993). There are about 30 taxa in Northern Africa, mainly in the western part (from Morocco to Tunisia); more than half of them are endemic. Data on the endemic species and on the Northern African populations of the taxa reaching Europe are extremely scarce (see Humphries *et al.* 1978).

This paper presents a karyological study on two taxa endemic to Northwestern Africa: *Genista ifniensis* A. Caballero, that belongs to sect. *Scorpioides* Spach, and *G. tricuspidata* Desf., belonging to sect. *Voglera* (Gaertn., Mey. & Schreb.) Spach. We also report previous references for all taxa of the above mentioned sections and formulate hypotheses about the most probable basic numbers for the different groups.

Materials and methods

The karyological analysis were carried out on seeds collected in the field (see Fig. 1). Voucher specimens are deposited in the Herbarium of the Department of Biology, University of Trieste (TSB). Mitoses were observed on root tips of seedlings, pretreated with 8-hydroxiquinoline, fixed in a 1 : 3 solution of glacial acetic acid:

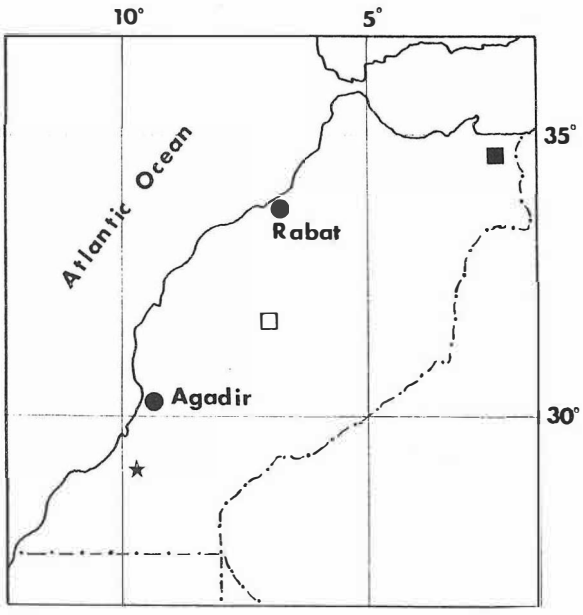

Fig. 1 - Sampling sites of the examined populations of *Genista ifniensis* (★) and *Genista tricuspidata:* Imi-n-Ifri (□), Beni-Snassen (■).

absolute ethanol (Carnoy's fluid), hydrolized in 1 N HCl at 60° C for six minutes and stained using the routine Feulgen method. Slides were prepared with the squash technique. For each population 10 to 15 metaphase plates were examined. Only numbers of chromosomes can be given here, because of the size of the chromosomes, too small (0.56 - 2.16 µm) for effective karyotyping.

Gibbs (1966) and Greuter *et al.* (1989) are followed for sections and species nomenclature, respectively.

The species

Genista ifniensis A. Caballero (= *G. ferox* Poiret subsp. *microphylla* (Ball) Font Quer; *G. ferox* var. *microphylla* Ball)

Ma: Anti - Atlas, Tiznit - Goulimine, near Tizi - Mighert, 9°47'W, 29°28'N, c. 900 m, 25 Jun 1987, *L. Feoli Chiapella et E. Feoli,* s.n. (TSB)

The chromosome number 2n = 48 was counted based on 10 metaphase plates (Fig. 2). Chromosome size ranges between 0.6 and 2.16 µm.

No previous karyological data are known for this taxon, endemic to Southern Morocco (Southwestern coast, Western Great Atlas, Western Anti - Atlas; Raynaud 1979, Maire 1987).

The chromosome numbers recorded in the various taxa of the sect. *Scorpioides* Spach of *Genista* are shown in Tab. 1. *Genista ferox* Poiret, a closely related species, occurs in Northwestern Africa in Algeria (coast of Costantina and Algeri) and Tunisia (Kroumirie) (Maire 1987); the only record for Europe is in Northern Sardinia (Asinara Gulf, near Castelsardo, Valsecchi 1981). This species shows the number 2n = 48. The same chromosome number was found for other taxa of sect. *Scorpioides,* such as *Genista corsica* (Loisel.) DC., endemic to Corsica and Sardinia (Gibbs 1966, Valsecchi 1977), on material from both islands, the close taxon *G. cadasonensis* Valsecchi, endemic to Sardinia, where it is spread through the central-eastern coast (Valsecchi 1984), and *G. morisii* Colla, endemic to Southwestern Sardinia (Valsecchi 1976).

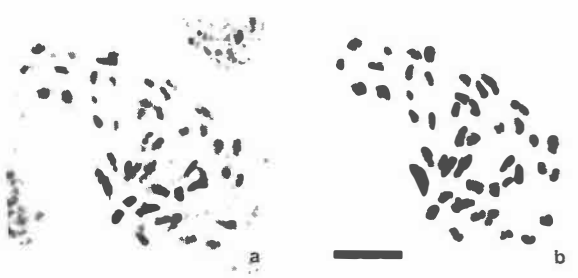

Fig. 2 - Photomicrograph (a) and drawing (b) of a somatic metaphase plate of *Genista ifniensis,* 2n = 48. Scale bar = 5 µm.

Other species of the same section have different chromosome numbers. The numbers n = 20, 2n = 40 and n = 6 were counted for *Genista carpetana* Lange, a Spanish endemic (Gibbs 1966). The number n = 6, reported by Gallego Martín *et al.* (1984) in a preliminary note but not in the following paper (Gallego Martín *et al.* 1985), may be considered as doubtful, because no taxa of *Genisteae* have such number.

Genista scorpius (L.) DC., the most widespread taxon within the section (Southwestern France, Eastern and Southern Spain; Gibbs 1966, Greuter *et al.* 1989), has the greatest variability in chromosome number. The numbers n = 20, 2n = 40 were constantly counted in Spanish populations, while also lower (down to 2n = 36) and higher (up to 2n = 44) numbers were counted for populations from Southern France; a highly polyploid race with 2n = 82-84 was found in Southeastern France.

Thus, in the sect. *Scorpioides, Genista ifniensis, G. ferox, G. corsica, G. cadasonensis* and *G. morisii,* all with the same chromosome number 2n = 48, would be tetraploid with x = 12, which is by far the most common secondary basic number in *Genista,* in *Cytisus* and generally in *Genisteae* (Sañudo 1979, Goldblatt 1981a, Cusma Velari & Feoli Chiapella 1994). *G. carpetana* and *G. scorpius,* in particular the latter, never have the chromosome number 2n = 48, but present a range of numbers, 2n = 40 being the most common. These numbers might be considered as deriving from a secondary basic number x = 10 by ascending and descending aneuploidy. A trend toward polyploidization may be detected in the easternmost part of the distribution range of *G. scorpius;* moreover, Verlaque *et al.* (1983) found strong mitotic and meiotic perturbations in different French populations.

Genista tricuspidata Desf.

Ma: Beni - Snassen, limestone rocks, 34°51'N, 2°21'W, 550 m, Aug 1989, *L. Feoli Chiapella et E. Feoli,* s.n. (TSB) (Fig. 3a, b)
Ma: Great Atlas, Imi - n - Ifri, near Demnate, 31°44'N, 7°03'W, 1000 m, Jul 1987, *L. Feoli Chiapella et E. Feoli,* s.n. (TSB) (Fig. 3c)

Genista tricuspidata is endemic to Morocco (Mediterranean coastal chains, High Atlas, Anti

Atlas and Southwestern coast), Algeria (Tell, Region of Orano) and Tunisia (Quezel & Santa 1962, Gibbs 1966, Raynaud 1979, Maire 1987). Chromosome number is 2n = 48 (Fig. 3). Chromosome size ranges between 0.56 and 1.33 µm. This is the first published chromosome count for this species.

The chromosome numbers recorded in the various taxa of *Genista* sect. *Voglera* (Gaertn., Mey. & Schreb.) Spach are reported in Tab. 1. The taxa of the section are distributed in Western (Southwestern Iberian Peninsula and Northern Africa), Central (Sicily) and Eastern (Turkey and Balkan Peninsula) Mediterranean region, respectively.

The chromosome number 2n = 48 is also found in other species of sect. *Voglera:* in the two Sicilian endemic species *Genista cupanii* Guss. and *G. aristata* C. Presl and in the eastern taxon *G. anatolica* Boiss. (Bulgaria and Western Turkey). 2n = 24 and 2n = 48 chromosomes were counted in *G. carinalis* Griseb. (Northern Greece, Southern Bulgaria and Northwestern Turkey). Furthermore, among the Western Mediterranean species, *G. hirsuta* Vahl has 2n = 48 in the studied Spanish populations, while *G. micrantha* Ortega presents n = 12, 2n = 24. Finally, *G. germanica* L. sporadically shows 2n = 48. Gibbs (1966) emphasizes the high morphological similarity between *G. tricuspidata, G. hirsuta* and *G. anatolica* and considers these species as an example of East-West Mediterranean vicariants. In all these taxa, chromosome numbers derive from a basic number x = 12; diploids are an exception, while the majority are tetraploids (see also Sañudo 1979).

A group of amphiadriatic species has a basic number x = 11. The Illyrian taxa *Genista sylvestris* Scop. subsp. *sylvestris* (n = 22, 2n = 88) and *G. sylvestris* subsp. *dalmatica* (Bartl.) H. Lindb. (n = 44, 2n = 88) would be octoploid or, more seldom, tetraploid, while the Italian endemic *G. michelii* Spach (2n = 132) would be dodecaploid. The chromosome numbers n = 22 and 2n = 44 were counted for *G. germanica,* too, together with a series ranging from 2n = 42 to 2n = 48, that probably can be interpreted as an example of unstabilized aneuploidy (Sañudo 1979, Verlaque 1988). Finally, the chromosome number 2n = 44 was also found in a Bulgarian population of *G. carinalis.* On the other hand, some western taxa have a basic number x = 9: *Genista hispanica* L. subsp. *hispanica* and subsp. *occidentalis* Rouy present 2n = 36; *G. micrantha* n = 18, 2n = 36; *G. tridens* (Cav.) DC. has n = 36, 2n = 72; finally *G. triacanthos* Brot. subsp. *vepres* (Pomel) P. Gibbs shows 2n = 72. Actually, this taxon seems to be limited to Algeria (Maire 1987, Greuter *et al.* 1989), and it is thus likely that the material from Western Morocco examined by Humphries *et al.* (1978), belongs to another taxon of this section. The chromosome number 2n = 36 was also counted for the Greek populations of the eastern species *G. carinalis.*

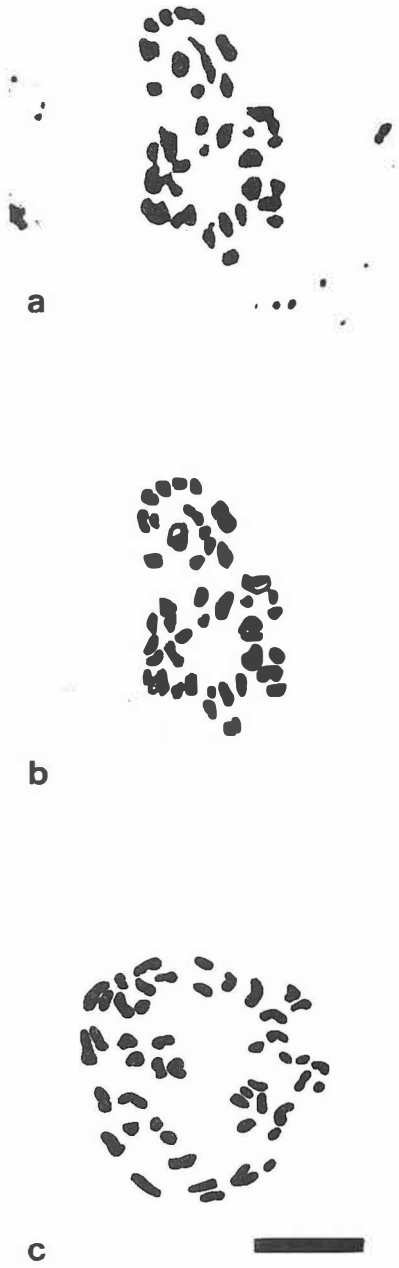

Fig. 3 - Photomicrograph (a) and drawings (b, c) of somatic metaphase plates of *Genista tricuspidata* from Beni-Snassen (a, b), and Imi-n-Ifri (c), 2n = 48. Scale bar = 5 µm (a, b).

Tab. 1. Chromosome numbers of the species of *Genista* sects. *Scorpioides* and *Voglera* with bibliographic references and source of the studied populations. The abbreviations of the territories follow Flora Europaea, except for Slovenija (Slo), Hrvatska (Hr), Ceská Republika (CR), and Greuter *et al.* (1989) for African states.

SECT. SCORPIOIDES	APLOID No.	DIPLOID No.	REFERENCES	LOC. ALITY
G. ifniensis A. Caballero		2n = 48	Present paper	Tiznit – Goulimine (Ma)
G. ferox Poiret		2n = 48	Tschechov 1931	"Institut für angewandte Botanik u. neuer Kulturen"
		2n = 48	Villa 1980	Peruledda, Castelsardo (Sa)
G. morisii Colla		2n = 48	Villa & Sanna 1983	Uras (Sa)
G. corsica (Loisel.) DC.		2n = 48	Contandriopoulos 1957, 1962	Corsica (Ga)
		2n = 48	Villa 1978	Cala Gonone, Codula di Sisine (Ga)
G. cadasonensis Valsecchi		2n = 48	Villa 1988	Santa Maria Navarrese (Sa)
G. scorpius (L.) DC.		2n = 36	Natarajan 1978	Languedoc, Bel-. AirMontpellier (Ga)
		2n = 36	Seidenbinder & Verlaque 1985	Vaucluse, Mont Ventoux (Ga)
	n = 18-20		Verlaque et al. 1983	Vaucluse, Mont Ventoux (Ga)
		2n = 36–40	Verlaque et al. 1983	Hérault, Pic Saint-Loup (Ga)
		2n = 36–44	Verlaque et al. 1983	Hérault, Bel-Air (Ga)
		2n = 40	Lorenzo Andreu & Garcia-Sanz 1950	Aula Dei, Aragon (Hs)
	n = 20	2n = 40	Gallego Martín et al. 1986	Villacampo, Zamora (Hs)
	n = 20 (ca 40)	2n = 40	Verlaque et al. 1983	Hérault, Pic Saint-Loup (Ga)
	n = 20	2n = 40	Sañudo 1971	Granada (Hs)
		2n = 40	Verlaque et al. 1983	Bouches–du –Rhône, S.te Victoire, Fontbelle (Ga)
		2n = 40	Verlaque et al. 1983	Alpes–de–Haute–Provence, Lure (Ga)
		2n = 40 (44)	Verlaque et al. 1983	Vaucluse, Mont Ventoux (Ga)
	n = (20) 21	2n = (40) 42 (44)	Verlaque et al. 1983	Bouches–du–Rhône, Les Alpilles, Roquemartine (Ga)
	n = 42		Verlaque et al. 1983	Var, Signes–Méounes (Ga)
		2n = 82-84	Verlaque et al. 1983	Var, Signes–Méounes (Ga)
G. carpetana Lange		2n = 40	Sañudo 1971	Hoyos del Espino, Avila (Hs)
	n = 20		Sañudo 1973	Santibáñez de Resoba, Palencia (Hs)
	n = 20		Cubas et al. 1998	Gredos, Avila (Hs)
	n = 6 (?)		Gallego Martín et al. 1984	S. Martín de Castañeda, Zamora (Hs)

SECT. VOGLERA				
G. tricuspidata Desf.		2n = 48	present paper	Beni-Snassen, Great Atlas, Imi-n-Ifri, Demnate (Ma)
G. hispanica L.	n = 18		Forissier 1973	Gréolières, Tartère, Massif du Coronat (Ga)
G. hispanica L. subsp. hispanica	n = 18	2n = 36	Sañudo 1972	Abentosa, Teruel (Hs)
		2n =36	Verlaque et al. 1983	Bouches-du-Rhône, Cabriès (Ga)
				Var, Forêt domaniale de la Gardiole de Rians (Ga)
				Vaucluse, Petit Luberon, la Font de l'Orme (Ga)
G. hispanica L. subsp. occidentalis Rouy	n = 18	2n = 36	Sañudo1972	Espinosa de los Monteros, Burgos (Hs)
G. tournefortii Spach	n = 15	2n = 30	Sañudo 1972	S.ta Elena, Jaén (Hs)
	n = 15	2n = 30	Gallego Martín et al. 1984, 1985	San Martín del Castañar, Salamanca (Hs)
		2n = 32	Fernandes et al. 1977	Caneças (Lu)
G. tournefortii Spach subsp. tournefortii	n = 32		Cubas et al. 1998	Navalperal de Tormes, Avila (Hs)
		2n = 32	Fernandes & Santos 1971	Figueira da Foz, Ser◆ da Boa Viagem (Lu)
G. hirsuta Vahl		2n = 32	Fernandes & Queirós 1978	Colares, Tapada do Cospeto (Lu)
	n = 24	2n = 48	Sañudo1972	S. Pedro de Alcántara, Málaga (Hs)
				S. Palmitera, Málaga (Hs) (sub *G. lanuginosa* Spach)
	n = 24	2n = 48	Gallego Martín et al. 1986	Cañaveral, Cáceres (Hs)
G. micrantha Ortega	n = 12	2n = 24	Gallego Martín et al. 1984	S. Martín de Castañeda, Zamora (Hs)
	n = 18	2n = 36	Sañudo1972	Monte Salcedillo, Palencia (Hs)
	n = 18	2n = 36	Gallego Martín et al. 1985	S. Martín de Castañeda, Zamora (Hs)
	n = 18		Cubas et al. 1998	Sierra de la Culebra, Zamora (Hs)
				Puente de Sanabria, Zamora (Hs)
G. triacanthos Brot.	n = 16		Forissier 1973	Bot. Gard., Coimbra (Lu)
	n = 16	2n = 32	Sañudo1972	Los Barrios, Cádiz (Hs) (sub *G. scorpioides* Spach)
				S. Roque, Cádiz (Hs)
		2n = 32	Fernandes & Santos 1975	Azeitão (Lu)
		2n = 32, 36	Horjales 1974	S. Sebastião, Coimbra (Lu)
	n = 18	2n = 36	Gallego Martín et al. 1984, 1985	Sotoserrano, Salamanca (Hs)
G. triacanthos Brot. subsp. vepres (Pomel) P. Gibbs (?)		2n = 72	Humphries et al. 1978	Essaouira – Saji (Ma)
G. tridens (Cav.) DC.	n = 36	2n = 72	Sañudo1972	S. Carbonera, Cádiz (Hs)
G. sylvestris Scop. subsp. sylvestris	n = 22		Forissier 1975	Učka, Istria (Hr)
		2n = 88	Cusma Velari & Feoli Chiapella 1986, 1991	Val Rosandra, Trieste (It); M.te Čaven (Slo)
G. sylvestris Scop. subsp. dalmatica (Bartl.) H. Lindb.	n = 44		Forissier 1975	Sarajevo (BiH); Bot. Gard., Neuchâtel (He)
		2n = 88	Cusma Velari & Feoli Chiapella 1991	Cres; Omis – Split; Brgat, Dubrovnik (Hr)
G. michelii Spach		2n = 132	Cusma Velari & Feoli Chiapella 1991	M. S. Vicino, Marche; Gargano, Puglia (It)
G. aristata C. Presl		2n = 48	Cusma Velari & Feoli Chiapella 1991	M. Madonie, Contrada Mangiarrati (Si)
G. cupanii Guss.		2n = 48	Bartolo et al. 1977	Madonie, Contrada Mandarini, Petralia Sottana (Si)
G. anatolica Boiss.		2n = 48	Krusheva 1975	M. West Strandzha, Golem Dervent (Bu)
G. carinalis Griseb.		2n = 24	Kuzmanov et al. 1973	M. Pirin (Bu)
		2n = 36	Papanicolau 1984	M. Pangeon, Ikosifinissa (Gr)
		2n = 44	Krusheva 1975	M. Pirin, Dobrinishe (Bu)
		2n = 48	Kuzmanov 1975	M. Stara Planina, Sliven (Bu)
G. germanica L.	n = 22		Forissier 1973	Montcherand, Vaud (He)
				Stube, Zwischbergental (He)
		2n = 42	Holub et al. 1970	Všenory, Praha (CR)
		2n = 44	Murin 1974 (after Goldblatt 1981b)	
		2n = 44 - 48	Semerenko & Shvet 1989 (after Goldblatt & Johnson 1991)	
		2n = 46	Loevkvist (after Löve & Löve 1974)	
		2n = 46 - 48	Reese1952	Traveufer, Lübeck, Schleswig – Holstein (Ge)

The chromosome numbers n = 16, n = 32, 2n = 32 were found in some Iberian taxa. In particular, 2n = 32 was counted on different Portuguese populations of *Genista tournefortii* Spach, n = 32 and n = 15, 2n = 30 in some Spanish populations. The chromosome numbers n = 16, 2n = 32 were found both in Spanish and Portuguese populations of *G. triacanthos,* besides 2n = 36. Finally 2n = 32 was found in a Portuguese population of *G. hirsuta.*

From a karyological point of view sect. *Voglera* emerges as the most heterogeneous within *Genista.* Chromosome numbers deriving from a basic number x = 12 were found in Eastern, Central and Western Mediterranean taxa, but they are not so frequent as in other sections of *Genista* and in other genera of the tribe. The secondary basic number x = 11 was only found in a group of three amphiadriatic endemic taxa and, occasionally, in *Genista germanica*, the species of the section with the most widespread distribution. In other sections of *Genista* this number was only found in *G. sessilifolia* DC. of sect. *Spartocarpus* (Kuzmanov 1974, 1978, Krusheva 1975). The basic number x = 9 is found in several western taxa and, sporadically, in *Genista carinalis,* and has proved to be more common than previously assumed in *Genista,* particularly in sect. *Spartioides* Spach and sect. *Erinacoides* Spach (Verlaque 1988, Cusma Velari *et al.* 1996, 1998). Finally, x = 8, that probably is the basic number for n = 16, n = 32 and 2n = 32, is quite uncommon in *Genista* and has not been found in species of other sections. Within the whole tribe of *Genisteae* this number is common only in the genus *Ulex* L., and has also been found in *Stauracanthus boivinii* (Webb) Samp. (see e. g. Tschechow 1931, Fernandes & Queirós 1978).

The secondary basic numbers x = 8, 9, 11 may be interpreted as derived by descending aneuploidy from x = 12, the most frequent secondary basic number in *Genista.* It should be stressed that in the whole tribe *Genisteae* several taxa have undergone considerable changes in the chromosome complement, owing to disploidy, polyploidy and aneuploidy (see also Sañudo 1979, Verlaque 1988). The proliferation of several basic numbers and the high chromosome variability within some taxa (particularly *Genista hirsuta, G. carinalis* and *G. micrantha*) reach a maximum in sect. *Voglera,* which can be considered as «karyologically fluid».

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