

CONTRIBUTION TO THE CYTOTAXONOMICAL KNOWLEDGE OF THE GENUS *PINGUICULA* L. (LENTIBULARIACEAE): A SYNTHESIS OF KARYOLOGICAL DATA

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This paper aims to summarize and briefly analyse the actual karyological knowledge of the genus *Pinguicula* L.

The checklist presented (Table 1) shows all the species of this genus, which have been karyologically studied, in alphabetical order. There are 129 records referring to 35 taxa (30 species and 5 infraspecific taxa). The total of different chromosome counts (considering two or more cytotypes for some units) is 47. The basic numbers are $x = 6, 8, 9, 11$ (Table 2).

Examining the data in Figure 1 indicates that 14 taxa (31.8%) show $2x$ complement of which 12 are exclusively diploid ($2n = 12, 16, 18, 22$); 3 taxa (4.6%) show $3x$ complement of which none is exclusively triploid ($2n = 24$); 20 taxa (45.4%) show $4x$ complement of which 14 are exclusively tetraploid ($2n = 32, 44$); 3 taxa (6.8%) show $6x$ complement of which 2 are exclusively hexaploid ($2n = 48$); 3 taxa (6.8%) show $8x$ octoploid complement of which 1 is exclusively octoploid ($2n = 64$), 3 taxa (4.6%) show aneuploidy of which none is exclusively aneuploid ($2n = 27, 28, 50$). Furthermore, 34.3% of the considered taxa are diploid, 42.8% tetraploid, 5.7% hexaploid, 2.9% octoploid, 14.3% show two or more cytotypes (representing more or less completely euploid series) or possibility of aneuploidy phenomena.

By comparing the karyological data with the systematic ones synthesized in a recent survey of the genus made by Legendre (2000), we can observe that all the representatives at the base of the tree of the karyological relationships (Figure 2) are characterized by homophylly. The subgenus *Isoloba* is here regarded as probably the most primitive and homogeneous, and is composed of homophyllous species showing tropical growth-type. All the representatives of the subgenus *Temnoceras* show homophylly and the tendency to develop a temperate growth-type together with the polyploidy. The representatives of the subgenus *Pinguicula* show both homophylly and heterophylly and, in the large majority, a temperate growth-type.

A group of species with a neo-basic number $x = 11$, probably derived from triploid ancestors (cfr. Figure 2), deserves particular attention. Flowing together in this group are two homophyllous representatives with tropical growth-type from the subgenus *Isoloba*, and the four heterophyllous representatives with tropical growth-type from subgenus *Pinguicula* section *Orcheosanthus* (Legendre, 2000).

Unfortunately the karyological knowledge of the genus *Pinguicula* is still partial (only 41.2% of the accepted spontaneous taxa have been studied) and this does not allow us to draw definitive conclusions. As such, to increase the depth of understanding of the cytological knowledge of the genus, it would be very interesting to verify if the peculiar group with $x = 11$ continues to maintain the characteristics of isolation from other groups. In this case probably this complex would deserve to be separated in some way from others.

The species with lower chromosome number, and probably the most primitive, is *P. lusitanica*, $2n = 12$.

The polyploidy is a phenomenon independently evolved in the three subgenera. The aneuploidy is generally ascendant, and it involves two or three couples of chromosomes.

Pinguicula crystallina is confirmed to be the species in absolute more variable from a cytological point of view, and moreover most of the variability is represented in *Pinguicula crystallina* subsp. *hirtiflora*.

Pinguicula balcanica seems to have two basic numbers (Table 1): this suggests an accurate systematic review of this species, aimed to clarify if this karyological variability is linked to some misidentification or to the union of more taxa under this species.

Table 1: Updated synthesis of karyological data for the genus *Pinguicula* L. (Lentibulariaceae). Nomenclature is according to Schlauer (2002); names originally used by the authors are kept in square parenthesis.

species	infraspecific taxa	chromosome number	source of material	Authors
1 <i>P. alpina</i> L.		2n = 32	Scandinavia	Löve & Löve, 1944
			France	Doulat, 1947
				Zurzycki, 1953
			Iceland	Löve & Löve, 1956
			USA	Wood & Godfrey, 1957
			Poland	Skalinska et al., 1959
				Sokolovskaja & Strelkova, 1960
			Russia	
			Austria	Casper, 1962
				Casper, 1963a
			Finland	Sorsa, 1963
			Norway	Laane, 1965
				Casper, 1966
			East Sayan	Krogulevich, 1976
			Slovakia	Murin, 1976
				Krogulevich, 1978
			Mongolia	Murin et al., 1980
			Austria	Dobes et al., 1997
2 <i>P. balcanica</i> Casper		2n = 24	Greece	Contandriopoulos & Quezel, 1974
		2n = 32	Bulgaria	Casper, 1966
		2n = 44		Heitz, 1926
			USA	Wood & Godfrey, 1957
3 <i>P. caerulea</i> Walt.		2n = 32	USA	Kondo, 1969
				Godfrey & Stripling, 1961
				Casper, 1963a
4 <i>P. colimensis</i> McVaugh & Mickel		2n = 22		Kondo, 1969
5 <i>P. corsica</i> Bernard et Gren ex Gren et Godr.		2n = 16	Corse	Contandriopoulos, 1957
			Corse	Favarger & Contandriopoulos,
			Corse	Contandriopoulos, 1962
			Corse	Casper, 1963a
6 <i>P. crenatiloba</i> A. DC.		2n = 16		Casper, 1963a
7 <i>P. crystallina</i> Sibth. subsp. <i>crystallina</i> et Smith		2n = 24	Turkey	Contandriopoulos & Quezel, 1974
		2n = 28	Cyprus	Mikeladze & Casper, 1997
	subsp. <i>hirtiflora</i> (Ten.) A. Strid	2n = 16	Italy	Honsell, 1959
				Casper, 1962
				Casper, 1963a
[var. <i>louisii</i> (Markgraf) Ernst]		2n = 24	Greece	Contandriopoulos & Quezel, 1974
				Contandriopoulos & Quezel, 1974
				Contandriopoulos & Quezel, 1974

Table 1 (continued)

		2n = 27	Greece	Strid & Franzen, 1981
			Italy	Peruzzi <i>et al.</i> , 2003
		2n = 28	Italy	Mikeladze & Casper, 1997
	[var. <i>gionae</i> Contandriopoulos et Quezel]	2n = 32	Greece	Contandriopoulos & Quezel, 1974
	[var. <i>megaspilaea</i> (Boiss. et Heldr.) Schindler]	2n = 48	Greece	Contandriopoulos & Quezel, 1974
8	<i>P. ehlersiae</i> Speta & Fuchs	2n = 32	Mexico	Speta & Fuchs, 1982
9	<i>P. esseriana</i> B. Kirchner	2n = 32	Mexico	Speta & Fuchs, 1982
10	<i>P. grandiflora</i> Lam. subsp. <i>grandiflora</i>	2n = 32	France	Doulat, 1947
				Contandriopoulos, 1962
				Casper, 1963a
			Spain	Zamora <i>et al.</i> , 1996
	[<i>P. reuteri</i> Genty]	2n = 32		Contandriopoulos, 1962
		2n = 64	USA	Wood & Godfrey, 1957
	subsp. <i>rosea</i> (Mutel) Casper	2n = 32		Contandriopoulos, 1962
11	<i>P. gypsicola</i> T. S. Brandege	2n = 22		Casper, 1963a
				Kondo, 1969
12	<i>P. ionantha</i> R. K. Godfrey	2n = 22	USA	Godfrey & Stripling, 1961
				Casper, 1963a
13	<i>P. leptoceras</i> Reichb.	2n = 32		Contandriopoulos, 1962
			Austria	Casper, 1962
14	<i>P. longifolia</i> Ram. ex subsp. <i>longifolia</i> DC.	2n = 32	France	Doulat, 1947
				Casper, 1962
				Casper, 1963a
			Spain	Zamora <i>et al.</i> , 1996
	subsp. <i>deriosensis</i> (Cañiguera) Schlauer ¹	2n = 48	Spain	Zamora <i>et al.</i> , 1996
	subsp. <i>reichenbachiana</i> (Schindler) Casper	2n = 32	France	Casper, 1962
	[<i>P. florii</i> Tammara et Pace]		Italy	Tammara & Pace, 1987
15	<i>P. lusitanica</i> L.	2n = 12	France	Contandriopoulos, 1962
				Casper, 1963a
				Kondo, 1969
			France	Schotsman, 1970
			British Islands	Hollingsworth <i>et al.</i> , 1992
16	<i>P. lutea</i> Walt.	2n = 32	USA	Godfrey & Stripling, 1961
				Casper, 1963a
				Kondo, 1969
17	<i>P. macroceras</i> Link ² subsp. <i>macroceras</i>	2n = 64	Japan	Uchiyama, 1990
18	<i>P. moranensis</i> H. B. et K. [P. <i>caudata</i> Schlecht.]	2n = 22		Kondo, 1969
		2n = 44		Casper, 1963a
19	<i>P. mundi</i> G. Blanca, M. Jamilena, M. Ruiz-Rejón & R. Zamora	2n = 48	Spain	Zamora <i>et al.</i> , 1996
20	<i>P. nevadensis</i> (Lindbg.) Casper	2n = 16	Spain	Zamora <i>et al.</i> , 1996

Table 1 (continued)

21	<i>P. planifolia</i> Chapm.	$2n = 32$	USA	Godfrey & Stripling, 1961 Casper, 1963a USA Kondo, 1973
22	<i>P. primuliflora</i> C. E. Wood et Godfrey	$2n = 32$	USA	Godfrey & Stripling, 1961 Casper, 1963a
23	<i>P. pumila</i> Michx.	$2n = 22$	USA	Godfrey & Stripling, 1961 Casper, 1963a
24	<i>P. ramosa</i> Miyoshi ex Yatabe	$2n = 18$	Japan	Yoshimura, 1973
25	<i>P. sharpii</i> Casper et K. Kondo	$2n = 16$	Mexico	Casper & Kondo, 1977
26	<i>P. vallisneriifolia</i> Webb ²	$2n = 32$	Spain	Löve & Kjellqvist, 1974 Spain Zamora <i>et al.</i> , 1996
27	<i>P. variegata</i> Turcz.	$2n = 64$	Russia	Zhukova & Tikhonova, 1971
28	<i>P. villosa</i> L.	$2n = 16$	Norway	Knaben, 1950
			USA	Wood & Godfrey, 1957
		$2n = 16$		Casper, 1963a
			Russia	Zhukova, 1967
			Russia	Sokolovskaya, 1968
			Canada	Löve & Löve, 1982
29	<i>P. vulgaris</i> L.	[<i>P. bohemica</i> Krajina] [<i>P. bohemica</i> Krajina]	$2n=32$	Czech Republic Czech Republic
				Studnicka, 1989 Studnicka, 1992
		$2n = 50$		Rosenberg, 1909 Tischler, 1934
		$2n = 64$	Scandinavia	Löve & Löve, 1944
			France	Doulat, 1947
			Iceland	Löve & Löve, 1948 Zurzycki, 1953
			Iceland	Löve & Löve, 1956
			USA	Wood & Godfrey, 1957
			Greenland	Jørgensen <i>et al.</i> , 1958
			Poland	Skalinska <i>et al.</i> , 1959 Sokolovskaja & Strelkova, 1960 Casper, 1962
			Austria	Casper, 1963a Lövkist, 1963
			Denmark	Larsen, 1965 Casper, 1966
			Finland	Laane, 1967 Fedorov, 1969
			Norway	Laane, 1969
			Russia	Sokolovskaya, 1972

Table 1 (continued)

	Canada	Löve & Löve, 1982 Krahulcovà & Jarolimová, 1991 Krahulcovà & Jarolimová, 1991 Zurzycki, 1953
[<i>P. bohemica</i> Krajina] [<i>P. bicolor</i> (Nordst. ex Fries) Woloszczàk]		
30 <i>P. zecheri</i> Speta & Fuchs	2n = 22	Mexico Speta & Fuchs, 1982
Notes:		
¹ Published under the name <i>Pinguicula submediterranea</i> G.Blanca, M.Jamìlena, M.Ruiz-Rejón & R.Zamora, see Blanca (2001).		
² Steiger (1974) published 2n = 16 for <i>P. vallisneriifolia</i> and 2n = 32 for <i>P. macroceras</i> subsp. <i>nortensis</i> J. Steiger ex J. Steiger & H. Rondeau. These chromosome counts proved to be wrong due to misinterpretation of the chromosome shapes. In reality, <i>P. vallisneriifolia</i> has 2n = 32 and <i>P. macroceras</i> subsp. <i>nortensis</i> 2n = 64 (Steiger J., pers. comm.).		

Table 2: Ploidy levels in *Pinguicula* L.

diploids × = 6	diploids × = 8	diploids × = 9	diploids × = 11	uncertain categorization
<i>P. lusitanica</i>	<i>P. corsica</i>	<i>P. ramosa</i>	<i>P. colimensis</i>	<i>P. balcanica</i>
	<i>P. crenatiloba</i>		<i>P. gypsicola</i>	
	<i>P. nevadensis</i>		<i>P. ionantha</i>	
	<i>P. sharpii</i>		<i>P. pumila</i>	
	<u><i>P. villosa</i></u>		<u><i>P. zecheri</i></u>	
	tetraploids (4×)		euploid series	
	<i>P. alpina</i>		<i>P. moranensis</i>	
	<i>P. caerulea</i>			
	<i>P. ehlersiae</i>			
	<i>P. esseriana</i>			
	<i>P. grandiflora</i> subsp. <i>rosea</i>			
	<i>P. leptoceras</i>			
	<i>P. longifolia</i> subsp. <i>longifolia</i>			
	<i>P. longifolia</i> subsp. <i>reichenbachiana</i>			
	<i>P. lutea</i>			
	<i>P. macroceras</i> subsp. <i>nortensis</i>			
	<i>P. macroceras</i> subsp. <i>macroceras</i>			
	<i>P. planifolia</i>			
	<i>P. primuliflora</i>			
	<u><i>P. vallisneriifolia</i></u>			
	hexaploids (6×)			
	<i>P. longifolia</i> subsp. <i>dertosensis</i>			
	<u><i>P. mundi</i></u>			
	octoploids (8×)			
	<u><i>P. variegata</i></u>			
	euploid series			
	<i>P. crystallina</i>			
	<i>P. grandiflora</i> subsp. <i>grandiflora</i>			
	<i>P. vulgaris</i>			

Ploidy level in the species considered

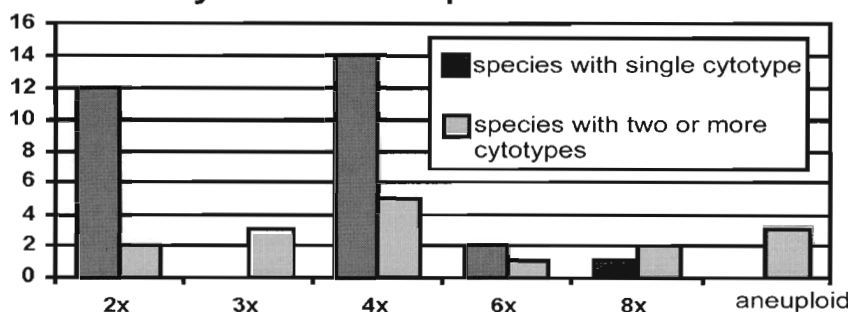


Figure 1: Number of species for every ploidy level, subdivided in species having single cytotypes and species having two or more cytotypes.

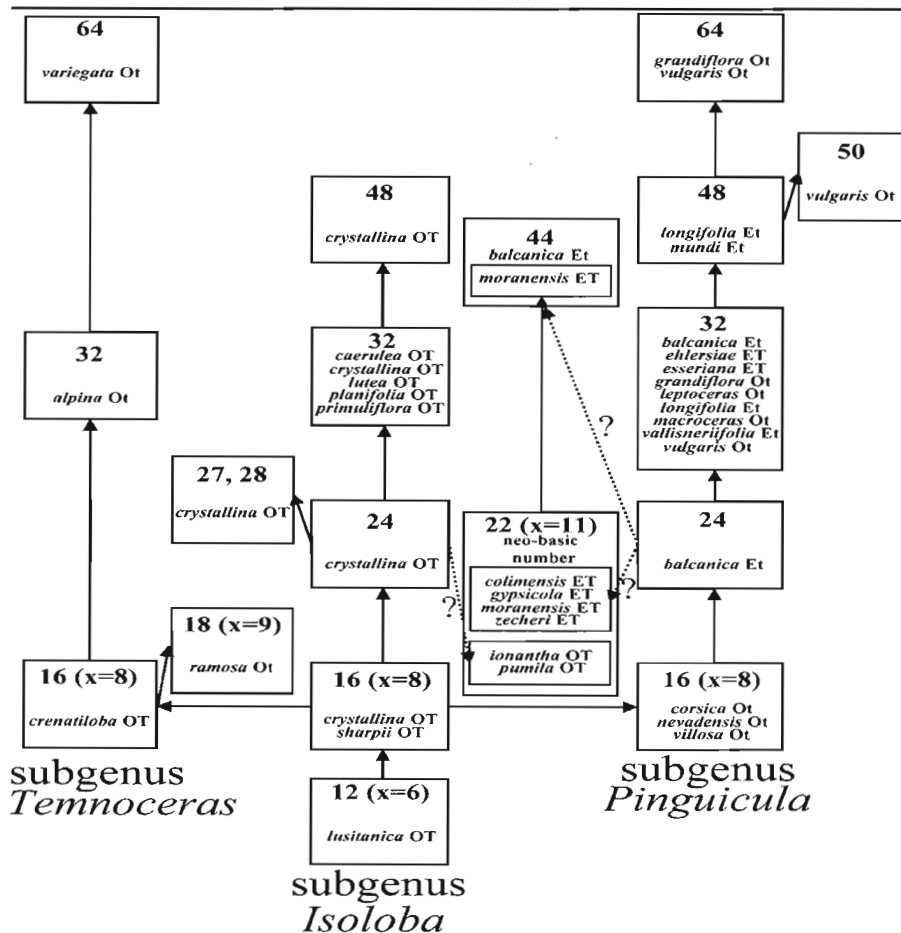


Figure 2: Karyological relationships of the studied taxa of *Pinguicula*. All the known chromosome numbers are organized in a tree subdivided by subgenera. Only specific epithets are cited. OT = homophyllous with tropical growth-type; Ot = homophyllous with temperate growth-type; ET = heterophyllous with tropical growth-type; Et = heterophyllous with temperate growth-type. Extra-karyological information follows Legendre (2000).

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