Neth. J. agric. Sci. 19 (1971) 176—183

Chromosome numbers in Begonia 2*

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Received: 7 May 1971

Summary

The somatic chromosome numbers of 90 species of *Begonia* were established. The following numbers were found: 16, 22, 26, 28, 30, 32, 34, 36, 38, 44, 48, 52, 56, 60, 64 and 76. *B. gigantea* Wall. (2n = 16) has the lowest chromosome number reported so far in *Begonia*. The conclusion of a previous paper that 22, 28 and 56 are the most common numbers within the genus was confirmed, but it was found that there is also a considerable number of species with 2n = 38.

Introduction

At the conclusion of a previous publication (Legro and Doorenbos, 1969) in which the chromosome numbers of 100 species of *Begonia* were given, the prospect was held out that shortly the chromosome numbers of another 100 species would be made known. The present article only partly fulfils this promise. In many species, the cytological observations presented more difficulties than expected. Other plants have not yet been identified with certainty. As a result, only ninety chromosome counts, not all of them conclusive, can be added to those of our previous paper.

In the course of the present study, a few imperfections of the first paper have come to light, viz a few cases of incorrect nomenclature and one case of an incorrect chromosome number. The species concerned have been listed again and are mentioned separately in the discussion.

Material and methods

Much of the plant material came from the sources mentioned in the first paper. An important contribution, mainly of Mexican species, was made by R. Ziesenhenne of Santa Barbara, California. Mrs. J. Neal of Worthing, Surrey, England, sent us several species, such as *B. prismatocarpa*, *B. venusta* and *B. pavonina*, the latter two collected in the Cameron mountains in Malaya. J. J. Bos gave us a number of species collected in the Cameroons, such as *B. elatostemmoides*, *B. mannii* and *B. quadrialata*, and in Natal, such as *B. princeae*. *B. ficicola* was brought by M. C. G. Middelburg from the type locality (Ekumbe) in the Cameroons. *B. keniensis* was collected by J. J. F. E. de

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Wilde in Ethiopia. J. F. M. Zieck sent us several species from New Guinea, such as *B. physandra.*

Correct identification is a perennial problem in this genus, of which no modern monograph exists. The species have been compared with all available descriptions, but not with type material. Of the plants studied, voucher specimens have been deposited in WAG, the Herbarium of the Department of Plant Taxonomy of the Agricultural University at Wageningen.

Some authors have used a wider species concept than is used in the present study. Smith and Schubert in particular consider several of the specific names used here to be synonymous with others. In many cases the present authors agree with them, but nevertheless it seemed advisable to use a narrow species concept in this study, as cytological differences between morphologically related plants might well have come to light.

The chromosomes were studied in squash preparations of root tips according to the methods described in the previous paper.

Results

The results are presented in Table 1, which is set up in the same way as Table 1 of the previous article. Species marked with an asterisk have been mentioned already in the

Table 1. Survey of somatic chromosome numbers in *Begonia* species in comparison with numbers mentioned by previous authors.

		Literature data		
	2n	2n	authors [1]	year
African species				
Squamibegonia				
B. haulevilleana De Wild.	38			
Augustia				
B. caffra Meissn.	26			
B. princeae Gilg	26			
B. suffruticosa Meissn.	26			
Scutobegonia				
B. ficicola Irmsch.	34++++			
B. elatostemmiodes Hook. f.	(38)			
Loasibegonia				
B. prismatocarpa Hook. f.	32			
Tetraphila (Fusibegonia)				
B. mannii Hook. f.	38			
B. polygonoides Hook. f.	36++			
*B. spraguei C. M. Weber (B. parva Sprague)	36++			
Rostrobegonia				
B. johnstonii Oliv.	26			
B. keniensis Gilg	(38)			
Asiatic species				
Haagea				
B. dipetala Grah.	30	ca. 28	Heitz	1927
Reichenheimia				
B. floccifera Bedd.	28++++ or 32	30	S. & B.	1957
B. rajah Ridl.	30++			

Table 1 (Continued)

	2n	Literature data 2n	authors [1]	year
Spenanthera				
B. roxburghii A.DC.	22			
Monopteron				
B. gigantea Wall.	16	28, 32, 34, 40, 42	S. & B.	1961
B. griffithiana (A.DC.) Warb.	22			
Platycentrum				
B. pavonina Ridl.	22			
B. tenuifolia Dryand.	22			
B. venusta Ridl.	44			
B. versicolor Irmsch.	22			
Diploclinium				
B. subnummularifolia Mer.	(32)			
Parvibegonia				
B. crenata Dryand.	56			
Petermannia				
B. brevirimosa Irmsch.	44			
B. sp. New Guinea	30			
Knesebeckia				
B. cyclophylla Hook. f.	22			
Section unknown				
B. physandra Merr. & Perry	28			
American species				
Doratometra				
B. franconis Liebm.	26			
Scheidweileria				
B. luxurians Scheidw.	56			
Steineria				
B. hookeriana Gard.	(56)			
B. oxyphylla A.DC.	(56)			
Pritzelia				
B. crispula Brade	(38)			
B. epipsila Brade	(56)			
B. hispida Schott var. cucullifera Irmsch.	56			
B. hugelii A.DC.	56			
B. itaguassiensis Brade	38++			
B. listida hort.	(76)			
B. olsoniae Sm. & Schub. (vellozoana Brade)	56			
B. paleata A.DC.	(38)			
B. paranaensis Brade	(56)			
B. princeps (Kl.) A.DC.	(48)	48	Piton	1962
B. pulchella Raddi	(56)			
B. sarmentacea hort.	(38)			
B. scabrida A.DC.	48			
B. scharffiana Regel	(56)			
B. tomentosa Schott	(56)			
B. valida Goebel	(38)	36, 38	Heitz	1927
B. vitifolia Schott (acerfolia hort. non HBK)	38			
B. vitifolia Schott (reniformis Hook. f. non Dry.)	38	36	Hamel	1937
Solananthera				
B. solananthera A.DC.	56			
Weilbachia				
B. purpusii Zies.	28			

Table 1 (Continued)

		Literature data		
	2n	2n	authors [1]	year
B. pustulata Liebm.	38			
Huszia				
*B. micranthera Griseb.				
var. hieronymii (Lind.) Sm. & Schub.	28			
var. fimbriata hort.	27			
var. foliosa Sm. & Schub.	28			
var. venturia hort.	27			
Giroudia				
B. barkeri Knowles & Westc.	28			
B. chivatoa Zies.	28			
B. cobana C.DC.	28			
B. daedalea Lemoine	28			
B. kortsae Zies.	28			
B. hypolipara Sandw.	28			
B. lindleyana Walp.	28			
B. megaphylla A.DC.	28			
B. plebeja Liebm.	28			
B. pringlei S. Watson	28			
B. sericoneura Liebm.	28			
B. squamosa C.DC.	28			
B. squarrosa Liebm. (hepaticamaculata Zies.)	28			
B. villipetiola C.DC.	28			
Latistigma				
B. aconitifolia A.DC.	60			
B. platanifolia Schott	60			
Begoniastrum				
B. crinita Oliv.	(34)			
B. cucullata Willd.	(64)	56	Bowden	1945
B. cucullata var. hookeri (A.DC.) Sm. & Schub.	34			
B. fischeri Schrank var. tovarensis Irmsch.	34			
B. hirtella Willd.	34	36	Piton	1962
B. leptotricha C.DC.	34			
B. leptotricha 'Woolly-bear'	34			
B. mollicaulis Irmsch. (subvillosa hort. non Klotzsch)	34			
B. parvifolia Schott	32			
B. porteriana Fisch.	60			
B. rotundifolia Lam.	52			
B. semperflorens Link & Otto	(34)	34	Zeilinga	1962
Knesebeckia				
B. bulbillifera Link & Otto	28			
B. biserrata Lindl. (palmaris A.DC.)	28			
B. cavum Zies.	28			
*B. ignea Warsz. (palmaris hort. non A.DC.)	56			
B. kellermannii C.DC.	28++++			
B. martiana Link & Otto	56			
B. uniflora S. Watson (taylori hort.)	28			
B. viscida Zies.	28			
B. wollnyi Herzog	28			
Tetrachia				
B. egregia N. E. Br.	(52)			

[1] S. & B. = Sharma and Bhattacharyya, 1961.

latter, but are repeated here because it appeared necessary to reconsider nomenclature or chromosome number.

Some results have been included here that are not yet fully conclusive. These tentative chromosome counts appear in the Table between brackets. The authors are fairly certain that they are correct, but have not been able to find sufficient cells showing distinct metaphase chromosomes which could be counted without any doubt.

Discussion

To the 18 different chromosome numbers listed in our previous article, the present results add only four new ones: 16, 32, 64 and 76, the last two being tentative counts. The recurrence of the same numbers and the fact that some appear to be characteristic of certain sections lead to the emergence of a pattern; the cytology of this genus may not be so complicated after all.

The chromosome numbers of West African species studied so far lie between 32 and 38. The determination of the exact number is hampered by the occurrence of bits of chromatin smaller than regular chromosomes. If these are not fragments, as has been assumed here, but chromosomes, the prevalent chromosome number among West African species would appear to be 38, at least within the large sections Scutobegonia and Tetraphila. The dainty *B. prismatocarpa,* however, which belongs to Loasibegonia, has 32 chromosomes.

In East Africa the number 26 is prevalent among the sections Augustia and Rostrobegonia. So far, *B. keniensis* (2n = 38) is the only exception. As this is a typical representative of Rostrobegonia, it may be of triploid origin. It is to be regretted that none of the 20 *Begonia* species of Madagascar (sections Mezierea, Erminea, Quadrilobaria, etc.) was available for study.

Among the Asiatic species studied, *B. gigantea* is the most interesting from a cytological point of view. Not only does it have the smallest number of chromosomes of all 190 species studied, but it is also the only species in which the individual chromosomes of the genome can be recognized (Fig. 1). The count of 2n = 16 for this species leads to the speculation that the number of 2n = 22, found in the Asiatic sections Platycentrum and Sphenanthera, may have arisen from a cross between a species with 2n = 16 and one with 2n = 28. The fact that *B. griffithiana,* morphologically very similar to *B. gigantea* and belonging to the same section, has 22 chromosomes supports this theory. Sharma and Bhattacharyya (1961) counted between 28 and 42 chromosomes for *B. gigantea.* These counts are very tentative (one wonders why they were published at all) but nevertheless render it highly unlikely that these authors had the same material as used for the present study.

B. dipetala of the small section Haagea is often treated as a subspecies of *B. malabarica* Lam. Irmscher (1961) however, considers it a species in its own right, and the present chromosome counts support this opinion. *B. venusta,* which has 3-5-fid placentae while those of the other species of Platycentrum are bifid, appears to be tetraploid in relation to these other species.

Knowledge of the large Asiatic sections Reichenheimia, Diploclinium and Petermannia remains scanty. Most species of Petermannia from New Guinea appear to have 44 chromosomes, but one unidentified species was found to have 30. Perhaps the species with 44 chromosomes arose from triploids of species with 30, rather than as tetraploids of species with 22 chromosomes.

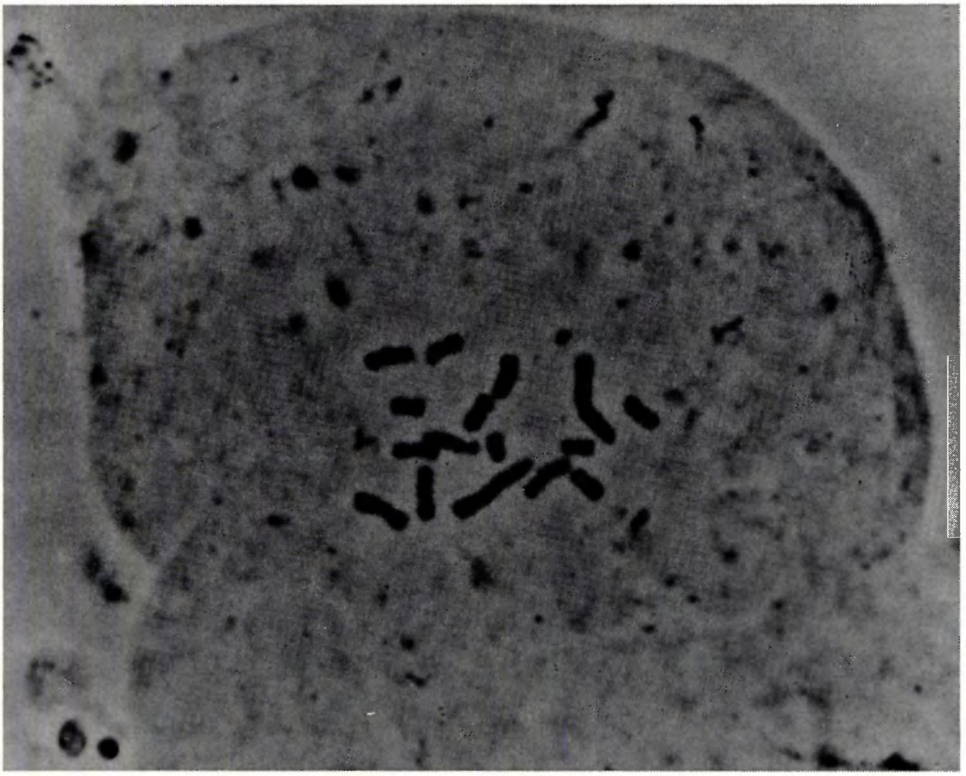

Fig. 1. Mitotic metaphase of *Begonia gigantea* Wall. Note the two very large chromosomes. Magnification × 3100.

The tuberous *B. physandra* has never been cultivated before. The ovaries (not described previously) were found to be two-celled. This probably makes it necessary to erect a new section for this species.

Among American sections, Pritzelia is one of the largest. Further study of the species of this section has confirmed that they can be divided into a group with 38 and a group with 56 chromosomes. So far, no correlation was found between these chromosome numbers and the morphological characteristics of the plants. The pretty *B. listida,* undoubtedly a true species but as far as we know not properly described yet, appears to have 76 chromosomes. This means it is tetraploid in relation to those species of Pritzelia which have 38.

B. princeps (2n = 48) may have originated as a hybrid between a species with 38 and one with 56 chromosomes. A plant grown as *B. scabrida* A.DC. in botanic gardens, and in fairly good agreement with A. de Candolle's description (although not all placentae are entire, as they should be), was also found to have 48 chromosomes.

B. vitifolia stands badly in need of taxonomic study. This species as interpreted by De Candolle, is grown in collections under the erroneous name *B. acerifolia* (non HBK). Although even Irmscher maintains that *B. reniformis* Hook. (non Dryander) is synonymous with *B. vitifolia,* it is a different species. *B. valida,* on the other hand, appears

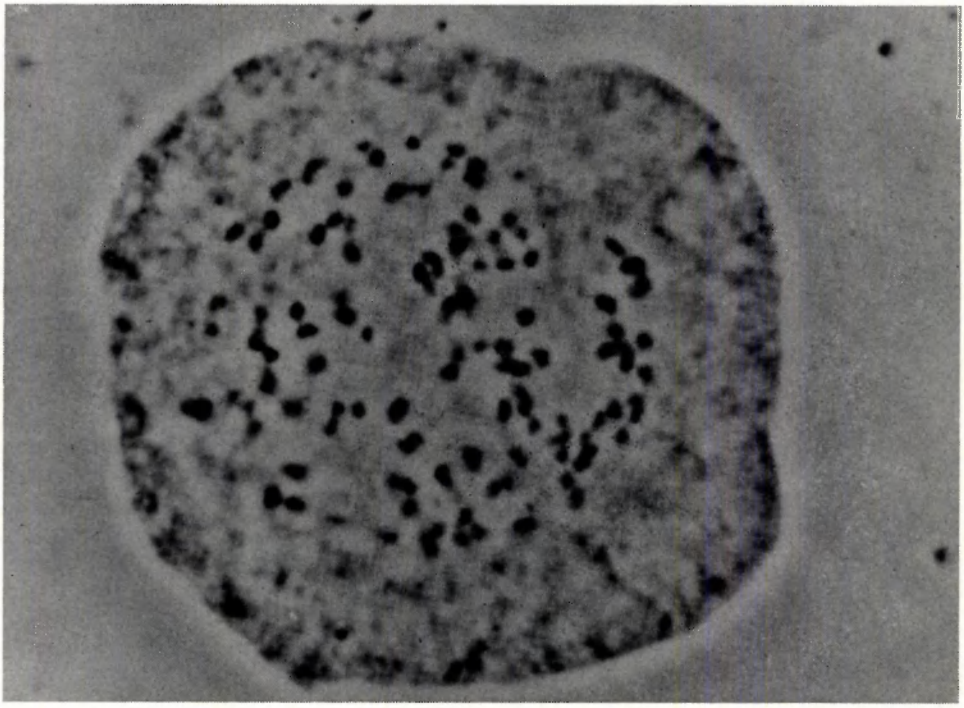

Fig. 2. Mitotic early metaphase of *Begonia plumieri* A. DC., demonstrating the difficulties (small, very numerous chromosomes in a granular protoplasm) which have made it impossible to arrive at a conclusive chromosome count for this species. Magnification × 3000.

to be closely related to *B. vitifolia* (sensu A.DC.). It is, however, beyond the scope of this article to solve these taxonomic puzzles.

The section Giroudia appears to be very homogeneous cytologically. The chromosomes of these species are relatively easy to count, with the exception of those of *B. pringlei*. In this species, one has to find exactly the right stage of the metaphase. Otherwise, one gets the impression that there are more than 28, possibly because of strong constrictions of the chromosomes. Within the related section Weilbachia, *B. pustulata* (2n = 38) is a notable exception among species with 28 chromosomes.

B. micranthera var. *hieronymii* is the same plant as *B. micranthera* of the previous publication. It is a dioecious plant with large pink flowers, and of much interest for hybridizing purposes. The var. *foliosa* is also dioecious, but the small white flowers have no ornamental value. From the USA we received two monoecious forms with showy, orange flowers, which are grown under the names *B. micranthera* var. *fimbriata* and *B. micranthera* var. *venturia*. Neither confirms to the original description of these varieties. Both were found to have 27 chromosomes. We regard the 'var. *fimbriata*' as a hybrid between *B. cinnabarina* (2n = 26) and, presumably, a form of *B. micranthera* with 2n = 28, and the 'var. *venturia*' as a similar hybrid, although its parentage is less clear.

Further study of Begoniastrum has shown that 34 is a common chromosome number in this section. The material of *B. leptotricha* was imported from two sources in Brazil as an unidentified species. The Begonia known among growers in the USA as 'Woolly-bear' differs from these imports in a more compact habit, broader, larger leaves and a denser fulvous tomentum.

B. cucullata was imported as an unidentified species from Venezuela. It has a stiff, erect and succulent stem, persistent foliaceous denticulate stipules and acute seeds. It agrees in all respects with the old picture of Loddiges' *B. spathulata,* reproduced by Smith and Schubert (1941, p. 102). It appears to be tetraploid, although 64 chromosomes were counted rather than the expected 68 (the number 56, given in the previous paper, was an administrative error). The plant called here *B. cucullata* var. *hookeri* has a much more spreading habit, stipules that are less broad and less persistent, and blunt seed. This may be the wild ancestor of *B. semperflorens,* although in the material studied there were several differences between the two.

There are still about 30 species in the collection of which the chromosome numbers could not yet be established with a reasonable degree of certainty. The reasons for this are threefold. In some species, the number of metaphase plates found is too small to permit definitive conclusions. Examples of such species are *B. dietrichiana* Irmsch., *B. fernandoi-costae* Irmsch., *B. obscura* Brade, *B. inciso-serrata* A.DC., *B. venosa* Skan and many others. Other species do yield sufficient metaphase plates, but the attainment of conclusive results is rendered very difficult because the chromosomes are very small, and the protoplasm is full of other granules, which are hard to distinguish from true chromosomes. This group includes species as *B. quadrialata* Warb., *B. angularis* Raddi and *B. lindeniana* A.DC. A third group comprises such species in which the sheer number of the very small chromosomes (well over 100) makes counting an almost impossible task. Examples of this (often complicated by granular protoplasm) are *B. convallariodora* C.DC., *B. serratifolia* C.DC. and *B. plumieri* A.DC. (Fig. 2). Presumably, these species have to be studied by more sophisticated methods than the ones used in the present study.

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