Chromosomal Evolution of Bromeliaceae

Moema Cortizo Bellintani2,*, J. G. de A. Assis1 and A. L. P. Cotias de Oliveira1

1 Instituto de Biologia, Universidade Federal da Bahia, Campus Universitario de Ondina. s/n, 40170-290, Salvador, Bahia, Brazil
2 PIBIC-CNPq

Received October 12, 2004; accepted October 30, 2004

Summary This paper presents the chromosomal number of 18 species of Bromeliaceae occurring in Brazil, which belong to the Neoregelia, Cryptanthus, Canistropsis, Canistrium, Hohenbergia, Orthophytum and Witrockia genera. The results display the $2n=50$ diploid number for the majority of the species, $2n=34$ for the Cryptanthus species and $2n=100$ for Orthophytum amoenum. B chromosomes were observed in Hohenbergia pennae. This is the first register for 14 species and the new counting for Neoregelia carolinae, Neoregelia cruenta, Canistropsis microps and Cryptanthus beuckeri. The chromosomal counting in this work agree with the basic number $x=25$ for the majority of the species and $x=17$ for the Cryptanthus ones.

Key words Bromeliaceae, chromosome number.

Bromeliaceae, with about 3000 species, is the largest essentially American plant family, distributing from the south of the United States as far as Chile. The only exception is Pitcairnia feliciana (A Chev.) Harms J. Milbraed, found in Guinea Gulf, Africa. The family’s biogeographical data suggest that the first species must have originated and begun their diversification at a period near to the continent separation, 200 million years ago, when the Atlantic Ocean was originated (Leme and Marigo 1993). There are 3 great species development and dispersion centers: the Andes, the Guyana plateau and Brazil’s Eastern Region.

In Brazil, almost half of the known species is found, especially on the coast region, at Mata Atlantica and Restinga areas, but they can also be seen in the Amazon region, at Caatinga and Cerrado areas, as well as on highly located fields. The long geological stability period which took place in that region where the Brazilian territory is included, provided for the survival and development of the groups which nowadays occur as the endemic genera, such as Canistrium, Cryptanthus, Encolirium, Nidularium, Orthophytum, Quesnelia and Wittrockia (Leme and Marigo 1993, Leme 1998).


Chromosomal analyses in Bromeliaceae started in 1904, while Billings (1904) analyzed Tillandsia usneoides, and became most expressive, from 1933 onwards, with Lindschau’s analysis in 50 species of different genera (Lindschau 1933). Later on, the chromosome countings for a few species were carried out by Sharma and Ghosh (1971), McWilliams (1974), Varadarajan and Brown

* Correspondence author, e-mail: ancotias@ufba.br

The variations found in these counting led to a proposal of the diversity for the family’s basic number. Lindschau (1933) proposed $x=9$ as the basic number for the family; Weiss (1965) considered $x=8$ for the Tillandsioideae, with different ploidy levels; Marchant (1967) considered that, save Cryptanthus ($n=17$), Bromeliaceae presents a homogeneous $x=25$ number; Sharma and Ghosh (1971) recognized the $x=9$ or $x=25$ numbers for Bromelioidae, $x=25$ for Pitcairnioideae and $x=8$ or $x=16$ for Tillandsioideae. McWilliams (1974) suggested that the chromosome number in Bromeliaceae is derived from $x=8$, while Raven (1975), proposed $x=17$ or $x=25$ for the family and Goldblatt (1980) considered $x=25$ with some exceptions (cf. Brown and Gilmartin 1986). A model for the basic number $x=25$ origin, involving hybridizations and polyploidy was presented by Brown and Gilmartin (1989). From this original basic number, there the one $x=17$ was derived, as observed in Cryptanthus.

The present paper includes the study of 18 species obtained in Brazil, which belong to the Neoregelia, Cryptanthus, Canistropsis, Canistrum, Hohenbergia, Orthophytum and Wittrockia genera from the subfamily of Bromelioidae, aiming to determine the chromosome number, characterizing the possible basic number and structural modifications in the karyotype and inferring about possible chromosome evolution mechanisms, which must have played an important role in family diversification.

Material and methods

The materials in the present study were collected in the natural habitats (Table 1). The plants were kept in xaxim to encourage rooting. Root tips were pretreated with 0.002 M 8-hydroxyquinoline at 18°C for 4 h and fixed in Carnoy 3 : 1 for overnight, transferred to 70% alcohol and stored in the refrigerator until used. They were then hydrolyzed in 1 N HCl for 8 min at 60°C and stained following the Feulgen method (Sharma and Sharma 1980). Squash preparations were made in a 1% acetic-carmine solution. The slides were mounted in Entellan. Chromosome counts were made in 5–20 metaphases of 1–4 plants of each species. Chromosome size were estimated from the metaphases using a micrometric scale of the same enlargement.

Results and discussion

The analyzed Bromeliaceae species presented the $2n=50$, 100 and 34 diploid number (Table 1). From the 18 species studied, 14 had their chromosome number determined for the first time. The countings for Neoregelia carolinae and N. cruenta, with $2n=50$, disagree from $2n=54$, registered by Lindschau (1933), while $2n=50$ for Hohenbergia penneae (Fig. 1a) confirms the previous register by Brown and Gilmartin (1997). In this species we observed also 2 supernumerary chromosomes, as registered for Hohenbergia utriculosa (Cotias de Oliveira et al. 2000).

Figure 1 shows the mitotic metaphases of the analyzed species. The chromosomes presented some uniformity in the same karyotype, but varied in size among different species. The 4 Cryptanthus species presented the largest chromosomes (Fig. 1f, h), with an average 1.07 μm long. On the other hand, Neoregelia carolinae and Wittrockia spiralipetala displayed the smallest chromosomes (Fig. 1b), their size varying from 0.54 to 0.71 μm.

Orhtophytum amoenum ($2n=100$) (Fig. 1d) was the only polyploid species, analyzed in this
Table 1. Localities of collection and chromosome number of species of the Bromeliaceae

<table>
<thead>
<tr>
<th>Species</th>
<th>Provenance</th>
<th>2n</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Neoregelia leucophoea</em> (Baker) L. B. Smith</td>
<td>Petrópolis-RJ** (Leme 1107)</td>
<td>50</td>
</tr>
<tr>
<td><em>Neoregelia longisepala</em> Pereira and Penna</td>
<td>Una-BA (Leme 3049)</td>
<td>50</td>
</tr>
<tr>
<td>Neoregelia cruenta (R. Graham) L. B. Smith</td>
<td>Macaé-RJ</td>
<td>50</td>
</tr>
<tr>
<td>Neoregelia carolinae (Beer) L. B. Smith</td>
<td>Cachoeira de Macacu–RJ</td>
<td>50</td>
</tr>
<tr>
<td><em>Neoregelia bahiana</em> (Ule) L. B. Smith</td>
<td>Andarai-BA (Leme 502)</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Mucugê-BA</td>
<td>50</td>
</tr>
<tr>
<td><em>Canistropsis simulans</em> (Pereira and Leme) Leme</td>
<td>Parati-RJ (Leme 1060)</td>
<td>50</td>
</tr>
<tr>
<td><em>Canistropsis seidelii</em> (L. B. Sm. and Reitz) Leme</td>
<td>Rio de Janeiro–RJ (Leme 698)</td>
<td>50</td>
</tr>
<tr>
<td><em>Canistropsis microps</em> (E. Morren ex Mez) Leme</td>
<td>Cachoeira de Macacu–RJ (Leme 4087)</td>
<td>50</td>
</tr>
<tr>
<td><em>Canistropsis bilbergioideae</em> (Schul.)</td>
<td>Rio de Janeiro–RJ (Leme 171)</td>
<td>50</td>
</tr>
<tr>
<td><em>Orthophytum amoenum</em> (Ule) L. B. Smith</td>
<td>Mucugê-BA</td>
<td>100</td>
</tr>
<tr>
<td><em>Canistrum fosterianum</em> L. B. Smith</td>
<td>Guaibim–BA (Leme 3289)</td>
<td>50</td>
</tr>
<tr>
<td><em>Wittrockia spiralispetala</em> Leme</td>
<td>Parati–RJ (Leme 1071)</td>
<td>50</td>
</tr>
<tr>
<td>Hohenbergia pennae Pereira</td>
<td>Mucugê-BA</td>
<td>50</td>
</tr>
<tr>
<td><em>Hohenbergia castelanosi</em> L. B. Smith and Read</td>
<td>Mata de Sao Joao–BA</td>
<td>50</td>
</tr>
<tr>
<td><em>Hohenbergia correia-araujoi</em> Pereira e Moutinho</td>
<td>Gandu–BA</td>
<td>50</td>
</tr>
<tr>
<td><em>Cryptanthus lyman-smith</em> Leme</td>
<td>Jaguaripe–BA</td>
<td>34</td>
</tr>
<tr>
<td>Cryptanthus beuckeri E. Morren</td>
<td>Jaguaripe–BA</td>
<td>34</td>
</tr>
<tr>
<td><em>Cryptanthus vexatus</em> Leme</td>
<td>Jaguaripe–BA</td>
<td>34</td>
</tr>
</tbody>
</table>

* First chromosome number reported for the species.
** The abbreviations of the localities correspond to Brazilian states: RJ, Rio de Janeiro; BA, Bahia.

Fig. 1. Mitotic chromosomes of some species of Bromeliaceae. a. Hohenbergia pennae (2n=50), b. Neoregelia longisepala (2n=50), c. Hohenbergia correia-araujoi (2n=50), d. Orthophytum amoenum (2n=100), e. Canistropsis seidelii (2n=50), f. Cryptanthus vexatus (2n=34), g. Canistrum fosterianum (2n=50), h. Cryptanthus beuckeri (2n=34). Bar: 5 μm.
work. The first references of cytological studies in the genus showed variations on the ploidy level for *O. burle-marxii*, 2n=100, *O. maracasense*, 2n=150 (Cotias de Oliveira *et al.* 2000) and *O. albopictum*, 2n=100 (Cotias de Oliveira *et al.* 2004). The polyploid occurrence in *Orthophytum* can be useful in taxonomic analyses. This is an endemic genus in Brazil, while the tetraploid *O. burle-marxii*, *O. albopictum* and *O. amoenum* species with 2n=100, have an even more restrictive distribution, occurring only in the Chapada Diamantina region of Bahia State. These species occur in the same habitat and are also morphologically very similar, belonging to the same subgroup (Smith and Downs 1983). The karyotype study reinforces the taxonomic proximity of the 3 species. On the other hand, *O. maracasense*, which belongs to another group, presents a bigger morphological divergence, as it is a 2n=150 hexaploid. The chromosomal numbers, found for these species reinforce the hypothesis of a basic x=25 number for the family (Marchant 1967).

The analyzed Cryptanthus species have 2n=34, agreeing with the chromosome number observed for other species of the genus (Marchant 1967). *C. beuckeri*, with 2n=34, confirms the previous register by Marchant (1967), but disagrees from 2n=54, observed by Lindschau (1933). According to Brown and Gilmartin (1989) the variation for 2n=34 found in *Cryptanthus* resulted from the decreasing aneuploidy of the basic x=25 number. The largest size of its chromosomes may reflect the displyoid effect, in which simple translocations resulted in genetic material transfer to the remaining chromosomes. If this hypotheses proves to be a correct one, aneuploidy have occurred in an ancestral stock, which had originated the entire genus. The particularity of the 2n=34 number can be a criterion to identify species in this genus. The continuity of the chromosome analyses will be able to result a large quantity of data, for a broad application in taxonomic studies.

Acknowledgments

The authors are very grateful to Elton Leme and Rogerio Marcos de Oliveira Alves, who have kindly supplied us with plants and Ervene Cerqueira Barreto for the technical support.

References


