

Gaganbawada, Bhuibawada Ghat, 619 m, 07 Oct 2007, *K.V.C. Gosavi* 2796 (SUK) [Fig. 12J].

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Methods are described in Grabile & al. (2010). RI, recombination index (Darlington, 1939); EC, excess chiasmata frequency (Burt & Bell, 1987). Abbreviation: PMC, pollen mother cells.

This contribution belongs to the series “Chromosome studies in Orchidaceae from Argentina, III”. For all taxa, these are the first reports on their gametic chromosome number and the meiotic behaviour, at the species (\*) or genus (\*\*) levels.

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#### ORCHIDACEAE

*Aspidogyne kuczynskii* (Porsh) Garay

\*\*  $n = 21$ , CHN (Fig. 13G). Argentina, Corrientes Province, Ituzaingó Department, Garapé, at the coast of Paraná river, in forest shade, 27°36' S, 56°22' W, 01 Oct 2002, *Almada 151* (MNES).

This terrestrial species occurs in Argentina, being restricted to the forests of Chaco, Corrientes, and Misiones Provinces, SE Brazil and Paraguay (Correa, 1996; Johnson, 2001). Only two chromosome counts were reported for this genus, by Daviña & al. (2009) who established  $2n = 42$  in this accession of *A. kuczynskii* and Grabile & al. (2004) who found the same number in *Aspidogyne* sp. from Misiones.

The meiotic behaviour of *A. kuczynskii* is regular. In PMC at diakinesis and metaphase I the chromosomes exclusively associate as 21 bivalents, mostly rings (90.0%) with distal chiasmata (90.1%) averaging 1.95 chiasmata per bivalent and 40.95 total chiasmata per cell. The RI and the EC values are high (61.95 and 19.95, respectively). This species is included in Appendix II of CITES.

*Brassavola tuberculata* Hook.

\*\*  $n = 20$ , CHN (Fig. 13M). Argentina, Misiones Province, Capital Department, Posadas, in forest, 50 m W of Zaimán stream and 2.3 km W of Paraná river, 27°24' S, 55°53' W, 13 Feb 2002, *Hojsgaard 228* (MNES); Argentina, Misiones Province, San Ignacio Department, San Ignacio, Teyú Cuaré, at the coast of Paraná river, in forest, 27°17' S, 55°35' W, 28 Oct 1993, *Seijo, Daviña & Rodríguez 706* (BAB, CTES, MNES).

This epiphytic taxon occurs in Argentina, in its northeast and central-east regions, NE Brazil, Bolivia and Paraguay (Correa, 1996; Johnson, 2001), constantly showing  $2n = 40$  (Afzelius, 1943; Blumenschein, 1960; Daviña & al., 2009).

The meiotic behaviour of *B. tuberculata* is regular. In PMC at diakinesis and metaphase I the chromosomes exclusively associate as 20 bivalents, mostly rings (85.0%) with distal chiasmata (89.7%) averaging 1.90 chiasmata per bivalent and 38.00 total chiasmata per cell. The RI and the EC values are high (58.00 and 18.00, respectively). This species is included in Appendix II of CITES.

*Campylocentrum neglectum* (Rchb. f. & Warm.) Cogn.

\*\*  $n = 19$ , CHN (Fig. 13L). Argentina, Chaco Province, San Fernando Department, in road between Resistencia and Colonia Benitez, in forest, 500 m W of Tragadero river, 27°20' S, 58°58' W, 10 Aug 2002, *Insaurralde 676* (MNES).

This epiphytic species occurs in NE Argentina, Brazil, Bolivia

and Paraguay (Correa, 1996) and only two chromosome counts were reported revealing  $2n = 38$ , in this accession of *C. neglectum* from Argentina (Daviña & al., 2009) and other from Paraguay (Dematteis & Daviña, 1999).

The meiotic behaviour of *C. neglectum* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 19 bivalents exclusively, mostly rings (84.2%) with distal chiasmata (91.4%) averaging 1.84 chiasmata per bivalent and 34.96 total chiasmata per cell. The RI and the EC values are high (53.96 and 15.96, respectively). This species is included in Appendix II of CITES.

*Capanemia micromera* Barb. Rodr.

\*\*  $n = 12$ , CHN (Fig. 13K). Argentina, Misiones Province, Capital Department, Garupá, in forest, 200 m W of Garupá stream, 27°27'S, 55°49'W, 03 Aug 2001, *Cerutti 13* (MNES); Argentina, Misiones Province, Capital Department, Posadas, in forest at the coast of Itaembé stream, 2 km SW of Paraná river, 27°21'S, 56°02'W, 28 Aug 1993, *Guillen, Dematteis & Seijo 232* (MNES); Argentina, Misiones Province, Capital Department, Garupá, in forest, 2 km W of Garupá stream, 27°28'S, 55°50'W, 07 Jul 2004, *Cerutti 70* (MNES).

This epiphytic taxon is present at NE Argentina, Brazil, Bolivia, and Paraguay (Tropicos.org, 2011), and its gametic number constitute the former chromosome count in *Capanemia* Barb. Rodr.

The meiotic behaviour of *C. micromera* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 12 bivalents exclusively, mostly rings (83.3%) with distal chiasmata (86.4%) averaging 1.83 chiasmata per bivalent and 21.96 total chiasmata per cell. The RI and the EC values are low (33.96 and 9.96, respectively). We propose  $x = 12$  as the basic chromosome number for the genus. This species is included in Appendix II of CITES.

*Cyclopogon calophyllus* (Barb. Rodr.) Barb. Rodr.

\*  $n = 14$ , CHN (Fig. 13D). Argentina, Misiones Province, Capital Department, Posadas, at the coast of Paraná river, in forest shade, 27°21'S, 56°00'W, 07 Jul 2004, *Cerutti 74* (MNES); Argentina, Corrientes Province, Ituzaingó Department, Garapé, at the coast of Paraná river, in forest shade, 27°36'S, 56°22'W, 10 Feb 2002, *Cerutti 28* (MNES).

This terrestrial species occurs in Argentina, restricted to Jujuy, Misiones and Corrientes Provinces, SE Brazil and Bolivia (Correa, 1996; Johnson, 2001; Insaurralde & Radins, 2007). In agreement with this record, Daviña & al. (2009) reported  $2n = 28$  for this accession of *C. calophyllus*.

The meiotic behaviour of *C. calophyllus* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 14 bivalents exclusively, mostly rings (78.6%) with distal chiasmata (88.4%) averaging 1.86 chiasmata per bivalent and 26.04 total chiasmata per cell. The RI and the EC values are low (40.04 and 12.04, respectively). Previous reports in other taxa of *Cyclopogon* Presl. found  $n = 14$  bivalents (*C. elatus* (Sw.) Schltr.: Martínez, 1981; Cerutti & al., 2004; *C. multiflorus* Schltr.: Felix & Guerra, 2005) or 16 bivalents (*C. congestus* (Vell.) Hoehne: Martínez, 1981). This species is included in Appendix II of CITES.

*Cyclopogon oliganthus* (Hoehne) Hoehne & Schltr.

\*  $n = 32$ , CHN (Fig. 13E). Argentina, Misiones Province, Apóstoles Department, Apóstoles, at the coast of Chimiray stream, in forest shade, 27°54'S, 55°49'W, 03 Aug 2004, *Hojsgaard, Cerutti & Grabielle 339* (MNES); Argentina, Misiones Province, Capital Department, Miguel Lanús, in forest shade, close to swamp of Zaimán stream, 27°26'S, 55°53'W, 03 Aug 2004, *Cerutti, Grabielle & Hojsgaard 71* (CTES, MNES).

This terrestrial orchid occurs in Argentina, limited to the forests of Salta, Corrientes, and Misiones Provinces, and Brazil (Correa, 1996; ww.tropicos.org, 2011). In accordance, Daviña & al. (2009) found  $2n = 64$  in this accession of *C. oliganthus*.

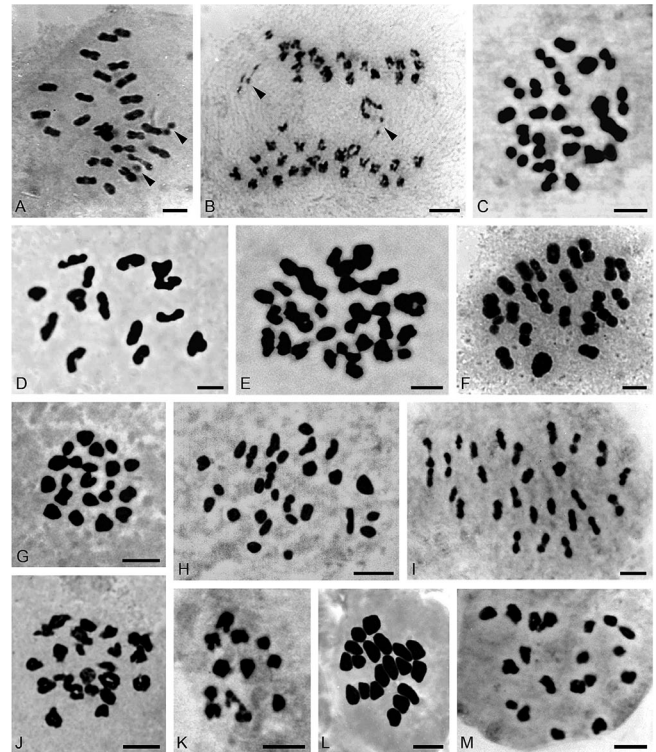
The meiotic behaviour of *C. oliganthus* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 32 bivalents exclusively, mostly rings (82.5%) with distal chiasmata (85.2%) averaging 1.91 chiasmata per bivalent and 61.12 total chiasmata per cell. The RI and the EC values are high (93.12 and 29.12, respectively). This species is included in Appendix II of CITES.

*Cyrtopodium hatschbachii* Pabst

\*  $n = 23$ , CHN (Fig. 13J). Argentina, Misiones Province, Capital Department, Miguel Lanús, in swamp of Zaimán stream, 27°26'S, 55°53'W, 26 Aug 2002, *Almada, Cerutti & Grabielle 153* (MNES), 23 Jan 1995, *Guillen, Dematteis & Insaurralde 406* (CTES, MNES), 09 Aug 2001, *Hojsgaard 185* (MNES), 24 Nov 1994, *Insaurralde, Cardozo, Honfi & Guillén 600* (CTES, MNES, SI), 02 Jul 1995, *Insaurralde, Galaverna & Guillén 626* (CTES, MNES).

This is a terrestrial orchid occurring in Argentina, Brazil, Bolivia, and Paraguay (Correa, 1996; Tropicos.org, 2011). In agreement with this record, Daviña & al. (2009) reported  $2n = 46$  for this accession of *C. hatschbachii*.

The meiotic behaviour of *C. hatschbachii* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 23 bivalents



**Fig. 13.** Pollen mother cells (PMCs) with meiotic chromosomes. **A**, *Sarcoglottis fasciculata*, metaphase I with 23II+3B; **B**, *S. fasciculata*, anaphase I with 23II+3B; while A chromosomes separate in homologues, the Bs separate in sister chromatids; **C**, *Mesadenella cuspidata*, metaphase I with 23 II; **D**, *Cyclopogon calophyllus*, metaphase I with 14 II; **E**, *C. oliganthus*, metaphase I with 32 II; **F**, *Pelexia bonariensis*, metaphase I with 23 II; **G**, *Aspidogyne kuczynskii*, metaphase I with 21 II; **H**, *Oeceoclades maculata*, metaphase I with 28 II; **I**, *Galeandra beyrichii*, metaphase I with 27 II; **J**, *Cyrtopodium hatschbachii*, metaphase I with 23 II; **K**, *Capanemia micromera*, metaphase I with 12 II; **L**, *Campylocentrum neglectum*, metaphase I with 19 II; **M**, *Brassavola tuberculata*, metaphase I with 20 II. Arrowheads in A and B point out B chromosomes. Scale bar = 5  $\mu$ m.

exclusively, mostly rings (78.2%) with distal chiasmata (88.4%) averaging 1.87 chiasmata per bivalent and 43.01 total chiasmata per cell. The RI and the EC values are high (66.01 and 20.01, respectively). Previous reports in other taxa of *Cyrtopodium* R. Br. found  $n = 22$  bivalents (*C. eugenii* Rchb. f.) and  $n = 23$  (*C. intermedium* Brade) (Felix & Guerra, 2000). This species is included in Appendix II of CITES.

*Galeandra beyrichii* Rchb. f.

\*\*  $n = 27$ , CHN (Fig. 13I). Argentina, Misiones Province, Capital Department, Garupá, in open wet forest, 2 km W of Garupá stream, 27°28'S, 55°50'W, 20 Jan 2003, *Insaurralde & Radins 705* (MNES).

This terrestrial orchid is widely distributed in America extending to the northern regions of Argentina, at Jujuy, Salta and Misiones Provinces (Correa, 1996; Insaurralde & Radins, 2007; Tropicos.org, 2011). In accordance with this record, Daviña & al. (2009) found  $2n = 54$  in this accession of *G. beyrichii*.

The meiotic behaviour of *G. beyrichii* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 27 bivalents exclusively, mostly rings (81.5%) with distal chiasmata (91.8%) averaging 1.81 chiasmata per bivalent and 48.87 total chiasmata per cell. The RI and the EC values are high (75.87 and 21.87, respectively). This species is included in Appendix II of CITES.

*Mesadenella cuspidata* (Lindl.) Garay

\*\*  $n = 23$ , CHN (Fig. 13C). Argentina, Misiones Province, Capital Department, Garupá, 2 km W of Garupá stream, in forest shade, 27°28'S, 55°50'W, 4 Jul 2004, *Hojsgaard, Grabile & Cerutti 349* (MNES); Argentina, Corrientes Province, Ituzingó Department, Garapé, at the coast of Paraná river, in forest shade, 27°36'S, 56°22'W, 20 May 2001, *Cerutti 68* (CTES, MNES), 25 Aug 1993, *Perez, Guillen, Insaurralde & Seijo 114B* (MNES).

This terrestrial species inhabits Argentina, at Misiones and Corrientes Provinces, Brazil and Paraguay (Correa, 1996; Johnson, 2001) with only  $2n = 46$  being reported (Martinez, 1985; Daviña & al., 2009; Grabile & al., 2011).

The meiotic behaviour of *M. cuspidata* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 23 bivalents exclusively, mostly rings (81.9%) with distal chiasmata (92.7%) averaging 1.87 chiasmata per bivalent and 43.01 total chiasmata per cell. The RI and the EC values are high (66.01 and 20.01, respectively). This species is included in Appendix II of CITES.

*Oeceoclades maculata* (Lindl.) Lindl.

\*\*  $n = 28$ , CHN (Fig. 13H). Argentina, Misiones Province, San Ignacio Department, San Ignacio, Teyú Cuaré, at the coast of Paraná river, in forest shade, 27°17'S, 55°35'W, 04 May 1995, *Dematteis & Daviña 486* (MNES); Argentina, Misiones Province, Capital Department, Posadas, in forest shade, 50 m W of Zaimán stream and 2.3 km W of Paraná river, 27°24'S, 55°53'W, 02 Nov 2006, *Daviña 613* (MNES).

This cosmopolitan terrestrial species represents *Oeceoclades* Lindl. in Argentina, living at the northern regions' forests (Correa, 1996; Johnson, 2001; Tropicos.org, 2011). In agreement with the present record, the Argentinean accessions of this taxon constantly display  $2n = 56$  (Dematteis & Daviña, 1999; Daviña & al., 2009) unlike that of Brazil ( $2n = 48$ , ca. 52, 54, 58; Guerra, 1986; Felix & Guerra, 2000).

The meiotic behaviour of *O. maculata* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 28 bivalents exclusively, mostly rings (84.2%) with distal chiasmata (84.3%) averaging 1.89 chiasmata per bivalent and 52.92 total chiasmata per cell. The RI and the EC values are high (80.92 and 24.92, respectively). This species is included in Appendix II of CITES.

*Pelexia bonariensis* (Lindl.) Schltr.

\*  $n = 23$ , CHN (Fig. 13F). Argentina, Misiones Province, Capital Department, Posadas, at the coast of Paraná river, in open field,

27°21'S, 56°00'W, 10 Jun 2002, *Cerutti 29* (MNES); Argentina, Misiones Province, Candelaria Department, Parque Provincial Cañadon de Profundidad, 2 km W of Garupá stream, in open field, 27°33'S, 55°42'W, 29 May 2003, *Hojsgaard 289* (CTES, MNES, SI).

This is a southern South American terrestrial orchid that extends as far as to the northern and central regions of Argentina (Correa, 1996), constantly showing  $2n = 46$  (Martinez, 1985; Dematteis & Daviña, 1999; Felix & Guerra, 2005; Daviña & al., 2009; Grabile & al., 2011).

The meiotic behaviour of *P. bonariensis* is regular. In PMC at diakinesis and metaphase I the chromosomes associate as 23 bivalents exclusively, mostly rings (86.3%) with distal chiasmata (90.5%) averaging 1.96 chiasmata per bivalent and 45.08 total chiasmata per cell. The RI and the EC values are high (68.08 and 22.08, respectively). A previous report in another taxon of *Pelexia* (Poi) Lindl. also revealed  $n = 23$  (*P. longifolia* (Cogn.) Hoehne: Felix & Guerra, 2005). This species is included in Appendix II of CITES.

*Sarcoglottis fasciculata* (Vell.) Schltr.

\*  $n = 23 + 3B$ , CHN (Fig. 13A–B). Argentina, Misiones Province, Capital Department, Posadas, at the coast of Paraná river, in forest shade, 27°21'S, 56°00'W, 10 Apr 2003, *Hojsgaard 291B* (CTES, MNES, SI).

This terrestrial species occurs in Argentina, being restricted to Misiones Province, Brazil, and Paraguay (Correa, 1996). The somatic number  $2n = 46$  is common for this species (Martinez, 1985; Felix & Guerra, 2005; Daviña & al., 2009; Grabile & al., 2011) but the presence of putative B chromosomes with mitotic instability is also recorded in this particular accession ( $2n = 46, 47, 49$ ; Daviña & al., 2009).

The meiotic behaviour of *S. fasciculata* is regular throughout the cycle except for the presence of the accessory chromosomes that separate mitotically in sister chromatids during anaphase I, unlike the As that regularly do in homologues. Regarding to the A set of chromosomes, in PMC at diakinesis and metaphase I they associate as 23 bivalents exclusively, mostly rings (86.2%) with distal chiasmata (92.8%) averaging 1.95 chiasmata per bivalent and 44.85 total chiasmata per cell. The RI and the EC values are high (67.85 and 21.85, respectively). Additionally, Felix & Guerra (2005) reported  $n = 23$  bivalents in Brazilian accessions of *S. fasciculata* in agreement with results in other taxa of *Sarcoglottis* Presl. from Argentina (*S. acaulis* (Sm.) Schltr.: Martinez, 1985; *S. grandiflora* (Lindl.) Klotzsch: Cerutti & al., 2004). This species is included in Appendix II of CITES.

Orchidaceae comprise ca. 20,000 species nevertheless the somatic chromosome number is known for a 10% to 13% of them (Daviña & al., 2009 and references therein). On the other hand, gametic chromosome counts and meiotic behaviour analysis are unusual in the family (Cerutti & al., 2004; Grabile & al. 2010; this work).

All the orchids analyzed here share main traits related to meiosis. In all the cases, the chromosomes associate as bivalents exclusively, typically rings (83.5%) with distal chiasmata (89.3%) averaging a high number of chiasmata per bivalent (1.89). In general the RI and EC values are high, and there is a positive correlation between the gametic number and the total chiasmata per cell, pieces of evidence which add to the high amount of chiasmata per bivalent suggest an elevated intra and interchromosomal meiotic recombination for each taxon, a major fact taken into account the widespread sexual reproduction in the family. On the other hand, the gametic number alone confines the total meiotic recombination in those taxa with low RI and EC values, i.e., *C. micromera* and *C. calophyllus*. Additionally to the regular and diploidized meiotic behaviour, the pollen grain viability of all the analyzed taxa is high, suggesting reduced, balanced and fertile gametes.

Furthermore, even though the phylogenetic distance between the studied taxa (Cameron & al., 1999; Cameron, 2004; Van den Berg, 2005), a diploidized meiotic behaviour and a high gametic number are common features to all of them, suggesting derived basic numbers and in turns the status of ancient polyploid orchids.

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