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CHROMOSOME NUMBERS OF ANGIOSPERMS COLLECTED IN THE STATE OF SÃO PAULO

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ABSTRACT

Chromosome counts are presented for 54 species belonging to 33 genera and 20 families of angiosperms from the State of São Paulo, Brazil. Thirty-three species and three genera are reported for the first time. The initial generic reports are in *Eriope* (Labiatae), $x = 20$, *Rhamnidium* (Rhamnaceae), $x = 12$, and *Tocoyena* (Rubiaceae), $x = 11$. New basic numbers are reported in *Camptosema* (Leguminosae), $n = 10$, *Cassearia* (Flacourtiaceae), $n = 11$, *Cordia* (Borraginaceae), $n = 9$, *Cuphea* (Lythraceae), $n = 7$, *Jungia* (Compositae), $n = 20$, *Lippia* (Verbenaceae), $n = 12$ and *Lithraea* (Anacardiaceae), $n = 15$. A brief review is presented of the literature pertaining to chromosome studies in the genera investigated.

INTRODUCTION

A thorough knowledge of the distribution of chromosome numbers in the angiosperms is of basic importance for research in taxonomy, biosystematics and crop improvement through breeding programs, among other areas. A cytological survey of the angiosperms is now fairly advanced, but unbalanced in the sense that our knowledge of tropical groups continues to

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be greatly inferior to that of temperate groups. In several tropical taxa no reports are available, even at the family level (Raven, 1975). In others, sometimes only a single report exists, or few reports and these not infrequently contradictory. It is clearly essential that these gaps in the cytological record be filled in and that additional reports be made for taxa previously reported, especially from other areas of their geographical ranges. The present paper represents a contribution toward the lessening of these insufficiencies. Chromosome counts are reported for 54 species belonging to 33 genera and 20 families. Of these, 3 are probable initial generic reports and 30 initial species reports.

MATERIAL AND METHODS

All the material studied in this investigation was collected in the State of São Paulo (Table I). The taxonomic identifications were made by the author, with the exception of those for *Cuphea aff. ramiflora, Desmodium discolor, D. distortum, D. uncinatum, Hyptis aff. fasciculata* and *H. suaveolens* which were made by Haroldo Cavalcante de Lima. A complete set of voucher specimens is deposited in the herbarium of the Instituto de Botânica, São Paulo (SP) and duplicate vouchers of the material identified by Mr. Cavalcante de Lima are deposited in the herbarium of the Jardim Botânico do Rio de Janeiro (RB). The voucher numbers presented in Table I are those of the author. The chromosome counts reported are all meiotic and were obtained through the study of microsporogenesis. Buds were fixed in a solution of 4 parts chloroform: 3 parts ethyl alcohol: 1 part propionic acid. Staining was done with acetocarmine, using standard squash techniques. Basic cytological reference sources used were Darlington and Wylie (1955) and the annual Index to Plant Chromosome Numbers, the last compilation of which was for the year 1974 (Moore, 1977).

RESULTS

The results are summarized in Table I.

Table I - Chromosome numbers of angiosperms collected in the State of São Paulo.

Family	Genus and species	Município of origin and voucher number	n =	Previous reports
Anacardiaceae	*Lithraea molleoides* (Vell.) Engl.	São José do Rio Preto. 644.	15	*
Aristolochiaceae	*Aristolochia giberti* Hook.	São José do Rio Preto. 633.	7	$2n = 14$
Borraginaceae	*Cordia verbenacea* DC	Glicério. 644.	9	*
Compositae	*Baccharis dracunculifolia* DC	São José do Rio Preto. 661.	9	$n = 9$
	Baccharis trinervis Pers.	São José do Rio Preto. 677.	9	$n = 9$
	Clibadium rotundifolium DC	São José do Rio Preto. 667.	16	$n = 24$ (16 + 8B)
	Erechtites hieracifolia (L.) Rafin.	São José do Rio Preto. 657.	20	$n = 20$; $2n = 40$
	Jungia floribunda Less.	São José do Rio Preto. 678.	20	*
Convolvulaceae	*Jacquemontia velutina* Chois.	São José do Rio Preto. 631.	9	*
	Merremia macrocalyx (R. & P.) O'Don.	São José do Rio Preto. 630.	15	*
	Quamoclit pennata (Desr.) Bojer	São José do Rio Preto. 651.	15	$n = 15$; $2n = 30$
Cucurbitaceae	*Momordica charantia* L.	São José do Rio Preto. 658.	11	$n = 11$; $2n = 22$
Erythroxylaceae	*Erythroxylon deciduum* St. Hil.	Glicério. 666.	12	*
	Erythroxylon pelleterianum St. Hil.	São José do Rio Preto. 646.	12	*
	Erythroxylon suberosum St. Hil.	Glicério. 663.	12	*
Flacourtiaceae	*Cassearia parvifolia* Willd.	São José do Rio Preto. 639.	11	*
Labiatae	*Eriope crassipes* Benth.	São José do Rio Preto. 671.	20	**
	Hyptis aff. fasciculata Benth.	São José do Rio Preto. 685.	14	*
	Hyptis suaveolens (L.) Poir.	São José do Rio Preto. 686.	16	$2n = 28, 32$
Leguminosae	*Aeschynomene hystrix* Poir.	São José do Rio Preto. 675.	10	*
	Camptosema tomentosum Benth.	São José do Rio Preto. 679.	10	$n = 11$

Continued

Table I, continued

Table I - Chromosome numbers of angiosperms collected in the State of São Paulo.

Family	Genus and species	Município of origin and voucher number	n =	Previous reports
	Copaifera martii Hayne	São José do Rio Preto. 649.	12	*
	Desmodium discolor Vog.	São José do Rio Preto. 652.	11	$n = 11; 2n = 22$
	Desmodium distortum (Aubl.) Macbr.	São José do Rio Preto. 656.	11	$n = 11; 2n = 22$
	Desmodium uncinatum (Jacq.) DC	São José do Rio Preto. 681.	11	$2n = 22$
	Galactia striata (Jacq.) Urb.	São José do Rio Preto. 672. Cultivated.	10	*
Loganiaceae	*Buddleia brasiliensis* Jacq.	São José do Rio Preto. 634.	19	$2n = 38$
Lythraceae	*Cuphea aff. ramiflora* St. Hil.	São José do Rio Preto. 670.	7	*
Malvaceae	*Gaya cf. guerkeana* K. Schum.	São José do Rio Preto. 676.	6	$2n = 12$
	Sida linifolia Cav.	São José do Rio Preto. 660.	7	$2n = 14$
	Wissadula amplissima (L.) Fries.	São José do Rio Preto. 659.	7	$2n = 14$
Myrtaceae	*Eugenia lilloana* Legr.	São José do Rio Preto. 669.	11	*
Rhamnaceae	*Rhamnidium elaeocarpum* Reiss.	São José do Rio Preto. 645.	12	**
Rubiaceae	*Tocoyena formosa* (Cham.& Schlcht.) K. Schum.	São José do Rio Preto. 665.	11	**
Solanaceae	*Solanum cernuum* Vell.	São Paulo. 641.	12	*
	Solanum concinnum Schott ex Sendt.	São Paulo. 642	12	*
	Solanum erianthum D. Don.	São José do Rio Preto. 635.	12	$n = 12$
	Solanum gilo Raddi	São José do Rio Preto. 627. Escape from cultivation.	12	$n = 12; 2n = 24$
	Solanum lycocarpum St. Hil.	São José do Rio Preto. 623.	12	*

Continued

Table I, continued

Table I - Chromosome numbers of angiosperms collected in the State of São Paulo.

Family	Genus and species	Município of origin and voucher number	n =	Previous reports
	Solanum mammosum L.	São José do Rio Preto. 628. Cultivated.	12	$n = 11, 12; 2n = 22$
	Solanum mauritianum Scop.	São José do Rio Preto. 626.	12	*
	Solanum mauritianum Scop.	São Paulo. 643.	12	*
	Solanum palinacanthum Dunal	São José do Rio Preto. 673.	12	*
	Solanum paniculatum L.	São José do Rio Preto. 625.	12	$n = 12$
	Solanum ramulosum Sendt.	São Paulo. 640.	12	*
	Solanum rufescens Sendt.	São Paulo. 638.	12	*
	Solanum sisymbrifolium Lam.	São José do Rio Preto. 624.	12	$n = 12; 2n = 24, 72$
	Solanum torvum Sw.	São José do Rio Preto. 636.	12	$n = 12; 2n = 24$
	Solanum variable Mart.	São Paulo. 637.	12	*
	Solanum viarum Dunal	São José do Rio Preto. 622.	12	$n = 12$
Styracaceae	*Styrax camporum* Pohl.	São José do Rio Preto. 629.	8	*
Tiliaceae	*Corchorus hirtus* L.	São José do Rio Preto. 632.	14	$2n = 28$
Verbenaceae	*Duranta repens* L.	São José do Rio Preto. 650. Cultivated.	17	$n = 12$
	Lippia lycioides Stend.	São José do Rio Preto. 647.	18	*
	Lippia salviaefolia Cham.	São José do Rio Preto. 682.	12	*

*First report for the species; **First report in the genus.

DISCUSSION

ANACARDIACEAE

Lithraea molleoides (n = 15)

This represents the first report for this species. The only previously reported species in the genus, *L. brasiliensis* March., was determined to have $2n$ = 28 (Gadella *et al.*, 1969) based on material from Parana.

ARISTOLOCHIACEAE

Aristolochia giberti (n = 7)

This report confirms a previous one by Gregory (1956). Counts of n = 4, 5, 6, 7, 12, 13 and 14 are reported in the genus, with n = 7 and 14 being most frequent. These counts indicate an aneuploid series of basic numbers with x = 4, 5, 6 and 7. Of the 135 South American species treated by Hoehne (1942), only 14 have been counted. All of these are diploid (n = 7) which suggests the genus to be cytologically conservative in the continent. Gregory (1956) has pointed out the strong tendency for tropical species to be diploid and temperate species tetraploid.

BORRAGINACEAE

Cordia verbenacea (n = 9)

This is the initial report for this species, as well as the first recording of n = 9 in the genus. Chromosome counts of n = 9, 14, 15, 16, 18, 24, ca. 36 and ca. 40 have now been reported in *Cordia.* The aneuploid series n = 14, 15 and 16 can alternately be explained on the basis of chromosome loss or gain or by polyploidy based on a lower aneuploid series of basic numbers, x = 7, 8 and 9. In the latter case, the n = 14 species would be based on 7 + 7, the n = 15 species on 7 + 8 and the n = 16 species on 8 + 8 or 9 + 7. The determination of n = 9 for *C. verbenacea* gives some support to the possible existence of such a series of lower basic numbers. In this regard it is significant that Britton (1951) concluded x = 8 to be basic in the family.

COMPOSITAE

Baccharis dracunculifolia (n = 9) — *B. trinervis* (n = 9)

The report for *B. dracunculifolia* confirms a previous one for material collected in the município of São Paulo (Coleman, 1970) and that for *B. trinervis* confirms reports for Mexican (Solbrig *et al.*, 1964), Columbian (Powell and Cuatrecasas, 1970) and Honduran material (Jackson, 1970). With a single exception, all reports in the genus are based on x = 9, with very infrequent tetraploidy. A Colombian species, *B. nitida* (P. & R.) Pers., has been reported to have n = 25 (Powell and King, 1969).

Clibadium rotundifolium (n = 16)

This species has been reported previously (under the synonym *C. armani* (Balbis) Sch. Bip.) based on material collected in the município of São Paulo (Coleman, 1968). That material showed 16 bivalents and 8 much smaller chromosomes which were suggested to be possible B chromosomes. The absence of such smaller chromosomes in the material studied in the present investigation supports the suggested supernumerary nature of these chomosomes. The few species reported in the genus all have n = 16.

Erechtites hieracifolia (n = 20)

This report confirms several previous ones for this widespread weedy species, including a prior report for Brazilian material collected in the município of São Paulo (Coleman, 1968). *Erechtites valerianaefolia* DC, the only other species reported, has n = 10 and 20, which establishes x = 10.

Jungia floribunda (n = 20)

This is only the second report in the genus. *Jungia paniculata* (DC) Gray from Peru has been reported to have $2n$ = ca. 36 (Diers, 1961). Until further nonequivocal reports become available, it can be considered that x = 20.

CONVOLVULACEAE

Jacquemontia velutina (n = 9)

This is the initial report for this species. The great majority of the species thus far reported have n = 9; however, reports of $2n$ = 20 indicate the genus to be dibasic with x = 9 and 10. Polyploidy is not reported.

Merremia macrocalyx (n = 15)

This constitutes the initial report for this species. Of the species of *Merremia* thus far reported, the majority are diploid with $2n$ = 30. A low incidence of tetraploidy is known. A few species have been reported to have $2n$ = 28 or $2n$ = 58. However in most, if not all, of these cases other reports give $2n$ = 30 or $2n$ = 60 for these same species. Sharma and Chatterji (1957), in reporting $2n$ = 28 for *M. emarginata* Hall., also observed cells with 26 chromosomes. Discounting these apparently minor deviations, x = 15.

Quamoclit pennata (n = 15)

This is the initial report for Brazilian material of this species and confirms previous reports based on material from the United States (Louisiana) (Jones, 1964) and an unidentified source (King and Bamford, 1937). The genus has x = 14 and 15, both numbers being reported in some species. Polyploidy is unreported.

CUCURBITACEAE

Momordica charantia (n = 11)

Previous reports of n = 11 are available for this species based on material cultivated in Colombia (Shibata, 1962) and India (Trivedi and Roy, 1972). Reports for other species reveal the genus to be dibasic with x = 11 and 14. Natural polyploidy is unreported, but Trivedi and Roy (1973) have reported on induced autoploids of *M. charantia.*

ERYTHROXYLACEAE

Erythroxylon deciduum (n = 12) – *E. pelleterianum* (n = 12) – *E. suberosum* (n = 12)

These are the initial reports for these species and apparently the first for Brazilian members of the genus. All species of *Erythroxylon* thus far reported have n = 12.

FLACOURTIACEAE

Cassearia parvifolia (n = 11)

This is the second report in *Cassearia.* The only previous determination is for the west African species *C. barteri* Mast. which has $2n$ = 44 (Mangenot and Mangenot, 1958). The present report establishes x = 11.

LABIATAE

Eriope crassipes (n = 20)

This is the initial report in the genus. The number appears high to be primitively basic and probably represents a derived condition, but additional counts are needed to clarify the question.

Hyptis aff. fasciculata (n = 14) – *H. suaveolens* (n = 16)

This is the initial report for *H. fasciculata*. *Hyptis suaveolens* has been reported previously to have $2n$ = 32 (Morton, 1962) and $2n$ = 28 (Miège, 1960; Harvey, 1966), based on African material. Reports of n = 8, 14, 15, 16, 28 and 32 are available in the genus. Most reports are based on x = 8.

LEGUMINOSAE

Aeschynomene hystrix (n = 10)

This is the initial report for this species. Several species of *Aeschynomene* are now known cytologically, the majority of which have n = 10. A few tetraploid species ($2n$ = 40) have been reported and a single species having $2n$ = 30. These numbers indicate that x = 10.

Camptosema tomentosum (n = 10)

A previous report of n = 11 is available for this species based on material collected in Minas Gerais (Turner and Irwin, 1961). The only other species reported in the genus is *C. coriaceum* Benth., which has n = 11 based on material collected in Minas Gerais (Turner and Irwin, 1961) and Bahia (Coleman and Smith, 1969). It would appear that the present report indicates an aneuploid condition in the material studied.

Copaifera martii (n = 12)

This constitutes the first report for this species. Turner and Irwin (1961) reported n = 12 for *C. langsdorfii* Desf. from Minas Gerais. The only other two species reported are Colombian (Atchison, 1951) and west African (Mangenot and Mangenot, 1957), both of which also have n = 12.

Desmodium discolor (n = 11) – *D. distortum* (n = 11) – *D. uncinatum* (n = 11)

These reports confirm earlier determinations for these species. The

previous reports for *D. discolor* were based on material from Brazil and New Guinea (Rotar and Urata, 1967) and on an unspecified source (Young, 1940). The reports for *D. distortum* were based on South African (Rotar and Urata, 1967) and Australian material (Pritchard and Gould, 1964). The report for *D. uncinatum* was based on Australian material (Pritchard and Gould, 1964). The great majority of reports in the genus are for $n = 11$; however, $n = 10$ is also known and a few species have been reported to have both $n = 10$ and 11. Polyploidy is not reported in *Desmodium.*

Galactia striata ($n = 10$)

This is possibly the initial report for this species. Burkart (1971) considered *G. tenuifolia* W. & A. to be in part synonymous with *G. striata.* That species has been reported as having $2n = 22$ based on material from Dahomey (Frahm-Leliveld, 1960) and $2n = 20$ based on Australian material (Pritchard and Gould, 1964). It is not possible to say whether the material on which those determinations were based is conspecific with that of the present report. *Galactia martii* DC is reported as having $n = 10$ from Minas Gerais (Turner and Irwin, 1961) and *G. decumbens* (Benth.) Hoehne and *G. eriosematoides* Harms have also been determined to have $n = 10$, both based on material collected in the State of São Paulo (Coleman and Menezes, 1980). Polyploidy is unreported in the genus.

LOGANIACEAE

Buddleia brasiliensis ($n = 19$)

This determination confirms previous reports for this species based on material originated from Rio de Janeiro (Moore, 1947, 1960). Darlington and Wylie (1955) consider $x = 19$ to be derived from 7 + 12. High polyploids (up to 16-ploid) are reported for some Asian species (Moore, 1960).

LYTHRACEAE

Cuphea aff. ramiflora ($n = 7$)

This is the initial report for this species and the first recording of $n = 7$ in the genus. The following series of haploid numbers are now reported in *Cuphea:* $n = 6, 7, 8, 9, 10, 12, 16, 18, 20, 32, 36$ and 54. It is evident that there exists an aneuploid series of basic numbers on which polyploidy has been superimposed. Intraspecific variation for chromosome number, including polyploidy, occurs in some species.

MALVACEAE

Gaya cf. guerkeana ($n = 6$)

This report confirms an earlier determination for this species based on material from Minas Gerais (Krapovickas, 1967). Of the four species of *Gaya* thus far reported, three have $n = 6$ and one $n = 8$. The genera *Gaya, Sida* and *Wissadula* belong to the tribe Malveae for which Bates and Blanchard (1970) postulate $x = 8$ as primitive with $x = 7$, 6 and 5 being derived by aneuploid reduction in at least certain lines, an event which they believe to have occurred independently several times.

Sida linifolia ($n = 7$)

This report agrees with an earlier one based on African material (Mangenot and Mangenot, 1962). The most freequent numbers in the genus are based on $x = 7$, and Hazra and Sharma (1971) consider 7, 8 and 9 to be basic. Although $n = 10$, 11 and 17 have also been reported for a few species, these authors do not consider these infrequent numbers in calculating basic numbers since some of these same species have also been reported to have numbers based on $x = 7$ or 8. The same argument can be made with respect to $n = 9$ which has been reported only for *S. acuta* Burm., which has also been determined to have $n = 7$. The recognition of $x = 7$ and 8 in *Sida* brings this genus in line with the suggestion of Bates and Blanchard (1970) concerning basic numbers in the Malveae and probably reflects the true general situation. Tetraploidy ($2n = 28$ and 32) is known in the genus, but higher polyploidy is unreported. Intraspecific tetraploidy and accessory chromosomes have been reported for *S. rhombifolia* L. (Hazra and Sharma, 1971).

Wissadula amplissima ($n = 7$)

This report confirms a previous one based on material of indefinite origin (Krapovickas, 1957). Of the six species thus far counted, five have $n = 7$ and one $n = 8$.

MYRTACEAE

Eugenia lilloana ($n = 11$)

This is the initial report for this species. The basic number of the genus is $x = 11$ with polyploidy as high as the hexaploid level reported. Intraspecific polyploidy is also known in the genus.

RHAMNACEAE

Rhamnidium elaeocarpum (n = 12)

This constitutes the initial report in the genus. The basic number x = 12 is frequent in the Rhamnaceae, occurring in more than half the genera thus far investigated.

RUBIACEAE

Tocoyena formosa (n = 11)

This is the initial report in the genus. Within the Rubiaceae, x = 11 is by far the most frequent basic number.

SOLANACEAE

Solanum cernuum (n = 12) – *S. concinnum* (n = 12) – *S. erianthum* (n = 12) – *S. gilo* (n = 12) – *S. lycocarpum* (n = 12) – *S. mammosum* (n = 12) – *S. mauritianum* (n = 12) – *S. palinacanthum* (n = 12) *S. paniculatum* (n = 12) – *S. ramulosum* (n = 12) – *S. rufescens* (n = 12) *S. sisymbrifolium* (n = 12) – *S. torvum* (n = 12) – *S. variable* (n = 12) *S. viarum* (n = 12)

The determinations for *S. cernuum, S. concinnum, S. lycocarpum, S. mauritianum, S. palinacanthum, S. ramulosum, S. rufescens* and *S. variable* are the first reports for these species. *Solanum erianthum* has previously been reported to have n = 12 based on material collected in Florida (U.S.A.) (Roe, 1967). The count for *S. gilo* agrees with previous reports for material of unstated (Gottschalk, 1954) and west African origin (Miège, 1962). The report for *S. mammosum* is the first for Brazilian material of this species. Previous reports of n = 12 have been published for Mexican (Nasrallah and Hopp, 1963) and Hawaiian collections (Bell, 1965), as have reports of n = 11 for Indian (Madhavadian, 1968) and Ecuadorian material (Heiser, 1971). The report for *S. paniculatum* confirms an earlier report for material from Bahia (Coleman and Smith, 1969). The report for *S. sisymbrifolium* agrees with several earlier determinations for this widely distributed weed. The only previous report for Brazilian material was based on material from Parana (Gadella *et al.*, 1969). Hexaploid material ($2n$ = 72) of this species originated from Japan has also been reported (Zutshi and Kaul, 1974). *Solanum torvum* occurs in tropical America and Asia and several reports for

material from both areas agree on $n = 12$. The report for *S. viarum* confirms a report for Indian material (Pingle and Dnyansagar, 1976). *Solanum* is dibasic having $x = 12$ and 23, with numbers based on $x = 12$ being more common. Polyploidy is frequent.

STYRACEAE

Styrax camporum ($n = 8$)

This is the first report for this species as well as the first report for a Brazilian member of *Styrax*. Counts of $n = 8$, 16 and $2n = 40$ are reported in the genus, indicating that $x = 8$.

TILIACEAE

Corchorus hirtus ($n = 14$)

This report confirms previous determinations for Jamaican (Islam and Qaiyum, 1961) and Bolivian material (Cristobal, 1967). The genus has $x = 7$ with low incidence of inter- and intraspecific tetraploidy.

VERBENACEAE

Duranta repens (= *D. plumieri* Jacq.) ($n = 17$)

This determination is in accord with previous reports for Indian material (Sharma and Mukhopadhyay, 1963; Bir *et al.*, 1979), but differs from reports of $n = 12$, also for Indian material (Nanda, 1962), $n = 8$ for Taiwanese material (Hsu, 1967) and $2n = 36$ for material of indefinite origin (Paterman in Darlington and Wylie, 1955). Evidently, no other species of the genus have been studied cytologically.

Lippia lycioides ($n = 18$) — *L. salviaefolia* ($n = 12$)

These are the first reports for these species and the initial determination of $n = 12$ in the genus. *Lippia* is now reported to have $n = 9$, 12, 15, 16 and 18. These reports suggest the possibility of an unusually low primitive basic number, $x = 3$.

RESUMO

São apresentadas contagens cromossômicas de 54 espécies pertencentes a 33 gêneros e 20 famílias de angiospermas, todas coletadas no Estado de São Paulo, Brasil.

Os números cromossômicos de trinta e três espécies e três gêneros foram determinados pela primeira vez. Estes gêneros são *Eriope* (Labiatae), *Rhamnidium* (Rhamnaceae) e *Tocoyena* (Rubiaceae) com, respectivamente, valores de x iguais a 20, 12 e 11. Números básicos diferentes dos registrados na literatura foram encontrados em *Camptosema* (Leguminosae), n = 10, *Cassearia* (Flacourtiaceae) n = 11, *Cordia* (Borraginaceae), n = 9, *Cuphea* (Lythraceae), n = 7, *Jungia* (Compositae), n = 20, *Lippia* (Verbenaceae), n = 12, and *Lithraea* (Anacardiaceae), n = 15. Um resumo da literatura referente a estudos cromossômicos nos gêneros investigados é apresentado.

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