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CYTOLOGY OF THE NATIVE AUSTRALIAN AND SEVERAL EXOTIC PASSIFLORA SPECIES

3. MORPHOLOGY OF SATELLITED CHROMOSOMES

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SUMMARY

The morphology of the satellited chromosomes was examined in three native Australian species of *Passiflora* (*P. aurantia* Forst., *P. herbertiana* Lindl., and *P. cinnabariana* Lindl. (all 2n = 12)) and four exotic species (*P. maliformis* L., *P. seemanni* Griseb., *P. quadrangularis* L. (all 2n = 18) and *P. suberosa* L. (2n = 24)). Karotypes are illustrated and evolution in the genus is discussed.

I. INTRODUCTION

The general chromosome morphology of the three native Australian and four exotic *Passiflora* species has been reported (Beal 1973). This paper reports on an examination of the chromosome morphology of the satellited chromosomes of the same seven species.

II. MATERIALS AND METHODS

Freshly collected root-tips from cuttings and germinating seed were pretreated for 2 hr in a saturated solution of aqueous para-dichlorobenzene at 45°F. Pretreated root-tips were stored in 70% ethyl alcohol at 45°F and macerated and stained using acid aceto-orcein according to Darlington and La Cour (1962, p. 157).

Details of material are given in Table 1.

Satellited chromosomes in suitable plates were drawn and measured showing the primary constriction (indicating centromere position) and the secondary constriction. In this study the term "satellite" is defined as that part of the chromosome distal to the secondary constriction. Karyotypes of satellited chromosomes drawn from one cell for each species are illustrated in Figure 1.

III. RESULTS AND DISCUSSION

Satellites were consistently found in the somatic chromosomes in different species of *Passiflora*. Five distinct types of satellited chromosomes were distinguished by chromosome length, centromere position and satellite appearance. Two types of satellited chromosomes occurred in *P. maliformis* and in the native species, four types in *P. suberosa* and five types in *P. quadrangularis* and *P. seemanni* (Figure 1). The average length and arm-ratio (the ratio of the long arm to the short arm) of each satellited chromosome are presented in Table 1 to support this suggested classification.

TABLE 1

AVERAGE LENGTH AND AVERAGE ARM-RATIO OF THE SATELLITED CHROMOSOMES OF SEVEN SPECIES OF PASSIFLORA

Species	Long, satellited				Short, satellited					
	Median Centromere		Sub-median Centromere		Sub-median Centromere				Median Centromere	
					Lagre Satellite		Small Satellite			
	Average Length (μ)	Average Arm-ratio	Average Length (μ)	Average Arm-ratio	Average Length (μ)	Average Arm-ratio	Average Length (μ)	Average Arm-ratio	Average Length (μ)	Average Arm-ratio
2n = 12										
P. aurantia	4·4±·14*	1·3±·04	..	..	..	..	..	..	2·9±·07	1·0±·16
P. herbertiana	..	..	4·2±·13	1·6±·08	..	..	..	..	3·2±·11	1·0±·04
P. cinnabarina	4·2±·11	1·3±·08	..	..	..	..	..	..	3·0±·12†	1·7±·12
2n = 18										
P. maliformis	4·2±·15	1·3±·05	..	..	..	..	..	..	2·8±·12	1·1±·06
P. seemanni	4·5±·15	1·3±·05	4·8±·31	1·7±·06	3·2±·04	1·8±·08	3·6±·20	1·9±·11	3·2±·15	1·0±·06
P. quadrangularis	4·5±·10	1·2±·03	4·3±·14	1·7±·11	3·4±·11	2·0±·09	3·6±·11	1·9±·08	3·4±·23	1·0±·00
2n = 24										
P. suberosa	3·6±·16	1·3±·04	..	..	2·0±·11	2·2±·25	2·3±·11	1·5±·08	2·9±·10	1·0±·07

* S.E. of mean.
† See text.

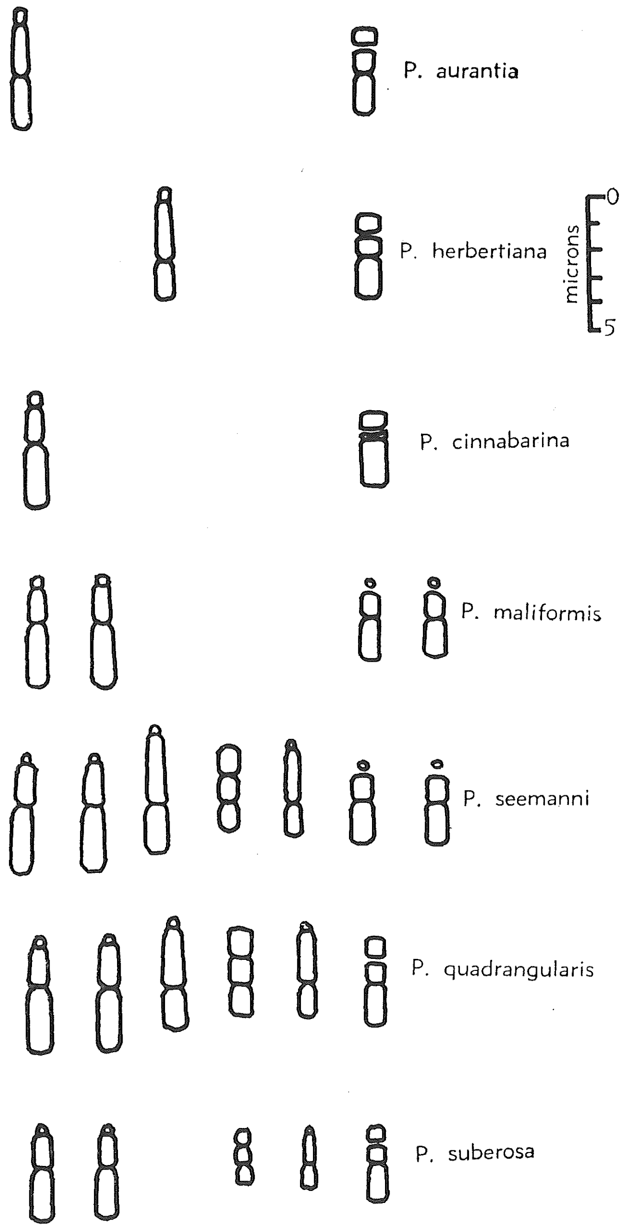

Figure 1.—Partial karyotypes of seven species of *Passiflora* (satellited chromsomes in haploid complement).

Three types of short, satellited chromosomes were found in the seven species. The short, satellited chromosome with the median centromere position common to all seven species generally had a satellite separated by a gap from the short arm, and no satellite fibres or stalks were observed in any preparations (Figure 2).

The satellite on this chromosome was markedly smaller in *P. seemanni* and *P. maliformis* (Figure 3) than in the other five species. The two short, satellited chromosomes with sub-median centromere position were distinguished by satellite size. The large, satellited type commonly had a marked secondary constriction very similar to the primary constriction. The short, satellited chromosome from *P. cinnabarina* despite its sub-median centromere position had a satellite attached to the short arm and was included in the category of median centromere position. Two types of long, satellited chromosomes were found and distinguished by median or sub-median centromere position.

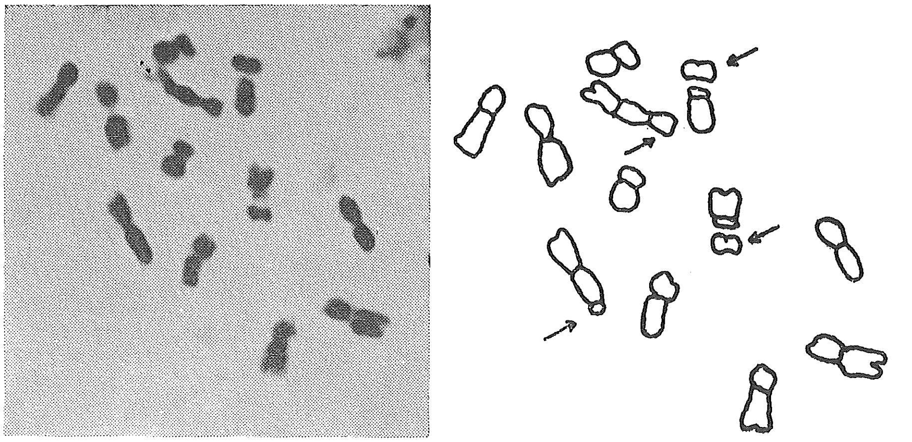

Figure 2.—*Passiflora herbertiana.* Left, 12 chromosomes at mitotic metaphase (x 3500). Right, 12 chromosomes at mitotic metaphase (drawn x 3500). Arrows indicate satellites.

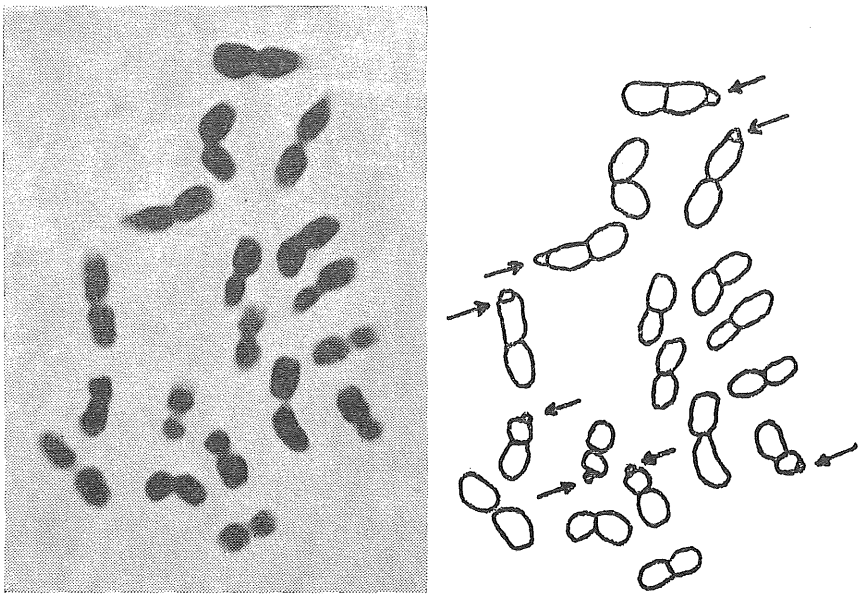

Figure 3.—*Passiflora maliformis.* Left, 18 chromosomes at mitotic metaphase (x 3500). Right, 18 chromosomes at mitotic metaphase (drawn x 3500). Arrows indicate satellites.

The similarity of satellited chromosomes from different species (in arm-ratio and total chromosome length) indicates their general constancy between species in spite of differences in chromosome number. The satellited chromosomes of *P. suberosa* were in general substantially smaller than satellited chromosomes in the other species (Table 1, Figure 1). This is also true for the non-satellited chromosomes of this species (Beal 1973) and this reduction in chromosome size in 2n = 24 *P. suberosa* is possibly the result of polyploidy. However, the satellited chromosomes in *P. suberosa* correspond in arm-ratio with those in the other species (Table 1). This indicates that the satellited chromosome constitution may be useful in suggesting the relationship between the different levels of ploidy of *Passiflora* species.

The occurrence of 2n = 18 species in the euploid interspecific series 2n = 12, 18, 24 is the main evidence of Storey's (1950) suggestion that the ancestral basic chromosome number in the genus was x = 3 rather than x = 6. However, the 2n = 18 species may be aneuploid derivatives of a 2n = 24 type (rather than of hexaploid origin) and this hypothesis still conforms with a basic number of x = 6 for the genus. If x = 3 is the basic number, the 2n = 84 race of *P. lutea* is an extremely high ploid. Further, the number 2n = 6 has not been recorded and if such species (necessary to a postulated basic number of x = 3), ever existed they have disappeared from the genus or are very uncommon. However, postulates of polyploid origins may be tested by following the satellited chromosomes in the 2n = 12, 2n = 18 and 2n = 24 species.

Two types of long, satellited chromosome, one with a median and the other with a submedian centromere position, occurred four times and twice respectively in both 2n = 18 species, *P. seemanni* and *P. quadrangularis* (Figure 1). Only one pair of one type of long, satellited chromosome occurred in any of the 2n = 12 species examined. The occurrence of six long, satellited chromosomes involving two types would seem to support Storey's (1950) suggestion of possible allohexaploid origins for the 2n = 18 species. However, this evidence was not conclusive in suggesting hexaploid origins, as *P. maliformis* only had four long, satellited chromosomes. Three types of short, satellited chromosomes also occurred in *P. seemanni* and *P. quadrangularis,* whereas a maximum of one type of short, satellited chromosome occurred in any of the Australian 2n = 12 species examined. Also, one pair of short, satellited chromosomes with a sub-median centromere position and large conspicuous satellite was observed in *P. seemanni* and *P. quadrangularis* and in *P. suberosa* but not in any 2n = 12 species. This suggested that 2n = 12 forms with different satellited chromosome constitutions from those examined may have been involved in the ancestry of the 2n = 18 and 2n = 24 species.

The satellited chromosome constitutions of 2n = 12 and 2n = 24 species generally revealed a basic chromosome number of 6. The disomy of the long, satellited and the short, satellited chromosomes with the median centomere position only suggested diploidy in the indigenous Australian 2n = 12 species.

Tetrasomy of the long, satellited chromosome in 2n = 24 *P. suberosa,* the highest level attained by any satellited chromosome, suggested possible tetraploidy in this species. The occurrence of secondary pairing in the 2n = 24 form and multiple associations up to and including hexavalents in the 2n = 36 form (Storey 1950) only reveals a basic number of 6 in the euploid intraspecific series 2n = 12,24,36 in *P. suberosa.* The stability of the basic number of 6 indicates that it has been significant in evolution in this series.

Three different types of short, satellited chromosome occurred in 2n = 24 *P. suberosa*. The 2n = 12 race of *P. suberosa* has not been studied, but a maximum of one type of short, satellited chromosome has been observed in any of the 2n = 12 species examined in this study. This suggests that two 2n = 12 forms differing in their constitution of short, satellited chromosomes may be involved in evolution of the 2n = 24 form and that it may be alloploid. In any case, the regular meiosis and high fertility observed in this form (Beal 1969) indicate the probable basis for its wide distribution.

Evidence from the satellited chromosome constitution of the 2n = 12, 2n = 18 and 2n = 24 species is not conclusive in suggesting that the basic number in the genus *Passiflora* is other than x = 6. Evidence from chromosome numbers of *Passiflora* species, of species in related genera and from related families (Darlington and Wylie 1955; Hutchinson 1959, pp. 236-46) indicates that it is probably x = 6. Dissimilar satellited chromosomes in the 2n = 18 species may be regarded as being brought together by interform hybridization at the 2n = 12 level prior to polyploidy (and prior to evolution of a 2n = 18 type by successive chromosome loss from a 2n = 24 polyploid) rather than by interform hybridization at the 2n = 6 level or by hybridization of a 2n = 6 and a 2n = 12 form prior to polyploidy (commensurate with the postulate of a basic number of x = 3). In any case, the tetrasomy of the long, satellited chromosome with the median centromere position in the 2n = 18 species suggested that only one hybridization may have been involved in their evolution.

P. maliformis, P. seemanni and *P. quadrangularis* have three satellited chromosome pairs in common, suggesting that these species may possess genomes in common. Also, *P. seemanni* has a further satellited chromosome pair in common only with *P. maliformis* and three other pairs in common only with *P. quadrangularis* within the species studied here, suggesting that *P. quadrangularis* may be more closely related to *P. seemanni* than to *P. maliformis;* this indication is supported by trends between these three species in average chromosome size (Beal 1973). The genomic composition of the 2n = 18 species and their evolutionary history may be further indicated by a knowledge of multiple associations at pachytene of meiosis in the different species or by pairing modes in interspecific hybrids.

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