

SUPERNUMERARY CHROMOSOMES IN *Partamona cupira* (HYMENOPTERA, APIDAE, MELIPONINAE)*

Marco A. Costa, Silvia G. Pompolo and Lúcio A.O. Campos

ABSTRACT

In *Partamona cupira*, males have a regular chromosome number of $n=17$, and females have $2n=34$. Cytogenetic analysis of 16 *P. cupira* colonies from the region of Viçosa, MG, using the technique of Imai *et al.* (*Jpn. J. Genet.* 63: 159-185, 1988), revealed a system of supernumerary chromosomes. This system consists of up to three small acrocentric chromosomes, varying among individuals within the same colony and from colony to colony, which, like chromosomes in the regular complement, present heterochromatin only in the pericentromeric region.

INTRODUCTION

The order Hymenoptera presents peculiar characteristics which make it an interesting group for the study of its biology. Crozier (1977) mentions as notable characteristics of this order the wide diversity of life patterns of its members, repeated occurrence of the evolution of social forms and arrhenotokous males (males originating from unfertilized haploid eggs).

The cytogenetic study of Hymenoptera has advanced with the development of relatively rapid techniques that allow good chromosome visualization, such as those of Hung *et al.* (1981), Hoshiba (1985), Pompolo and Takahashi (1987) and Hoshiba *et al.* (1989) for Vespidae, Ramberg *et al.* (1984) for Halictidae, and Imai *et al.* (1988) for Formicidae. Supernumerary or B chromosomes have been rarely recorded in this order.

* This paper is dedicated to Professor Warwick E. Kerr on the occasion of his 70th Birthday.

Imai (1974) first recorded their occurrence in a study of *Leptothorax spinosior* ants, in which he detected a complex containing as many as 12 supernumerary chromosomes.

Occurrence of a supernumerary chromosome system in the bee *Partamona cupira* in the region of Viçosa, MG, in which up to three B chromosomes were detected, is reported.

MATERIAL AND METHODS

The cytogenetic analyses were performed on samples from 16 colonies collected in the municipalities of Viçosa (20°45'20" LS 42°52'40" LW), São Miguel do Anta (20°42'26" LS 42°43'08" LW), and Guaraciaba (20°33'54" LS 43°00'12" LW), all in the state of Minas Gerais, Brazil. Slides were prepared using the cerebral ganglion or gonads of larvae in the prepupal or white-eyed pupal phase, by the technique of Imai *et al.* (1988). C bands were obtained using the technique of Sumner (1972), slightly modified by Pompolo and Takahashi (1990). On average, ten metaphases per slide were analyzed and those of best quality were photographed with Agfa Copex Pan AHU film.

RESULTS

P. cupira has a regular karyotype with $n=17$ for the male (Kerr and Silveira, 1972) and $2n=34$ for females, consisting of meta and submetacentric chromosomes (Figure 1a), which are always present. In addition to these chromosomes, in some of the populations sampled, small supernumerary acrocentric chromosomes, ranging from 0 to 3 in number (Figure 1b-d), were detected among colonies as well as among individuals within the same colony. Table I shows the cytogenetic data obtained for 16 *P. cupira* colonies.

Most of the samples studied, i.e., six colonies from Viçosa (PD, PE, PF, PG, PJ, PP) and two from São Miguel do Anta (PH, PK) presented the normal karyotype with $2n=34$, with no supernumerary chromosomes. In three of these colonies (PE, PF, PH), males with $n=17$ were detected. In the PI colony from São Miguel do Anta and the PN colony from Guaraciaba, only workers with $2n=35$ were detected, i.e., workers with one supernumerary chromosome. Males with $n=17$, without the B chromosome, were detected in PI. In two colonies from Viçosa (PB, PC) and in one from Guaraciaba (PL), there was interindividual variation, with the presence of no or one B chromosome. Among the workers analyzed, $2n=34$ and 35 and among the males, $n = 17$ and 18 were found. A colony from Guaraciaba (PM) had only workers with $2n=36$, with two small supernumerary chromosomes, and a male with $n=18$ plus another with $n=19$, i.e., with one and two supernumerary chromosomes, respectively. Finally, two colonies from Viçosa (PA, PO) presented interindividual variation of one to three supernumerary

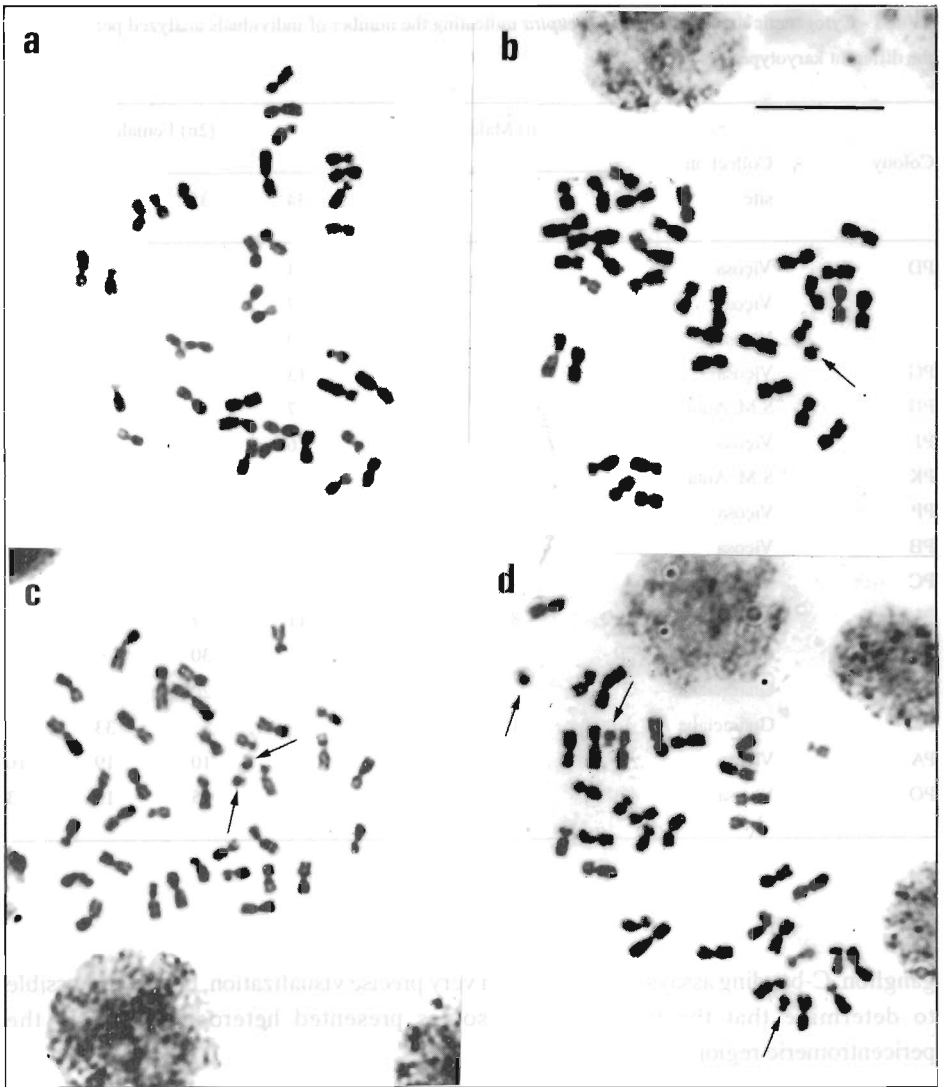


Figure 1 - Ganglionic metaphases of *Partamona cupira*. (a) female with 2n=34 chromosomes, (b) with 1B (2n=35); (c) with 2B (2n=36) and (d) with 3B (2n=37) chromosomes (arrows). Bar represents 10 μ m.

chromosomes, with workers having 2n=35, 36 and 37. No males were detected in this colony.

No difference in chromosome number was detected between somatic and germ cells in individuals in which it was possible to analyze both the gonad and the cerebral

Table I - Cytogenetic data obtained for *P. cupira* indicating the number of individuals analyzed per colony for the different karyotypes detected.

Colony	Collection site	(n) Male			(2n) Female			
		17	18	19	34	35	36	37
PD	Viçosa				14			
PE	Viçosa	1			7			
PF	Viçosa	4			9			
PG	Viçosa				13			
PH	S.M. Anta	13			7			
PJ	Viçosa				6			
PK	S.M. Anta				10			
PP	Viçosa				7			
PB	Viçosa				7	7		
PC	Viçosa				8	13		
PL	Guaraciaba	12	8		11	7		
PI	S.M. Anta	9				30		
PN	Guaraciaba					20		
PM	Guaraciaba		1	1			33	
PA	Viçosa					10	19	16
PO	Viçosa					5	12	3

ganglion. C-banding assays did not permit a very precise visualization, but it was possible to determine that the two B chromosomes presented heterochromatin in the pericentromeric region.

DISCUSSION AND CONCLUSIONS

White (1973) has described the following characteristics of supernumerary chromosomes: 1) in general, their presence or absence does not seem to affect individuals in a remarkable manner; 2) many are smaller than the chromosomes in the regular complement, although some are large; 3) although most supernumerary chromosomes are heterochromatic, in some species they have been described as fully or partially euchromatic; 4) both inter and intraindividual numerical variations can occur.

The present results indicate that the three small chromosomes detected in *P. cupira* have the characteristics of supernumerary chromosomes. As to their heterochromatic constitution, the fact that heterochromatin is distributed only in the pericentromeric region assigns *P. cupira* to the small group of species having partially euchromatic B chromosomes. Analysis of gonads and cerebral ganglion demonstrated that the B chromosomes studied here do not have intraindividual instability, as they are detected in a constant manner in both organs. Evidence for the instable type of variation in Hymenoptera has been obtained by Imai (1974) who, in a study of cerebral ganglion and gonadal cells from the ant *Leptothorax spinosior*, found that the B chromosomes detected in the germ cells were rare in somatic cells, indicating their instability in the latter. According to the data presented in Table I, the type of variation detected in the population under study is interindividual and intercolonial, resulting in karyotypes with $2n=34, 35, 36$ and 37 and $n=17, 18$ and 19 . However, there were colonies presenting only $2n=34$ and $n=17$; only $2n=35$ and $n=17$; only $2n=36$ and $n=18$ and 19 ; $2n=34$ and 35 and $n=17$ and 18 ; $2n=35, 36$ and 37 . This variation may be explained, supposing that nonmendelian segregation of B chromosomes would result in genetic variations in females and that each male may produce a single type of gamete. Thus, if a male is $n=18$ ($17+1$) and the female $2n=34$ (eggs with $n=17$), the colony will only produce $2n=35$ females as in PI and PN. The same may be assumed for PM, in which the male may be producing only $n=19$ gametes ($17+2$) and the female $n=17$. The males detected in this colony may be the offspring of workers with $2n=36$. Sakagami *et al.* (1963) report the occurrence of ovary-developed workers in queenright colonies of *P. cupira*. Colonies PB, PC and PL may represent typical cases in which an $n=17$ male mated with a female producing $n=17$ and $n=17+1$ eggs. PA and PO may represent the case in which $n=18$ males ($17+1$) mated with females producing $n=17, 17+1$ and $17+2$ eggs. The fact that the number of B chromosomes did not exceed three suggests either the possible existence of a mechanism controlling their accumulation in individuals, or that the bees with four or more B-chromosomes are selected against.

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RESUMO

Em *Partamona cupira* os machos apresentam o número cromossômico regular $n=17$, e operárias $2n=34$. A partir de análises citogenéticas em 16 colônias de *P. cupira* na região de Viçosa, MG, utilizando-se

a técnica de Imai et al. (*Jpn. J. Genet.* 63: 159-185, 1988), foi evidenciada a ocorrência de um sistema de cromossomos supranumerários. Este é constituído de até 3 pequenos cromossomos acrocêntricos que variam entre indivíduos de uma mesma colônia e entre colônias, apresentando heterocromatina apenas na região pericentromérica como nos cromossomos do complemento regular.

REFERENCES

- Crozier, R.H. (1977). Evolutionary genetics of Hymenoptera. *Ann. Rev. Entomol.* 22: 263-288.
- Hoshiba, H. (1985). G-banding analysis of two species of hornets, *Vespa mandarinia* Smith and *Vespa simillina xanthoptera* Cameron (Vespidae, Hymenoptera). *Proc. Japan Acad.* 61(B): 116-118.
- Hoshiba, H.; Matsuura, M. and Imai, H.T. (1989). Karyotype evolution in the social Wasps (Hymenoptera, Vespidae). *Jpn. J. Genet.* 64: 209-222.
- Hung, A.C.F., Reed, H.C. and Vinson, S.B. (1981). Chromosomes of four species of *Polistes* Wasps (Hymenoptera, Vespidae). *Caryologia*, 34: 225-230.
- Imai, H.T. (1974). B-chromosomes in the Myrmecine ant *Leptothorax spinosior*. *Chromosoma* 36: 431-444.
- Imai, H.T., Taylor, R.W., Crosland, M.W.J. and Crozier, R.H. (1988). Modes of spontaneous chromosomal mutation and karyotype evolution in ants with reference to the minimum interaction hypothesis. *Jpn. J. Genet.* 63: 159-185.
- Kerr, W.E. and Silveira, Z.V. (1972). Karyotypic evolution of bees and corresponding taxonomic implications. *Evolution* 26: 197-202.
- Pompolo, S.G. and Takahashi, C.S. (1987). Cytogenetics of Brazilian Polybiini wasps (Hymenoptera, Vespidae, Polistinae). *Rev. Brasil. Genet.* 10: 483-496.
- Pompolo, S.G. and Takahashi, C.S. (1990). Chromosome numbers and C-banding in two wasps species of the genus *Polistes* (Hymenoptera, Polistinae, Polistini). *Insectes Sociaux.* 37: 251-257.
- Ramberg, F.B., Kukuk, P. and Brown, Jr., W.L. (1984). Karyotypes of three species of Halictidae (Hymenoptera, Apoidea). *J. Kansas Ent. Soc.* 57: 159-161.
- Sakagami, S.F., Beig, D., Zucchi, R. and Akahira, V. (1963). Occurrence of ovary - developed workers in queenright colonies of stingless bees. *Rev. Brasil. Biol.* 23: 115-129.
- Sumner, A.T. (1972). A simple technique for demonstrating centromeric heterochromatin. *Exp. Cell. Res.*, 75: 304-306.
- White, M.J.D. (1972). *Animal Cytology and Evolution*. Cambridge University Press, London.

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