Non-random segregation during anaphase II in an individual of *Arcyptera tornosi* (Bol.) (Orthoptera) heterozygous for three supernumerary heterochromatic segments

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Abstract

An individual of *Arcyptera tornosi* heterozygous for distal heterochromatic segments affecting M₆, S₁₀ and S₁₁ chromosomes has been analyzed during all the meiotic stages in order to establish the pattern of meiotic segregation in anaphase I and II. S-bivalents invariably show an equational separation during anaphase I and the anaphase II separation is non-random, both chromatids with heterochromatic segments often segregating to the same pole. Differences are significant if compared with the expected segregation. Some aspects of this particular chromosome behaviour are briefly discussed.

Introduction

Polymorphic heterochromatic segments affecting different chromosome pairs have been described in Orthoptera (Hewitt, 1979, p. 43). Although in some cases they seem to play an adaptive role within a population it is not usual to find modifications in the meiotic process other than those related to changes in the distribution and frequency of chiasmata.

In the case of the Acridoids, heterochromatic segments usually only appear on the small telo- or acrocentric members of the complement (John, 1973). Thus when a single chromosome of a pair has a distal segment, formation of a chiasma in the heterozygous bivalent leads to an equational separation in anaphase I. Random second-division segregation of two chromosomes thus affected would result in gametes having two, one or no segments in the ratio 1:2:1.

In the present study we have analyzed the meiotic behaviour of a male of *Arcyptera tornosi* where two heterozygous half-bivalents show a non-random chromatid separation during anaphase II.

Material and methods

Testes of *Arcyptera tornosi* were fixed in 3:1 ethanol:acetic and the C-banding technique as reported by López-Fernández and Gosálvez (1981) was employed.

Results and discussion

*Arcyptera tornosi* has a male chromosome complement consisting of 23 acrocentric elements (2n = 22 + X; 2L, 6M, S₃ + X). We have recently reported the existence of polymorphic heterochromatic segments on the M₆, S₁₀ and S₁₁ autosomes and fixed distal segments on M₅, M₇, M₉ and S₉ (Gosálvez et al., in press).

One individual proved to be heterozygous for segments on the M₆, S₁₀ and S₁₁ autosomes while big fixed segments are present on the M₉ and S₉ pairs. This particular state offers a unique opportunity to analyze the behaviour of the heterozygous pairs through both meiotic divisions.

A heterozygous bivalent, due to the existence of a
heterochromatic telomeric segment ($AbbAhh^*$), may separate in two different ways during anaphase I: reductionally ($AbbAhh \rightarrow Abb + Ahh$) or equatorially ($AbbAhh \rightarrow Abh + Abh$). In the presence of a telomeric segment the number rather than the position of chiasmata determines which kind of separation may take place. A single heterozygous bivalent $AbbAhh$ may theoretically produce three different half-bivalents after anaphase I ($Abb, Abh, Ahh$). Thus after the first meiotic segregation and depending on the kind of separation for each bivalent, a triple heterozygote could produce 27 different chromosome combinations at the start of the second meiotic division. The length of the chromosomes and their heterochromatin distribution govern the number of chiasmata per pair (Fox, 1973; Fox et al., 1973) and often the same number is obtained in each type of bivalent in different cells. Thus not all possible combinations of segregating segments are observed. In our case only one chiasma is formed in the short (S) bivalents, determining an equational separation in all the cases (half-bivalents $Sbh$ in Figures 1 and 2). In larger chromosomes (e.g. $M_6$) two chiasmata may be formed and this may lead to a reductional or equational separation considering the chromatid interference (see Sybenga, 1975, p. 20). All the possible gametic combinations can be obtained from both $Mhh, Sbh, Sbh$ (Fig. 1) and $Mbb, Sbh, Sbh$ (Fig. 2) cells given a random separation of the chromosomes at anaphase II. This was not the case since 42 out of the 58 anaphase II cells studied contained both S-chromatids with the segment at the same pole (Fig. 3b). Only 16 anaphase-II cells presented a combined segregation ($Sb + Sh$) (Fig. 4) ($\chi^2 = 11.6; P < 0.01$).

If this mechanism is operating at the population level and if a similar process takes place in the females, it would favour the presence of double heterozygous ($Sbh, Sbh$) and both double basic ($Sbb, Sbb$) and double heterochromatic ($Shh, Shh$) individuals in the population via $SbSb$, $\varphi \times ShSh$ $\varphi$. Lower ratios of the single heterozygous individuals ($Sbh, Sbb$) are expected.

B-chromosomes have been well studied in Orthoptera and a variety of non-mendelian modes of

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* $b$ corresponds to the basic state (without segment); $h$ corresponds to the heterochromatic state (with segment).