

X₁X₁X₂X₂:X₁X₂Y MECHANISM OF SEX DETERMINATION IN *Anastrepha bistrigata* AND *A. serpentina* (DIPTERA: TEPHRITIDAE)

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ABSTRACT

The most frequent situation in the genus *Anastrepha* is the diploid number $2n = 12$ and the sex determination system is XX:XY. In *A. bistrigata* and *A. serpentina* we detected variation in the male diploid number due to an X₁X₁X₂X₂:X₁X₂Y system of sex determination. In this paper we discuss the probable origin of this sex determination mechanism in the karyotypes of *A. bistrigata* and *A. serpentina*.

INTRODUCTION

Cytogenetic studies carried out on tephritids have shown that the characteristic chromosome number is $2n = 12$. Variations in the diploid number were detected in a few species, especially in those having an XX:XO or X₁X₁X₂X₂:X₁X₂Y mechanism of sex determination.

Considering the mechanism of sex determination, male heterogamy was detected in most of the species studied (Bush, 1962; Solferini and Morgante, 1987). Female heterogamy was detected in *Cryotrypanea trifasciata* (Bush, 1966), *Cecidocarella borrichia* (Bush and Huettel, 1970), *Procecidocares utilis* (Bush and Taylor, 1969), *Acinia fucata*, *A. mallochi* and *Rachiptera limbata* (Frias, 1981). *Anastrepha fraterculus* and *A. obliqua* (Bush, 1962), *Trupanea foliosi*, *T. chrysantifolii* and *T. thuriferae* (Frias, 1985) have homomorphic sex chromosomes.

Our objective in the present paper is to describe the probable origin of the sex determination mechanism of *Anastrepha bistrigata* and *A. serpentina*.

MATERIAL AND METHODS

Samples of *A. bistrigata* were collected in Sorocaba, São Paulo (host: *Psidium guajava*); *A. serpentina* were collected in São Sebastião, São Paulo (host: *Manilkara zapotilla*); *A. striata* were collected in Manaus, Amazonas (host: *Psidium guajava*) and *A. barnesi* in São Carlos, São Paulo (host: *Pouteria torta*).

The cytological techniques employed are those described by Solferini and Morgante (1987). The chromosomes were measured according to the method of Robertson (1957). Based on the mean lengths of the chromosomes, idiograms were constructed representing the karyotypes of males of each species. The chromosomes were presented in the idiograms by their percentage of the total length of the diploid complement.

RESULTS

The karyotypes of the four species are presented in Figures 1 to 4. They were described by Solferini and Morgante (1987). Figures 5A to 5D are the idiograms of *A. striata*, *A. bistrigata*, *A. barnesi* and *A. serpentina*.

DISCUSSION

Cytogenetic studies showed that 11 out of 13 species of *Anastrepha* have the XX:X₁Y mechanism of sex determination (Bush, 1962; Solferini and Morgante, 1987). The other two species, *A. bistrigata* and *A. serpentina*, have an X₁X₂Y sex determination mechanism. In all species studied males are heterogametic.

These cytogenetic studies carried out on *Anastrepha* let us outline a possible origin of the sex determination mechanism of *A. bistrigata* and *A. serpentina* from karyotypes with an XY, as proposed by White (1973).

The autosome complement of *A. bistrigata* (Figures 2 and 5B) consists of two metacentric and two acrocentric pairs which show morphological correspondence to the karyotype of *A. striata* (Figures 1 and 5A). The females of these two species have identical karyotypes. The karyotype of *A. bistrigata* may derive from that of *A. striata* if we suppose the occurrence of a fusion between the Y chromosome and one chromosome of pair V, giving rise to a submetacentric Y (neo-Y) chromosome. The original X chromosome would then be called X₁ and the other chromosome of pair V, X₂ (neo-X) (Figure 6).

Morphologically, *A. striata* and *A. bistrigata* were grouped by Norrbom (1985) into the same subgroup of species; isozyme analyses showed that they are closely related to each other (Morgante *et al.*, 1980). Both species especially infest fruits of the family Myrtaceae (*Psidium* spp.) but show distinct patterns of geographic distribution, *A. striata* being found in the northern area of South America and in Central

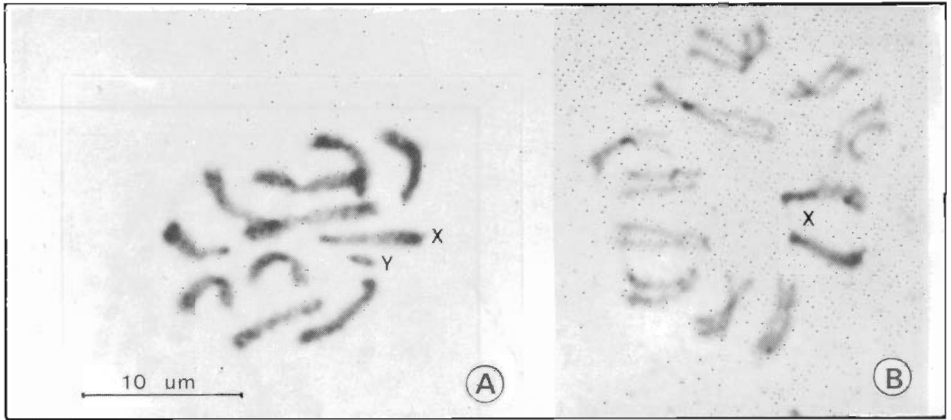


Figure 1 - Mitotic metaphases of *A. striata*. (A) spermatogonium; (B) ovarian cell.

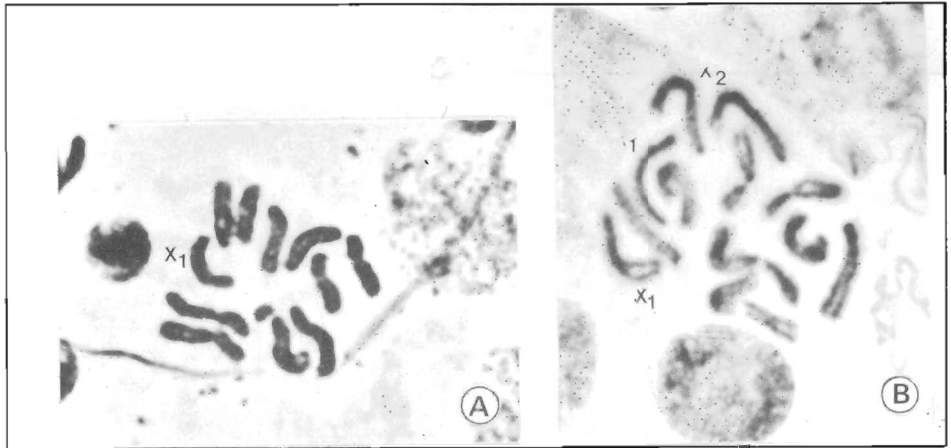


Figure 2 - Mitotic metaphases of *A. bistrigata*. (A) spermatogonium; (B) ovarian cell.

America, and *A. bistrigata* in the central zone of South America (Stone, 1942; Zucchi, 1978).

A. barnesi and *A. serpentina* have similar karyotypes (Figures 3, 4A, 4B, 5C and 5D). These species preferentially infest plants of the family Sapotaceae and show overlapping patterns of geographic distribution (Stone, 1942). Both species have a secondary constriction in the long arm of a chromosome pair. We may propose that the karyotypes of these species originated from a hypothetical "A" karyotype composed by of an acrocentric and four metacentric pairs, one of which had a secondary constriction in the long arm (Figure 7). Chromosome X may be acrocentric and Y dot shaped. The karyotype of *A. barnesi* may have arisen from "A" through a pericentric inversion in pair V and a deletion in chromosome X. The karyotype of *A.*

serpentina may be derived by an "Y-autosome" fusion as described for *A. striata*-*A. bistrigata*.

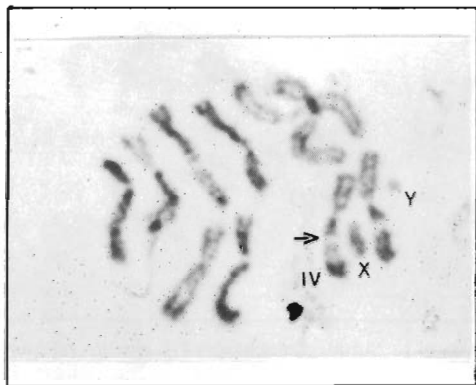


Figure 3 - Spermatogonial metaphase of *A. barnesi*; arrow indicates the secondary constriction on pair IV.

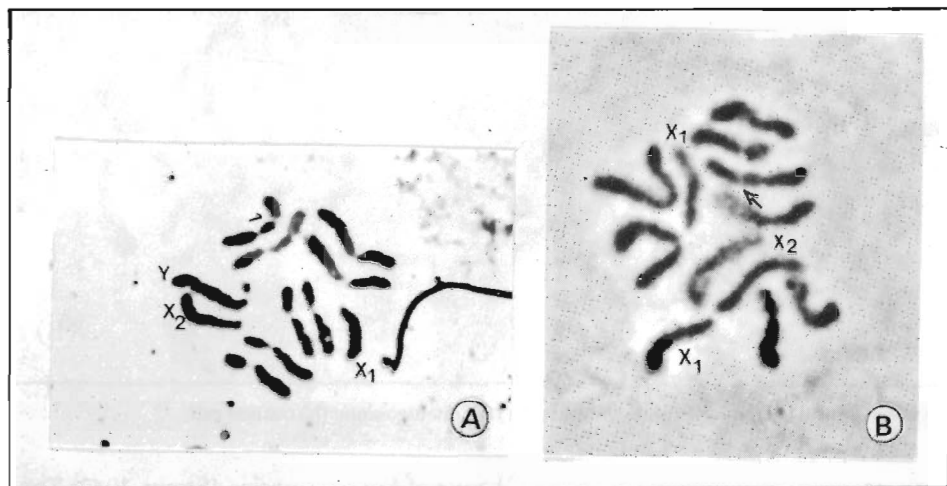


Figure 4 - Mitotic metaphases of *A. serpentina*. (A) spermatogonium; (B) ovarian cell. Arrows indicate the secondary constriction on pair V.

In both species (*A. bistrigata* and *A. serpentina*) the somatic character of the long arm of chromosome Y is shown in Figures 2A and 4A in which somatic pairing between the long arm of the Y and chromosome X₂ can be observed.

A similar condition has been reported for *Drosophila miranda*, in which the diploid number of the male is $2n = 9$ and that of the female $2n = 10$. The morphological appearance of the female karyotype is similar to that of *D. pseudoobscura* and *D. persimilis* (Dobzhansky, 1935).

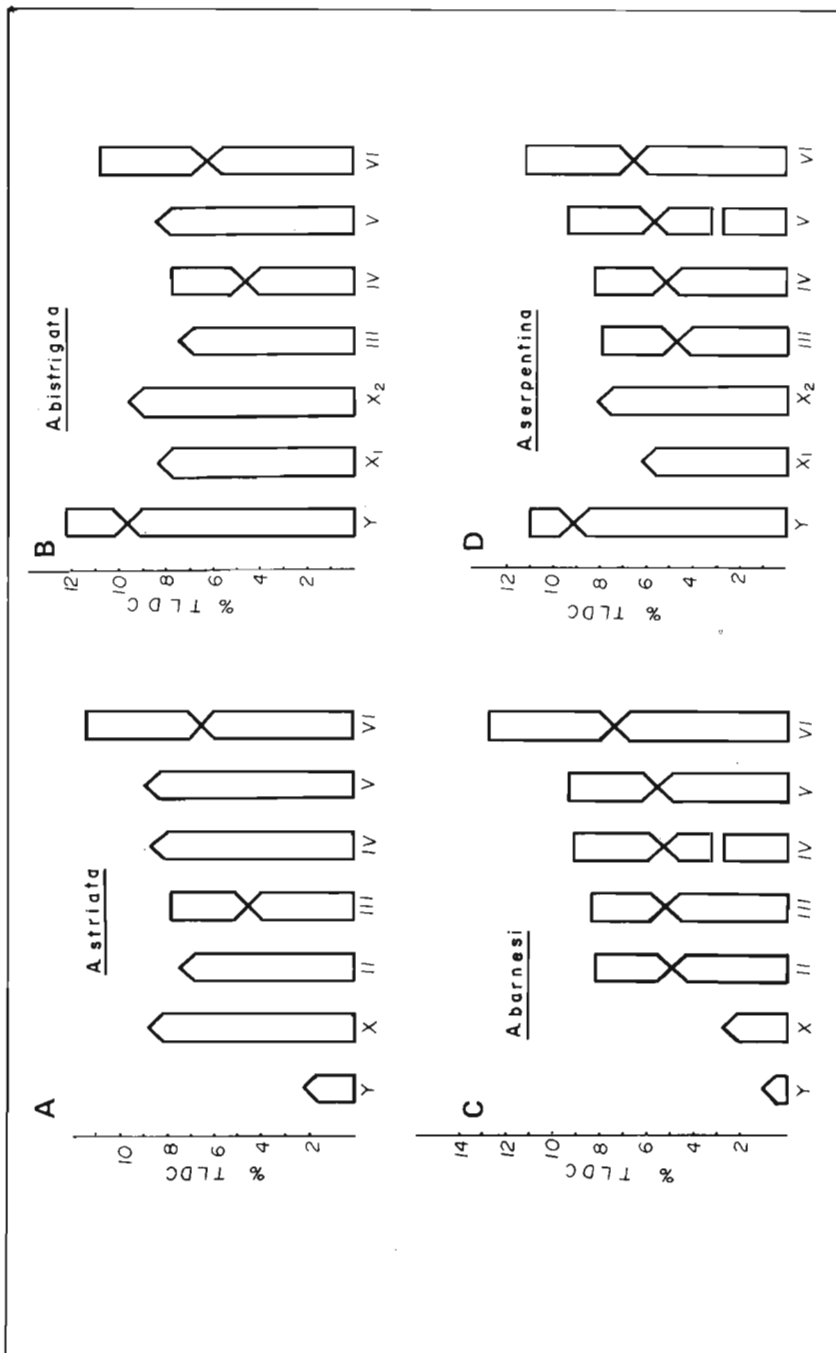


Figure 5 - Idiograms of the four *Anastrepha* species (TLDC: Total Length of the Diploid Complement; n: number of metaphases measured; x: mean; s: standard deviation). (A) Idiogram of *A. striata* (TLDC: x = 68.30 μ m; s = 2.04; n = 5); (B) Idiogram of *A. bisrigata* (TLDC: x = 50.66 μ m; s = 3.59; n = 10); (C) Idiogram of *A. barnesi* (TLDC: x = 77.19 μ m; s = 4.07; n = 4); (D) Idiogram of *A. serpentina* (TLDC: x = 57.27 μ m; s = 3.63; n = 10).

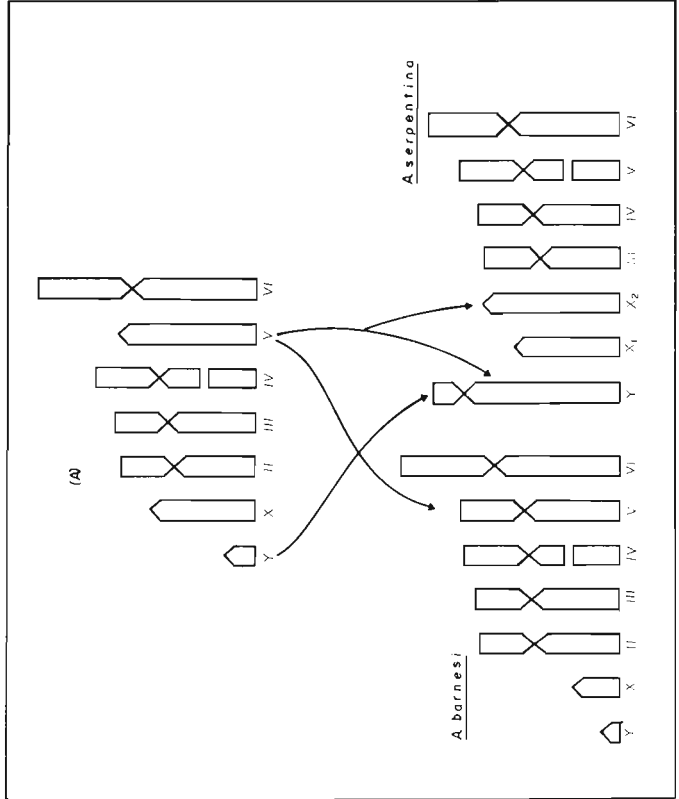
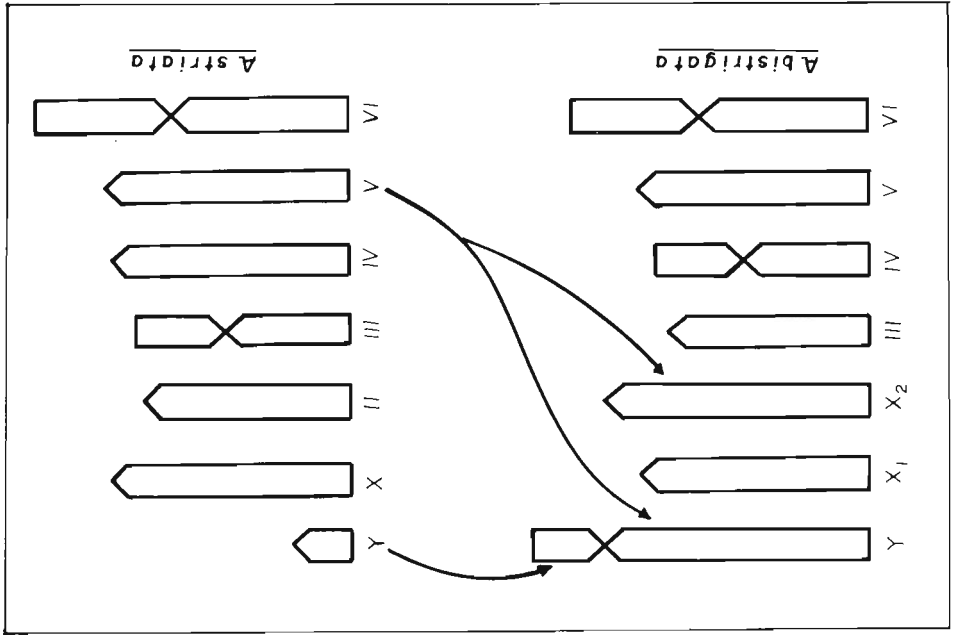


Figure 7 - Karyotype relationship between *A. barnesi* and *A. serpentina*

Figure 6 - Karyotype relationship between *A. striata* and *A. bisstrigata*.

Distinct mechanisms of sex determination are found among Tephritidae. Even though a limited number of species have been studied, there is a predominance of heterogametic males. In some species the females are heteromorphic, while in others there are homomorphic sex chromosomes.

The genus *Anastrepha* comprises more than 150 species. Isozyme analyses showed that the speciation pattern was fast and recent (Morgante *et al.*, 1980). The study of chromosome morphology is an important tool to establish a possible phylogeny in some species groups, although these rearrangements may not represent a primary cause of the speciation process. However, the shifts to a new host or the utilization of a host in areas free from competitors may contribute to the fixation of a structural chromosomal change that may play an important role in the speciation process.

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RESUMO

No gênero *Anastrepha*, o número diplóide mais frequente é $2n = 12$, com sistema de determinação sexual XX:XY. Em *A. bistrigata* e *A. serpentina* encontrou-se diferenças no número diplóide dos machos devido a um sistema de determinação sexual $X_1X_1X_2X_2:X_1X_2Y$. Neste trabalho discute-se uma provável origem deste mecanismo de determinação sexual em *A. bistrigata* e *A. serpentina*.

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