HETEROCHROMATIN PATTERNS AND KARYOTYPE RELATIONSHIPS WITHIN AND BETWEEN THE GENERA Brycon AND Salminus (PISCES, CHARACIDAE)

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ABSTRACT

Chromosomes of two Brycon species (B. lundii and B. microlepis) and Salminus hilarii were analyzed. Based on constitutive heterochromatin distribution patterns, karyotypic relationships within and between Bryconinae and Salmininae were examined. A monophyletic origin for the genus Brycon, comprising at least two chromosome synapomorphies (presence of two large submetacentric bearing paracentromeric and telomeric heterochromatin), is suggested. Moreover, Bryconinae and Salmininae may represent a monophyletic unit among Characidae, as they share several chromosome features.

INTRODUCTION

Characidae, the largest family among the Characiformes, includes nearly 55% of the fishes belonging to this freshwater fish order (Fink and Fink, 1981), and may not assemble a monophyletic group of species (Lucena, 1993). The genus Brycon has about 40 species (Howes, 1982), and together with Triportheus and Chalceus, had been included in the tribe Bryconini (Weitzman, 1960). Currently, Brycon appears alone in the subfamily Bryconinae (Gery, 1977), and has been considered more closely related to Triportheus and Salminus than other South American characids (Uj, 1990; Portugal, 1990).

Previous chromosome studies on Brycon species from various hydrographic basins revealed significant karyotype stability, characterized by the same chromosome number (2n = 50) and great similarity in chromosome structure among species. Nucleolar organizer region (NOR) sites also appear to be conserved within this genus, and a common chromosome pair has been detected carrying these sites in all species thus far studied (Almeida-Toledo et al., 1996; Margarido and Galetti Jr., 1996). In contrast, changes in constitutive heterochromatin seem to have an important role in the chromosome evolution of these fishes, and two major patterns of heterochromatin distribution have been reported for this genus (Margarido and Galetti Jr., 1996). First, a group consisting of B. lundii, B. brevicuda and B. insignis was characterized by predominantly paracentromeric C bands, mainly in the submetacentric chromosomes. Another group, comprising Brycon sp., B. orbignyanus, B. microlepis and B. cephalus, was characterized by telomeric bands in some metacentric chromosomes.

In the present study, representative species of both heterochromatin major patterns were reanalyzed through C banding and base-specific fluorochrome mithramycin and DAPI staining (new data). Chromosomes of Salminus hilarii were also analyzed and a phylogenetic relationship between Bryconinae and Salmininae is discussed.

MATERIAL AND METHODS

Mitotic chromosomes obtained from anterior kidney cells (Bertollo et al., 1978; Fenocchio et al., 1991) of Brycon lundii (5 females and 5 males) from the São Francisco River (Três Marias, MG) and Brycon microlepis (7 females and 3 males) from the Cuiabá River (Cuiabá, MT), as well as Bryconinae and Salminus hilarii (Salmininae, 5 females and 3 males) from the Mogi-Guaçu River (Pirassununga, SP), were analyzed using C banding (Sumner, 1972) and fluorescent staining with mithramycin A (MM) and 4′6-diamidin-2-phenylindole (DAPI) and counterstained with distamycin A (DA) (Schweizer, 1976; Schmid, 1980).

RESULTS

Brycon species studied here presented less heterochromatin than S. hilarii. B. microlepis showed pale C bands in centromeric regions of most chromosomes. Dark heterochromatic blocks appeared to be equilocally distributed in the paracentromeric region of both arms of the first metacentric (M) pair, apparently in the entire short arm and telomeres of the long arm of the second M pair, and in the telomeres of the long arm of the third M pair. Darkly stained heterochromatic blocks were also detected on the long arm, near the centromere of the two largest submetacentric (SM) (11 and 12) and three other SM pairs (13, 16, 22) (Figure 1A).

Equilocal dark C bands could also be observed in the paracentromeric region of both arms of the first M pair in B. lundii. Paracentromeric dark C bands were also observed in at least two M pairs (2, 6) and eight SM pairs

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Figure 1 - C banding karyotypes of (A) *Brycon microlepis*, (B) *Brycon lundii* and (C) *Salminus hilarii*. 
(12, 13, 14, 15, 16, 17, 18, 23). In one of these (13), dark C bands were detected in the telomeres of its long arm (Figure 1B). Larger amounts of heterochromatin could be observed in *S. hilarii*, with paracentromeric dark C bands in most chromosomes of the complement. Like Bryconinae species, the largest M pair also showed equilocal paracentromeric heterochromatic blocks on both chromosome arms. A large SM pair showed a particular C banding pattern with a pale C band on the telomere of the short arm, a conspicuous centromeric heterochromatic block, a proximal dot-like C band on the long arm, and dark C bands on its telomeres (Figure 1C).

Mithramycin staining revealed two fluorescent MM$^+$ bands in the chromosome complement of *B. lundii* (Figure 2A), located in the telomeric region of the long arm of the second SM pair. DAPI staining showed no differential fluorescence among these chromosomes (Figure 2B). Similar results were obtained in *B. microlepis* (Figure 2C, D).

**DISCUSSION**

The karyotypic macrostructure observed in *Brycon* is quite similar to the chromosome complement of *S. hilarii*. 

**Figure 2** - Metaphases stained by mithramycin in (A) *Brycon lundii* and (C) *Brycon microlepis*, and by DAPI in (B) *Brycon lundii* and (D) *Brycon microlepis*. Mithramycin positive bands are indicated by arrows.
In conclusion, chromosome data strongly suggest that Bryconinae and Salmininae may form a monophyletic unit among characids, and heterochromatin may have an important role in their karyotype diversification.

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RESUMO

Foram analisados os cromossomos de duas espécies de peixes do gênero *Brycon* (*B. lundii* e *B. microlepis*) e de *Salminus hilarii*. Principalemente baseado no padrão de distribuição da heterocromatina constitutiva, foram discutidas as relações cariotípicas dentro e entre os grupos Bryconinae e Salmininae. É sugerida uma origem monofilética para o gênero *Brycon*, com pelo menos duas sinapomorfias cromossômicas (presença de dois grandes submetacentéricos apresentando blocos pericentromérico e telomérico de heterocromatina constitutiva). Ainda, Bryconinae e Salmininae, compartilhando vários caracteres cromossômicos, podem formar uma unidade monofilética entre os Characidae, na qual outros caracídeos não estão incluídos.

REFERENCES


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