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KARYOLOGY OF LARGE SIZE BRAZILIAN SPECIES OF THE GENUS *OECOMYS* THOMAS, 1906 (RODENTIA, MURIDAE, SIGMODONTINAE) [1]

(With 4 figures)

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ABSTRACT: Karyotypes in large size Brazilian *Oecomys* vary from 2n=58 to 2n=86. A new karyotype from Rio Jamari, 2n=82, FN=106, and a new locality in Pernambuco for the 2n=60, FN=62 karyotype are reported. A summary of karyological data on large size *Oecomys* available in the literature is used to discuss hypothesis on speciation and karyotype evolution in this *Oecomys* group.

Key words: Karyotypes, Brazilian *Oecomys* speciation, karyotype evolution.

RESUMO: O cariótipo em espécies brasileiras de grande tamanho do gênero *Oecomys* Thomas, 1906 (Rodentia, Muridae, Sigmodontinae)

O cariótipo em espécies brasileiras de *Oecomys* de grande tamanho varia de 2n=58 a 2n=86. Comunica-se um novo cariótipo do Rio Jamari, 2n=82, NF=106, e uma nova localidade em Pernambuco para o cariótipo de 2n=60, FN=62. Um resumo sobre a informação cariotípica disponível na literatura serve como base para formular uma hipótese sobre especiação e evolução cariotípica neste grupo.

Palavras-chave: Cariótipo, *Oecomys* brasileiros, especiação, evolução cariotípica.

INTRODUCTION

The genus *Oecomys* Thomas 1906 may be divided in two groups of species, lumped by the first and last reviser of the genus (HERSHKOVITZ, 1960) in two forms, the large size *Oecomys concolor* (Wagner, 1845) and the small size *Oecomys bicolor* (Tomes, 1860). The first karyotypes of a species of the *concolor* group were published by GARDNER & PATTON (1976) for *Oecomys superans* Thomas, 1911 from Balta, Rio Curanja, Peru, originally called *O. concolor* according to G. MUSSER in PATTON, SILVA & MALCOLM (2000). They also described a karyotype of a "true" *O. concolor* from Colombia, Villavicencio, 900km NW of the type locality (Tab.1). Later PATTON, SILVA & MALCOLM (2000) reported several karyotypes from populations at the Rio Juruá, revealing that up to four species of *Oecomys* may occur in sympatry (Tab.1). ANDRADES-MIRANDA *et al.* (2001) published other karyotypes from Goiás and from the Jamari river. More recently, ANDRADE & BONVICINO (2003) provided new cytogenetic data from the Rio Negro and from the Atlantic Forest (Tab.1).

This bulk of data showed that *Oecomys* is more diverse than suggested by HERSHKOVITZ (1960) and karyotypes are helping substantially in revealing such diversity.

We publish here for the first time a karyotype of *Oecomys bahiensis* Hershkovitz, 1960 from São Lourenço, Pernambuco, in Brazilian Northern Atlantic Forest, and also a karyotype of specimens of *Oecomys roberti* (Thomas, 1904) captured at the Rio Jamari in Rondônia State. We further discuss some issues on chromosome variability, morphology, and evolution in the group of large size species of *Oecomys*.

MATERIAL AND METHODS

The following specimens of *Oecomys* have been studied. They belong to the mammal collections of the Departamento de Sistemática e Ecologia,

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Universidade Federal da Paraíba (UFPB) and Naturhistorisches Museum Wien (NHM). Karyotyped animals are marked with (*)

Oecomys concolor – Rio Curicuriari, affluent of the right margin of the upper Rio Negro below São Gabriel da Cachoeira, State of Amazonas. NHM Inv. Nr. 482, holotype.

Oecomys bahiensis – Rancho Mineiro, 6km NE of São Lourenço da Mata, Km 12,5 of the road to Aldeia, Municipality of Camaragibe, State of Pernambuco: UFPB 4447*, UFPB 4449*, UFPB 5029*. Reserva Biológica de Saltinho, Rio Formoso, Pernambuco: UFPB 4450*.

Oecomys roberti – Rio Jamari at the Samuel Hydroelectric Dam, State of Rondônia, collected during flooding. We received a pregnant female which gave birth to 3 young on 5 Jan 1989, all were raised in the laboratory and killed (karyotyped) on 29 Aug 1989 (UFPB 5030*, UFPB 5031*, UFPB 5032*, UFPB 5033*). We also obtained other 4 adult specimens (UFPB 1258, UFPB 1260, UFPB 1261, UFPB 1263).

Table 1. Karyotypes in large size species of the genus *Oecomys*.

SPECIES	2n	FN	ONE- ARMED	BI-ARMED	LOCALITY	SOURCE
Oecomys sp.	72	90	25	10	Corumbá, MS	5
Oecomys sp.	86	98	35	7	Rio Juruá, AM	4
Oecomys bahiensis	60	62	27	2	São Lourenço da Mata, PE	2
Oecomys bahiensis	60	62	27	2	Saltinho, PE	2
Oecomys concolor	60	62	27	2	Brasília, DF	3
Oecomys concolor	60	62	27	2	Villavicencio, Meta, Colombia	1
Oecomys concolor	60	62	27	2	Sumidouro and Guapimirim. RJ	5
Oecomys concolor	60	62	27	2	Teresina de Goiás, GO	5
Oecomys concolor	60	62	27	2	Sete Barras and Capão Bonito, SP	5
Oecomys concolor	60	62	27	2	Guajará-Mirim, RO	6
Oecomys concolor	60	62	27	2	20 km NW de Colinas do Sul, GO	6
Oecomys concolor	60	62	27	2	Minaçú, GO	6
Oecomys concolor	60	62	27	2	Ipameri, Caldas Novas and Corumbaíba GO	6
Oecomys roberti	80	114	21	18	Rio Juruá, AM	4
Oecomys roberti	82	106	21	16	Rio Jamari, RO	2
Oecomys superans	80	108	24	15	Rio Curanja, Balta Ucayali, Peru	4
Oecomys superans	80	108	24	15	Rio Juruá, Penedo, AM	4
Oecomys superans	80	108	24	15	Lower Rio Negro, AM	5
Oecomys trinitatis	58	96	8	20	Rio Juruá, AM	4

(2n) diploid number; (FN) fundamental number. Brazilian States: (AM) Amazonas, (MS) Mato Grosso do Sul, (PE) Pernambuco, (DF) Distrito Federal, (RJ) Rio de Janeiro, (GO) Goiás, (SP) São Paulo, (RO) Rondônia. Sources: (1) GARDNER & PATTON (1976); (2) this paper; (3) SVARTMAN (1989); (4) PATTON, SILVA, & MALCOLM, (2000); (5) ANDRADE & BONVICINO (2003); (6) ANDRADES-MIRANDA *et al.* (2001). See figure 4.

The karyotypes were obtained from bone marrow cells according to the technique described by BAKER *et al.* (1982). C and G banding treatments were performed as described by SUMNER (1972) and SEABRIGHT (1971), NORs staining where obtained by the technique outlined by HOWELL & BLACK (1980).

RESULTS AND DISCUSSION

The karyotypes of *O. bahiensis* from São Lourenço da Mata in Pernambuco (Fig.1a) showed a 2n=60 and a FN=62 formed by one pair of large submetacentrics, 27 pairs of acrocentrics of decreasing size from large to small and one pair of small metacentrics. The sexual pair is formed by a large X chromosome and the Y is a large acrocentric, similar in size to the largest arm of the X chromosome. Constitutive heterochromatin (CH) was observed in the pericentromeric regions of all autosomes and in, at least, two pairs (17 and 23) is clearly present around the telemetric area. CH is spread in large parts of the short arm of the X chromosome and present as a positive band in the terminal third of its long arm. The whole Y appears CH positive (Fig.1b). Four to 7 nucleolar organizer regions were observed in 20 cells, all located in the short arms of acrocentric chromosomes (Fig.1c).

The karyotypes of *O. roberti* from Rio Jamari in Rondônia (UFPB 5033, Fig.2) showed a 2n=82 and a FN=106 formed by 27 pairs of acrocentrics or subtelocentric chromosomes gradually decreasing in size from large to medium and 13 pairs of metacentric or submetacentric chromosomes also gradually decreasing in size from medium to small. The sexual pair is formed by large X chromosomes. In the male specimen UFPB 5032 the Y is a small acrocentric.

The wide distribution of the 2n=60, FN=62 karyotype from Colombia to the Atlantic forest in Brazil (Tab.1, Fig.4) was not expected and raises questions about the co-specificity of specimens from Colombia and Pernambuco. Not expected was also that intensive collecting along the Juruá river (PATTON, SILVA & MALCOLM, 2000), not too far from Guajará-Mirim where ANDRADES-MIRANDA *et al.* (2001) reported the 2n=60, FN=62 karyotype, revealed four different species of *Oecomys* but none with the last referred chromosomes.

Up to now the karyotype of the true *O. concolor* of the type locality is unknown but *Oecomys* collected at the Rio Negro west but not too far away (ca. 450 km) of the type locality of *O. concolor* did not show the 2n=60, FN=62 chromosomes attributed to the species (ANDRADE & BONVICINO, 2003).

To identify Pernambuco specimens we compared them with HERSHKOVITZ's (1960) description of *O. concolor* and with a description of the holotype of this species made by Langguth in 1966 in the Natural History Museum of Vienna (Fig.3, skull; Tab.2). The holotype bears labels with a Nr. 12 (Sendung); a black ink Nr. 291; Natterer´s Nrs. 174 (67); and the inventory Nr. 482. The skull has a relatively short rostrum, 33.4% of total length, interorbital and postorbital regions with posteriorly diverging cristae continued with less marked temporal lines. The interparietal is large anteroposteriorly and the parietals strongly curved transversally. The frontal has a flat dorsal outline. The proximal end of nasals is depressed as well as the anterior end of frontals. The zygomatic plate is rounded in the antero-superior corner, and very slightly projected forward when seen from above thus configuring a shallow zygomatic notch. The incisive foramina, occupying 64% of diastema length, have convex lateral borders and are narrower anteriorly, reaching the anterior lamina of m^1. A long palate ends beyond m^3, with posterior palatal pits. The molars are as described for the genus by HERSHKOVITZ (1960). The connection between paracone and mesostyle and a paralofule are not conspicuous in m^1 but evident in m^2. First and second internal fold of m^{1-2} are confluent with corresponding primary folds. Anterior internal fold and anterior secondary fold coalesced, the last is isolated from the margin. At the procingulum of m_1 anterior primary fold, first secondary fold and first internal fold are also coalescent. Skull measurements of the holotype are given in table 2, they fall within the range of measurements given by HERSHKOVITZ (1960) for *O. concolor concolor.* Only the length of incisive foramen of the holotype is smaller.

The well-preserved skin of the holotype is dorsally rufous-brown and ventrally the pelage is white to the base. Sides are sharply defined from ventral coloration. The tail is longer than head and body length (tail length 125mm, head and body length 110mm both in the dry skin) and unicolored, covered with short brown hairs with no tuft at the end. The foot (c/u 26,5 and s/u 25,2 in the dry skin) is covered with short light colored hairs. The claws are medium sized and periungeal hairs are shorter than the claws. Ears (15mm dry) are covered with short, fine, and light colored hairs. The mystacial vibrissae are around 40mm long.

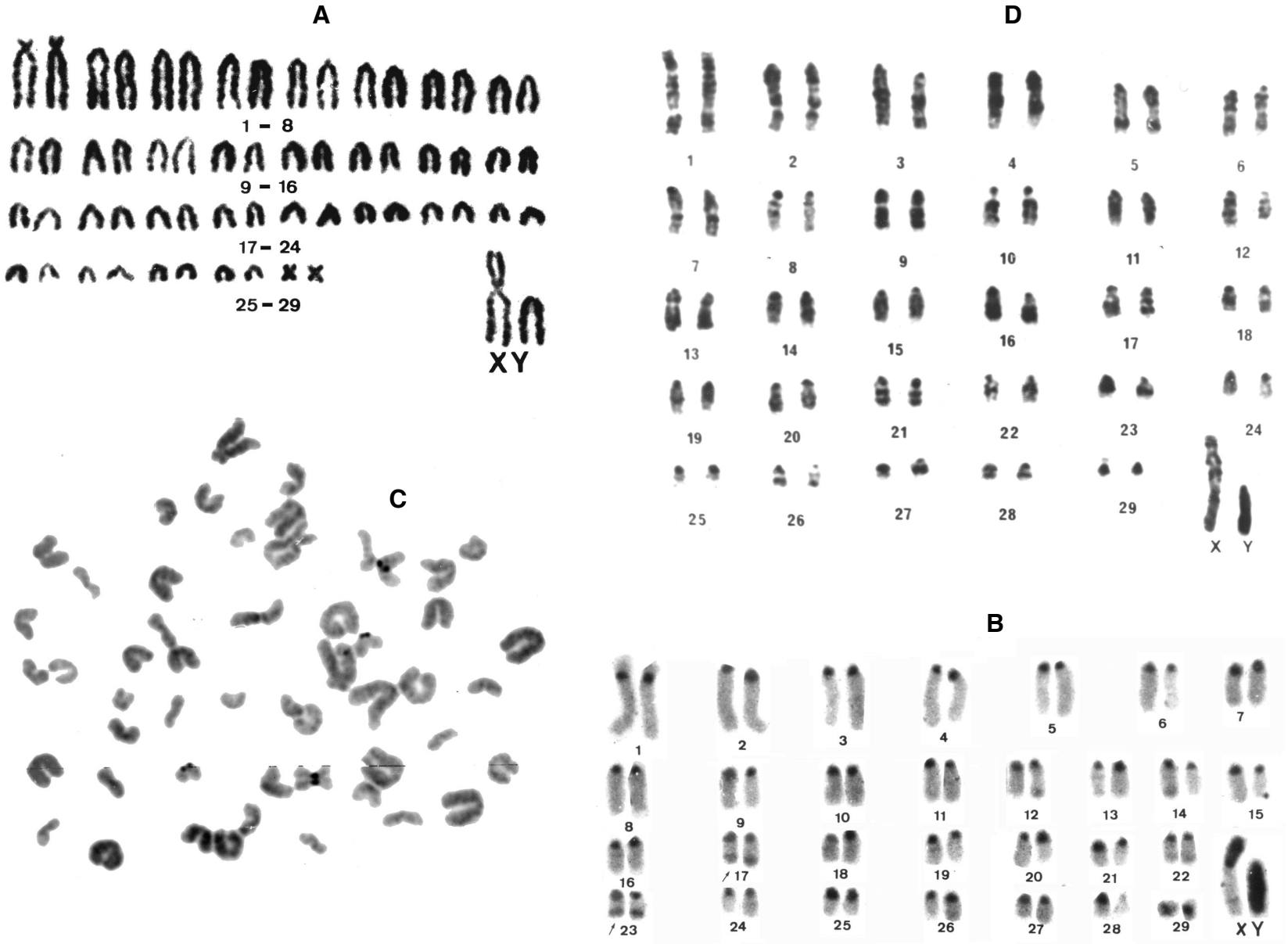

Fig.1- Karyotype of *Oecomys bahiensis* from São Lourenço da Mata, State of Pernambuco, male UFPB 4450. (A) Giemsa staining, (B) C banding, (C) NOR bands, (D) G banding.

Table 2. Measurements of selected specimens of *Oecomys*.

SPECIMEN #	SEX	HB	T	HF cu - su	E	SL	ZB	IF	LD	LR	MR	ZPW	IB
Oecomys concolor													
NHM Wien 482 holotype		124[3]	137[3]	cu 26	-	29,6	15,9	4,7	7,3	9,9	4,9	3,0	5,1
Oecomys bahiensis													
UFPB 4450	♂	103	100	-	-	27,3	14,5	4,7	6,1	9,8	5,2	2,7	4,9
UFPB 4449	♂	112	133	25 - 28	18	32,5	17,0	5,2	8,1	11,1	5,5	3,3	5,4
UFPB 4447	♂	-	-	-	-	32.8	17,4	5,4	7,9	11,1	4,9	3,4	5,5
UFPB5029	♀	-	-	-	-	28,9	16,1	4,8	7,3	-	4,8	3,2	5,6
holotype [2]	♂	140	145	27cu.	-	33,0	18,0	6,0	8,0	-	5,3	3,8	-
paratype [2]	-	130	150	28 cu.	-	36,6	16,7	5,9	7,9	-	5,3	3,4	-
Oecomys roberti													
Holotype [2]	♂	110	145	s/u 26,7	16	32,0	16,0	5,0	8,0	-	4,8	-	-
UFPB 5031	♀	143	136	25 - 27	16	34,6	17,9	5,8	9,2	12,3	5,2	3,1	5,9
UFPB 5032	♂	122	150	su.24 - cu25	16	33,2	16,5	4,6	8,5	11,6	4,7	3,1	6,2
UFPB 5033	♀	129	145	24 - 25	16	31,8	16,6	4,7	8,9	11,3	4,9	2,9	6,0
UFPB 5030	♀	124	139	23 - 24	15								
UFPB 1258	♀	100	170	24 - 26	14	32,3	16,9	5,2	8,2	11,3	4,9	3,2	5,7
UFPB 1261	-	-	-	-	-	-	-	-	-	-	-	-	-
UFPB 1263	-	-	-	-	-	31,6	15,2	4,3	8,3	11,6	4,7	3,2	4,6
UFPB 1260	♂	-	-	-	-	31,1	17,1	5,1	7,9	10,6	5,2	2,9	5,6
Oecomys superans													
holotype [2]	♀	150	199	su 31	17	37,3	18,7	6,3	-	-	6,2	-	-
Rio Juruá [4]	-	149	174	cu 33	-	33,7[1]	19,0	6,2	9,4	13,0	5,8	3,7	6,5

(HB) head and body length; (T) tail length, (HF) hind foot: s/u= without claw c/u= with claw, (E) ear height from notch, (SL) skull greatest length, (ZB) Zygomatic breadth, (IF) length of incisive foramina, (LD) length of diastema, (LR) length of rostrum, (MR) length of molar row, (ZPW) zygomatic plate width, (IB) interorbital breadth. Measurements taken according to LANGGUTH & BONVICINO (2002), (LR) according to PATTON, SILVA & MALCOLM (2000) and SL was taken to allow comparisons with holotype of *O. concolor*, and measured as greatest length with skull on a flat surface. (1) Condyloincisive length of a different, smaller, specimen; (2) mesurements from the original description; (3) Natterer´s measurements, (4) PATTON, SILVA & MALCOLM (2000).

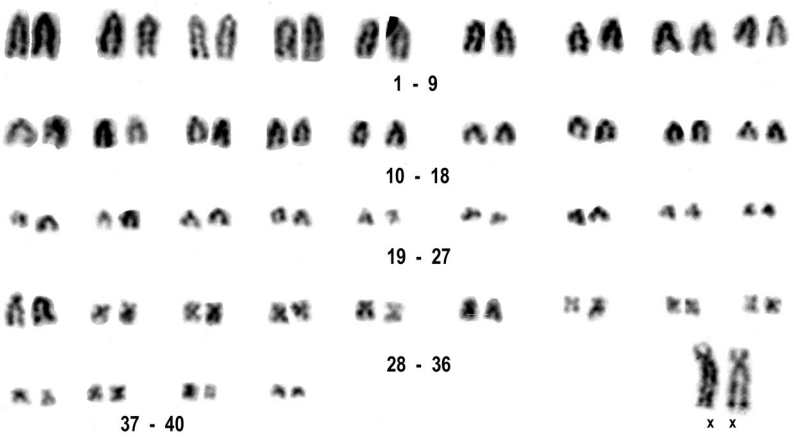

Fig.2- Karyotype of *Oecomys roberti* from Rio Jamari, State of Rondônia, female UFPB 5033. Giemsa staining.

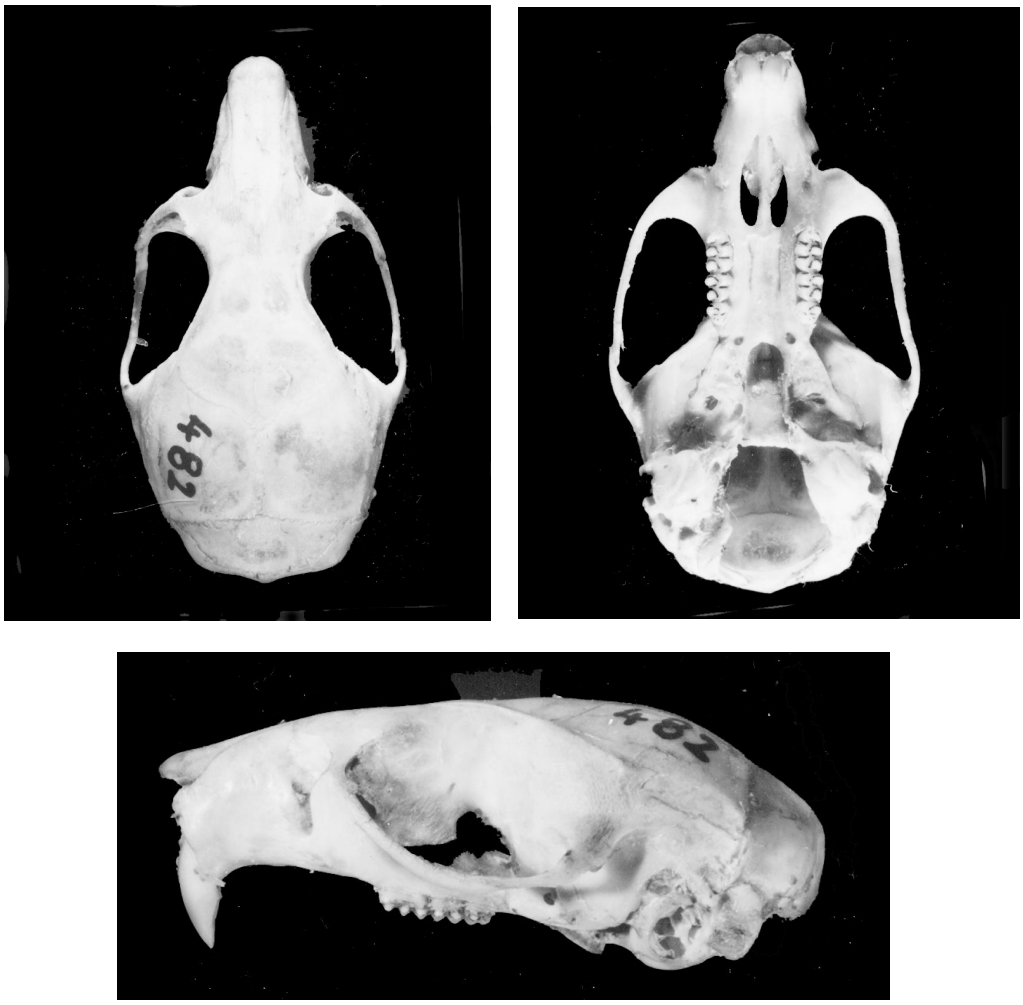

Fig.3- Dorsal, ventral, and lateral views of the skull of the holotype of *Oecomys concolor*.

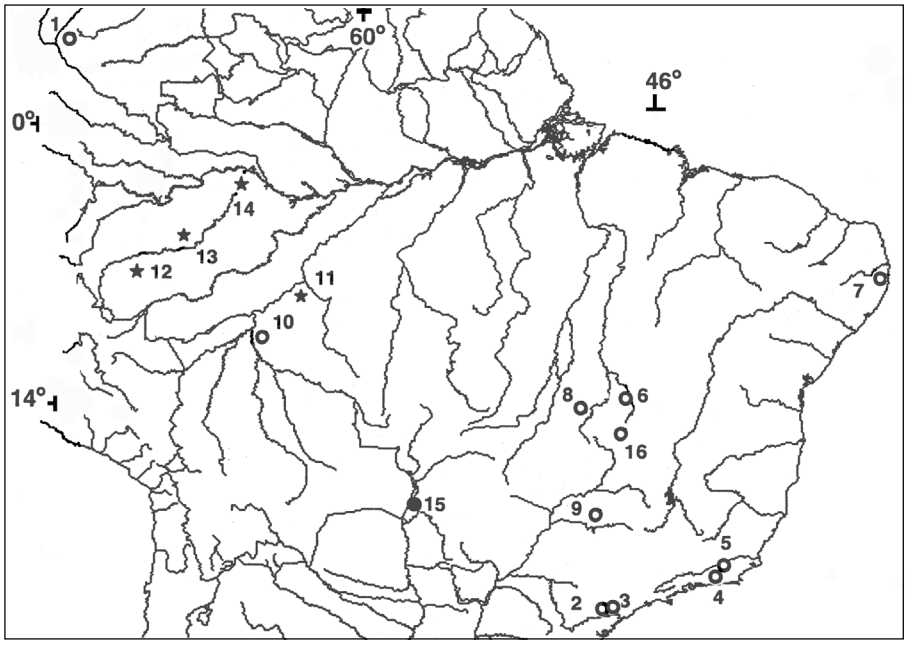

Fig.4- Localities where karyotyped specimens of some large species of *Oecomys* have been collected. (★) *Oecomys* group *concolor* 2n=60, FN=62. (○) *Oecomys roberti* 2n=80, FN=114; 2n=82, FN=106; (●) *Oecomys sp.* 2n=72, FN=90. Data from ANDRADE & BONVICINO (2003), ANDRADES-MIRANDA *et al.* (2001) and this paper.
(1) Villavicencio, Meta, Colombia; (2, 3) Sete Barras and Barra Grande, State of São Paulo; (4, 5) Sumidouro and Guapimirim, State of Rio de Janeiro; (6) Teresina de Goiás, State of Goiás; (7) São Lourenço da Mata, and Saltinho, State of Pernambuco; (8) 20km NW de Colinas do Sul and Minaçú, State of Goiás; (9) Ipameri, Caldas Novas and Corumbaíba, State of Goiás; (10) Guajará-Mirim, State of Rondônia; (11) Rio Jamari, State of Rondônia; (12) Sacado Rio Juruá, State of Amazonas; (13) Barro Vermelho, Rio Juruá, State of Amazonas; (14) Igarapé Arabidi, Rio Juruá, State of Amazonas; (15) Corumbá, State of Mato Grosso do Sul; (16) Brasília, Distrito Federal.

The karyotyped *Oecomys* specimens from Pernambuco have a long and dense dorsal fur, light brown colored with an orange wash, lighter on the sides, which are not well defined from belly. Venter is grayish with a light buffy wash the dark base of the hairs showing through. In the throat the hairs are white or light buffy to the base. The feet are well covered with light colored hairs.

The holotype of *O. concolor* and specimens from Pernambuco are both bright colored and have similar external and cranial measurements (Table II), but they differ in the pattern of ventral pelage color: the former is white and sharp defined from sides but the latter is not.

The ventral pattern in *Oecomys* from Pernambuco is similar to that found in Hershkovitz taxon *O. bahiensis* from São Lourenço, Pernambuco. Thus the specimens from Pernambuco could be co-specific with the animals sharing the same karyotype, reported from further south in the Atlantic Forest (Tab.1, Fig.4). The name *O. bahiensis* Hershkovitz 1960 is available and used here for the studied species from Pernambuco, because our specimens and those from the type-locality of *O. bahiensis* (HERSHKOVITZ, 1960) share important morphological characters, and are geographically close.

The other karyotype here reported is attributed to *Oecomys roberti*, based on characters of the pelage and size. Our specimens have underparts sharply defined from sides, covered with entirely white hairs. External and cranial measurements of specimens from Rio Jamari fall within the range given by HERSHKOVITZ (1960) and by PATTON, SILVA & MALCOLM (2000) for *O. roberti* (Tab.2). We believe that, in general, dorsally more dull colored specimens with white underparts sharply defined from sides and smaller size may be considered *O. roberti*. Large dull colored specimens with grayish belly are referred to *O. superans*.

In Corumbá, State of Mato Grosso do Sul (Fig.4) specimens that agree with HERSHKOVITZ (1960)

description of *O. roberti* have been reported with a new karyotype (ANDRADE & BONVICINO, 2003) (Tab.1). They have however a dark reddish dorsal color and grayish head not found in Bolivian *O. roberti* nor in *Oecomys marmorae* according to the descriptions of ANDERSON (1997). The holotype of the last species was, regrettably, fixed in alcohol so that the color of the specimen is biased. The specimen from Corumbá probably belongs to an undescribed species.

Further, PATTON, SILVA & MALCOLM (2000) reported another different karyotype (Tab.1) for specimens called *O. roberti* that also agree with Hershkovitz´s description of this species. Considering only the karyotypic characters they may be considered different biological species but according to the morphology they may belong to the same taxonomic species.

The collecting place at Rio Jamari is located nearly 1100km west of the type locality of *O. roberti*, but Rio Juruá, where a different karyotype (Tab.1) has been found is further 600km west (Fig.4). In summary, we find over a wide area a morphological species, *O. roberti*, with different karyotypes. Karyological differences are of such magnitude that isolating reproductive mechanisms may be involved. However, naming different species without clear-cut morphological distinctions is not recommendable.

Topotypes of *O. concolor*, *O. superans*, and *O. roberti* should be karyotyped. The picture that is emerging is similar to that found in *Oligoryzomys*. Several sibling karyological species with a variable pattern of color are described. Small statistical, cranial differences in size and proportions overlap with intrapopulational variation. Without cytogenetic information it's hard to recognize the different species.

An hypothesis to explain chromosome evolution in *Oecomys* suggests that the primitive karyotype may be 2n=60, FN=62 because it has the widest geographic distribution. The others may have originated from it by Robertsonian rearrangements such as pericentric inversions followed by central fissions. For instance, the 2n=82, FN=106 karyotype from Rio Jamari may have evolved from the ancestral form 2n=60, FN=62 by 44 pericentric inversions in uniarmed chromosomes followed by 16 fissions. A molecular phylogeny of the group accompanied by a detailed cytogenetic analysis may test this hypothesis.

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