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Karyotypes of Bats of the Subfamily Carolliinae (Mammalia; Phyllostomatidae) and Their Evolutionary Implications¹

The North American leaf-nosed bats of the family Phyllostomatidae are a most complex group of animals. Some members are adapted to feeding on other vertebrates, insects, fruit, nectar, blood (Desmodontinae, see FORMAN et al.²), and we have observed *Carollia* feeding on tender stems of plants. Even though several extreme morphological modifications are found and form the basis for the several subfamilies, the phylogenetic affinities of most groups are not easily understood. Karyotypic characteristics were used by BAKER³ to hypothesize phylogenetic affinities and to delineate several lines of evolution within the family. One line of evolution involved the Carolliinae and part of the Glossophaginae. At that time karyotypic data for the Carolliinae were based on two species of *Carollia*.

In this present communication we describe the chromosomes of another species of *Carollia* and two species of the other genus (*Rhinophylla*) of the Carolliinae.

Methods and Materials. Specimens were collected from natural populations with the aid of mistnets. Chromosomal preparations were made at nearby field stations. A 2 hour in vivo culture of bone marrow was followed by treatment with a 1% sodium citrate solution. Fixation was by methanol, acetic acid (3:1). Mitotic slides were blaze dried and stained with Giemsa's blood stain. Testicular meiotic preparations were by the aceto-orcein squash technique. Voucher specimens are deposited in the collection of mammals, Department of Biology,

Texas Tech University. To measure the relative size of the *X* to the autosomes, microphotographs were made and the length of the chromosomes were measured with a pair of dial calipers.

The total length of the *X* chromosome was divided by the total length of the haploid autosomal complement. The *X* chromosome is easily determined in species of *Carollia* because of its secondary constriction^{4,5}. The *X* of *Rhinophylla* cannot be positively determined by comparing the karyotypes of males and females, but the determination of the general size of the largest heteromorphic element in males is reasonably accurate. Fundamental number is considered to be the number of arms of the autosomal complement.

¹ We thank Dr. C. J. MARINKELLE and A. CADENA of the Universidad de Los Andes for assistance and facilities. PVT. GENARO LOPEZ assisted with the field work. Dr. R. STRANDTMANN translated the summary. Supported by National Science Foundation Grant No. GB-8120.

² G. L. FORMAN, R. J. BAKER and J. D. GERBER, *Syst. Zool.* 17, 417 (1968).

³ R. J. BAKER, *SWest. Nat.* 12, 407 (1967).

⁴ T. C. HSU, R. J. BAKER and T. UTAKOJI, *Cytogenetics* 7, 27 (1968).

⁵ Y. YONENAGA, O. FROTA-PESSOA and K. R. LEWIS, *Caryologia* 22, 63 (1969).

Size of the *X* chromosome to the autosomal genome

Karyotype Catalogue Number and Species	Sex	Locality in Colombia	Size of <i>X</i> in relationship to haploid autosomal size expressed as a percentage			No. of cells measured
			Low	Mean	High	
Z75 <i>Carollia castanea</i>	♀	Villavicencio	15.64	16.44	17.10	6
Z137 <i>Carollia subruja</i>	♀	Leticia	14.94	17.32	18.71	6
Z3 <i>Carollia perspicillata</i>	♀	Restrepo	16.17	17.70	18.31	8
Z146 <i>Carollia perspicillata</i>	♀	Leticia	15.44	16.51	19.61	5
Z62 <i>Carollia perspicillata</i>	♂	Leticia	16.82	18.25	19.92	8
Z124 <i>Rhinophylla fischeriae</i>	♂	Leticia	6.04	6.94	8.31	7
Z125 <i>Rhinophylla pumilio</i>	♀	Leticia	5.36	6.34	7.86	8
Z192 <i>Rhinophylla pumilio</i>	♂	Leticia	5.02	5.39	5.65	4

See text for method of determination.

Results. A brief description of the chromosomes of the species studied is as follows: *Carollia castanea* H. Allen (Figure 1). $2N = 21 \text{♂♂}, 20 \text{♀♀}; FN = 36$.

The karyotype of this species is like that reported for *Carollia subrufa* and *C. perspicillata*³. The autosomes consist of a very large pair of submetacentric elements, 2 large pairs of subtelocentric elements and 6 pairs of smaller biarmed elements. The X is a subtelocentric element with a distinct secondary constriction on the longer arm. The larger Y is a medium sized acrocentric and the smaller Y is dot sized. In 6 spreads the size of the X chromosome to the haploid autosomal complement varies from 15.64 to 17.10 with a mean value of 16.44 (Table). Similar values were found for *C. perspicillata* and *C. subrufa* (see Table). Meiotic studies on 4 male *C. perspicillata* revealed a meiotic pattern identical to that described by Hsu^{4,5} for that species.

Rhinophylla fischeriae Carter (Figure 2). $2N = 34, FN = 56$. The autosomes consist of 10 pairs of meta-centric or submetacentric elements, 2 pairs of subtelocentric elements, 3 pairs of acrocentric elements, plus a very small pair of chromosomes. The X is a medium sized submetacentric, and the Y is a small acrocentric. In 7 spreads the size of the X chromosome to the haploid autosomal complement was from 6.04 to 8.31 with a mean value of 6.94.

Rhinophylla pumilio Peters (Figure 3). $2N = 36, FN = 62$. The autosomes consist of 14 pairs of meta-centric or submetacentric elements plus 2 pairs of medium sized and one pair of small acrocentrics. The X is a medium sized metacentric, and the Y is a small acrocentric. In 12 spreads from 2 animals the size of the X chromosome to the haploid autosomal complement was 5.02–7.86 with a mean 6.02.

Discussion. The chromosomal characteristics of the hypothesized line of evolution (BAKER'S Group B)³ involving *Carollia* (Subfamily, Carollinae) and *Choeromiscus* and *Choeronycteris* (Subfamily, Glossophaginae) were a low diploid number (16–21), a low fundamental number (24–36), and an XX/X₁Y₁Y₂ sex determining system. The chromosomes of *Carollia castanea* agree with these values, but the chromosomes of *Rhinophylla fischeriae* and *R. pumilio* have none of these characteristics. Karyological differences between the 2 genera are further demonstrated by the length of the X chromosome to the total length of the haploid autosomal genome (Table). The values for *Rhinophylla* are near those reported for most mammalian species studied, whereas the values for *Carollia* are approximately three time that value. In light of the lack of variation reported by OHNO⁶, these different values appear to be quite significant.

In fact the chromosomes of *Rhinophylla* are much more like those of members of two other lines of evolution (Groups C and F) hypothesized by BAKER³ than they are like Group B. This presents a situation similar to that found in the subfamily Glossophaginae where two karyotypically distinct groups are present.

Interpretation of these data is difficult. The two logical choices are: 1. Even though the two genera (*Carollia* and *Rhinophylla*) are closely related (at the subfamily level) in the evolution of these genera there have been so many changes in the chromosomes that all cytological similarities have been lost; and 2. The cytological differences show true relationships of the respective genera (*Carollia* to the *Choeromiscus* group, and *Rhinophylla* to the Phyllostomatine or Stenodermine group). The second alternative would mean that the two genera should not be placed in the same subfamily.

Several authors have suggested that successful chromosomal changes are unlikely because of the selection

pressure of mitosis and meiosis. Such information favors the second interpretation of the chromosomal divergence in the Carollinae. Conversely, the subfamily taxon within the Phyllostomatidae is probably quite old which would allow considerable time for the establishment of such cytogenetic divergence.

Specimens Examined: *Carollia castanea*, Colombia: Meta: Villavicencio (2♂♂); Amazonas: Leticia (2♂♂);

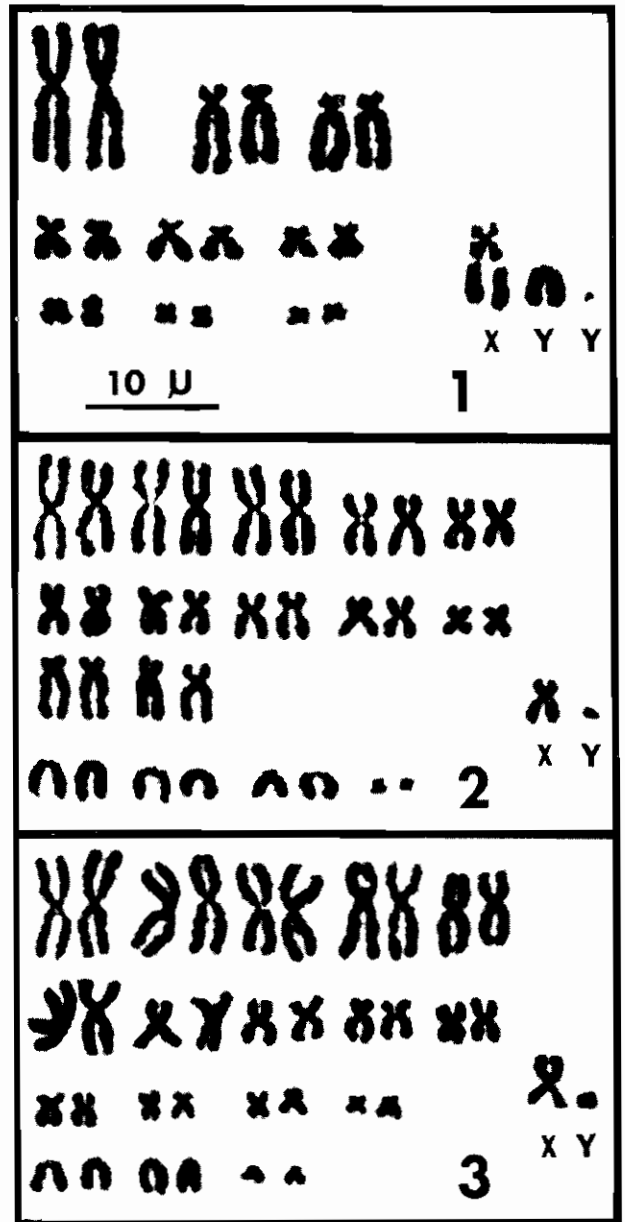


Fig. 1. Representative karyotype of a male *Carollia castanea* collected from Leticia, Colombia.

Fig. 2. Representative karyotype of a male *Rhinophylla fischeriae* collected from Leticia, Colombia.

Fig. 3. Representative karyotype of a male *Rhinophylla pumilio* collected from Leticia, Colombia.

⁶ S. OHNO, in *Sex Chromosomes and Sex-linked Genes* (Springer-Verlag, New York 1967), vol. 1, p. 192.

Carollia perspicillata, Colombia: Meta: Restrepo (1 ♂ and 1 ♀); Amazonas: Leticia (2 ♀♀); Amazonas: Monkey Island (1 ♂); *Carollia subrufa*, Colombia: Meta: Villavicencio (1 ♂); Amazonas: Leticia (1 ♀); *Rhinophylla fischeriae*, Colombia: Amazonas: Leticia (1 ♂); *Rhinophylla pumilio*, Colombia: Amazonas: Leticia (3 ♀♀ and 3 ♂♂).

Zusammenfassung. Es werden die Kennzeichen der Chromosomen von *Rhinophylla fischeri*, *R. pumilio* und

Carollia castanea beschrieben. Für die Gattung *Carollia* ist bei niedriger Diploidzahl (21 ♂♂, 20 ♀♀) eine niedrige «nombre fundamental» (34–36) charakteristisch. Für die Gattung *Rhinophylla* wird eine grössere Diploidzahl (34–36) und eine grössere «nombre fundamental» (56–62) gefunden.

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