Chromosome polymorphism of the large naked-soled gerbil, 
*Tatera indica* (Rodentia, Muridae)

By Toshihide H. Yosida

National Institute of Genetics, Misima 411

(Received December 13, 1980)

**ABSTRACT**

Karyotype of the large naked-soled gerbil, *Tatera indica*, was investigated by conventional, G- and C-band stainings. This animal had 68 chromosomes, comprising 25 acrocentric and 8 biarmed autosome pairs, besides an X-Y pair. The X-chromosome was characterized by the largest metacentric, and the Y a small acrocentric. The smallest biarmed autosome pair (no. 33) was polymorphic by having three chromosome types (A, B and C). Based on the frequency of the polymorphic chromosomes, type-B (small submetacentric) was suggested to be an original form; type-A (large submetacentric) was derived from type B through tandem duplications of both arms, and type-C (small subtelocentric) was accounted for by inversion and deletion of the basic type.

**1. INTRODUCTION**

Chromosome polymorphism has been found in many species of rodents involving inversion, Robertsonian fusion and fission. Chromosome number of the large naked-soled gerbil (*Tatera indica*) has already been reported (Yosida et al. 1973; Mittal and Kaul 1974; Sobti and Gill 1980), but details of the karyotype of this species and also the presence of chromosome polymorphism have not been reported yet so far. In the offspring of the animals collected from southern India in 1972, a polymorphism of the smallest biarmed chromosome pair no. 33 was found. The present paper deals with detailed analyses of the karyotype of the large naked-soled gerbil by G- and C-band stainings and the occurrence of polymorphism of the chromosome pair no. 33, with a special interest to their origin.

**2. MATERIALS AND METHODS**

The large naked-soled gerbils (*Tatera indica*) used in the present study were collected in Mysore, India, in 1972 (Yosida et al. 1973), and then they have been bred by random matings in our institute until the present time. Their karyotypes were analysed from bone marrow cells and cultured cells of the tail tip.

1) Contribution no. 1356 from the National Institute of Genetics, Japan. Supported by Grants-in-Aid for Scientific Research from the Ministry of Education, Science and Culture (nos. 339025, 501001 and 53728).
G- and C-band stainings according to our routine procedures were used.

3. RESULTS

The large naked-soled gerbil here studied had 68 chromosomes (34 pairs) consisting of 25 acrocentric autosome pairs (nos. 1 to 25), 8 biarmed autosome pairs (nos. 26 to 33) and a large metacentric X and a small acrocentric Y. Among the biarmed autosome pairs, the largest one (no. 26) was subtelocentric, but the other pairs (27 to 33) were metacentric or submetacentric (Fig. 1). All of the chromosome pairs could be identified by their characteristic G-band patterns (Fig. 2). As seen in the figure, almost all autosomes had a small centromeric C-band, but the X and Y chromosomes were rather uniformly stained by the C-band technique (Fig. 3). The whole body of the Y chromo-

![Karyotype](image)

Fig. 1. Karyotype of the large naked-soled gerbil, Tatera indica, by conventional staining. 2n = 68(2). Pair nos. 1 to 25 are acrocentrics and nos. 26 to 33 are biarmed chromosomes. The X is a large metacentric and the Y is a small acrocentric. Pair no. 33 is heteromorphic by a considerably large submetacentric (type-A) and a small subtelocentric (type-C).
some was always stained heavily, but the C-staining pattern of the X was somewhat variable. In most cells both arms of the X were strongly stained as seen in Fig. 3, although one arm was slightly paler than the other. In some cells one whole arm and the distal part of the other arm of the X were heavily stained, but in some others only the latter was stained dark. At present it is difficult to explain why such a differential staining of the X-element was found in this animal.

Among the autosome pairs, the smallest biarmed one (no. 33) was remarkable for polymorphic characteristics with respect to its size and shape. This chromo-
Fig. 3. C-banding karyotype of the large naked-soled gerbil (♀). Small centromeric C-bands were found in almost all autosomes. The X and Y are stained through the whole body by C-band technique.

Table 1. Relative length and the arm index of the pair no. 32 and type A, B and C chromosomes of the pair no. 33 (10 cells) in the large naked-soled gerbil

<table>
<thead>
<tr>
<th>Pair nos.</th>
<th>32</th>
<th>33</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Length</td>
<td>10.0±1.3</td>
<td>9.4±1.2</td>
</tr>
<tr>
<td>Arm index</td>
<td>1.2</td>
<td>1.7</td>
</tr>
</tbody>
</table>

A, large submetacentric; B, small submetacentric; C, small subtelocentric.
some was classified into 3 types; A, B and C. Size of the type-A was the largest among them, although it was slightly smaller than the pair no. 32 (Table 1). Its shape was characterized by submetacentrics having the arm index of 1.7. The type B was also characterized by submetacentrics (arm index 1.5), but its size was rather smaller than the type A. The chromosome size of the type-C was the smallest and its shape was characterized by subtelocentrics.

Table 2. Frequency of chromosome polymorphism in pair no. 33 of the large naked-soled gerbil

<table>
<thead>
<tr>
<th>Types of pair no. 33</th>
<th>No. of animals observed</th>
<th>Expected no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>AB</td>
<td>3</td>
<td>2.9</td>
</tr>
<tr>
<td>AC</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>BB</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>BC</td>
<td>3</td>
<td>2.9</td>
</tr>
<tr>
<td>CC</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>12.9</strong></td>
</tr>
</tbody>
</table>

Refer to Table 1 for the A, B and C.

![Fig. 4. Chromosome pair nos. 32 and 33 in the large naked-soled gerbil. Pair no. 33 is polymorphic with respect to the large submetacentric (A), the small submetacentric (B) and the small subtelocentric (C).](image-url)
If these three chromosome types (A, B and C) are distributed at random in the animals bred in our laboratory, 6 combinations are expected to be obtained (Table 2). Four combinations, AB, AC, BB and BC, however, were actually found in 13 specimens examined (Fig. 4). As seen in the table, the frequency of the combination BB was the highest (38.4%), those of the combinations AB and BC ranked the second (23.1%) and that of AC was the lowest (15.4%). Combinations of AA and CC, however, were never observed in the present material. Frequencies of the A, B and C types in 26 chromosomes among the above 13 animals were counted to be 5, 16 and 5, respectively (Table 3). The observed numbers were significantly different from those expected based on random distribution and segregation of the three types.

4. DISCUSSION

In the rodents chromosome polymorphism has been found in several species. In the black rats the polymorphism due to pericentric inversion, Robertsonian fusion and fission has been commonly observed in the specimens distributed widely in the world (Yosida 1980). Polymorphism of chromosome pair no. 3 due to pericentric inversion is also reported in the Norway rat (Yosida and Amano 1965; Sasaki et al. 1979). Frequent occurrences of chromosome polymorphism have been found in the mouse (Gropp et al. 1972; Capanna et al. 1976), deer mouse (Hsu and Arrighi 1966; Ohno et al. 1966), and some other rodents.

In the large naked-soled gerbil the smallest biarmed autosome (no. 33) showed polymorphism by three chromosome types; A, B and C. Among them the frequency of the B type was the highest and those of the A and C types were about one third of it. Interesting is that among 6 combinations (AA, AB, AC, BB, BC, CC) expected theoretically, the frequency of the BB type is the highest and those of the AB, BC and AC ranked the second and the third. However, the other two types (AA and CC), were never obtained in our laboratory colony, suggesting a lethality in these chromosome combinations during the

<table>
<thead>
<tr>
<th>Types of pair no. 33</th>
<th>No. of chrom. observed</th>
<th>Expected no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>8.7</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>8.7</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>8.7</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>26.1</td>
</tr>
</tbody>
</table>

($\chi^2=8.8, p<0.01$)

Refer to Table 1 for the A, B and C.
embryogenesis. From the present results, the type B seems to be basic, and the two other types (A and C) could have been derived from the type B. The largest type A might have been derived from the type B chromosome by tandem duplication in both arms, and furthermore, the type C seems to be due to the pericentric inversion and partial deletion of the basic type B (Fig. 5). Another explanation on the polymorphism of pair no. 33 is that the largest A type is basic, and the B type has been derived from the deletion of the both arms of the type A. If this is true, a more number of specimens with the homologous type A could have been obtained, but these animals were never found so far in our breeding colony. Based on these observations it is highly reasonable to categorize the B type as the basic. This is, however, my tentative speculation derived from a small sample obtained from our breeding colony. To resolve this problem, therefore, a more number of specimens sampled from our laboratory colony as well as the natural population should be investigated.

It is questionable at present whether the variable C-staining patterns observed in the X chromosome of the present materials are due to technical error or not. According to Ohno (1967) the heterochromatic X chromosome of mammals comprises about 5 percent of the total genome. Based on this hypothesis, it is suggested that the genuine heterochromatic portion of the X chromosome of this species should correspond to one arm of the X which is stained most heavily by the C-banding procedure. This is also a further problem to be solved using more materials.

The author is indebted to Mrs. Yuriko Hirai-Ochiai for her technical assistance to the cytogenetical work and to Mr. Hisaharu Iwasaki for his assistance to breeding of the animals.

REFERENCES


