**Karyotype of Four Malayan Rats**  
*(Muridae, Genus *Rattus* Fischer)*

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A great deal of information concerning the Malayan rats (Muridae, genus *Rattus* Fischer) exists in the literature. However there is no report on the karyotype of these rats. Karyotype information of wild rats in other parts of the world exists, but is scanty. Makino (1942, 1943, 1949b, 1952c) studied six species of *Rattus* found in Japan. Most other studies have been confined to *Rattus norvegicus* albino (Tanaka 1953, Makino and Hsu 1954). The techniques employed in the earlier studies were not sufficiently refined to permit critical analysis. A more recent paper is that of Tanaka and Kano (1957) on *R. norvegicus* albino.

The present paper deals with four species of Malayan rats. They are *Rattus bowersii* Anderson, *R. muelleri* Jentink, *R. edwardsi* Thomas, and *R. sabanus* Thomas. According to Chasen (1940) as modified by Ellerman and Morrison-Scott (1956), the Malayan mainland forms for these species are *R. b. ferreocanus* Miller, *R. m. validus* Miller, *R. e. ciliatus* Bonhote, and *R. s. vociferans* Miller.

**Materials and methods**

All rats were trapped from the wild, *R. bowersii* and *muelleri* from near Kampong Janda Baik, Bentong District, Pahang, *R. edwardsi* from Gunong Bunga Buah, Selangor, and *R. sabanus* from Kampong Janda Baik and Kepong, Selangor. The number of individuals used of each species is shown in Table 1.

Bone marrow was used for chromosome preparations. The method employed was that of Ford (1962) with modifications. The rat was injected intraperitoneally with 0.01 ml colcemid solution (0.04% w/v in distilled water) per gram of its body weight. After two hours the rat was killed and bone marrow from the femur or tibia was extracted with a syringe in Hank’s solution at 37°C (or at room temperature). The bone-marrow cell suspension was centrifuged at 500 rpm for two minutes. The supernatant was pipetted away and 1% sodium citrate solution (10× the volume of packed cells) added to resuspend the cells. The suspension was allowed to stand for 30 minutes at 37°C and then spun down at 500 rpm for 2 minutes. The supernatant was again removed and 10× packed cell volume of freshly prepared fixative (3 parts ethyl alcohol to 1 part acetic acid) added to resuspend the cells. The suspension was finally allowed to stand for about 30 minutes and then resuspended in fresh fixative.

A drop of cell suspension was allowed to spread on a well-cleaned slide, and was then air-dried and stained with lactic-acetic orcein (Harleco) for 20 minutes, differentiated in 95% ethanol for 30 minutes and mounted in Euparol. A total of 10 to 20 slides were prepared of each rat.

The chromosome numbers were counted visually under oil immersion and counter-checked with photomicrographs. A total of at least 20 well-spread cells were counted. The karyograms were constructed from the photomicrographs (Figs. 1-11).
Results

Table 1 shows the karyotype of the four species. The convention of Tjio and Levan (1956) for chromosome morphology is used in the present karyotype analysis, i.e. metacentric with inter-arm ratio of 1.0–1.9 (V-shaped); subterminal with inter-arm ratio of 2.0–4.9 (J-shaped), and acrocentric with inter-arm ratio of more than 5.0 (rod-shaped; also telocentric).

Table 1. Karyotype of Stenomys Thomas and Leopoldamys Ellerman

<table>
<thead>
<tr>
<th>Subgenus</th>
<th>Species</th>
<th>Number of specimens examined</th>
<th>2n</th>
<th>Autosomes*</th>
<th>Allosomes</th>
<th>FN**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td>M</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>Stenomys</td>
<td>R. bowersii</td>
<td>3</td>
<td>2</td>
<td>40</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>R. muelleri</td>
<td>5</td>
<td>3</td>
<td>42</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Leopoldamys</td>
<td>R. edwardsi</td>
<td>2</td>
<td>1</td>
<td>42</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>R. sabanus</td>
<td>4</td>
<td>3</td>
<td>42</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

* M, metacentric; S, subterminal; A, acrocentric.
** FN=fundamental number (number of major chromosome arms).

1) *Rattus bowersii ferreoeanus* (Figs. 1, 2, and 8)

The diploid number (2n) is 40 being composed of 16 metacentric, 10 subterminal and 12 acrocentric autosomes, acrocentric X and acrocentric Y sex-chromosomes. The Fundamental Number (FN) is 66.

The subterminals constitute the longest chromosomes. The longest metacentric is about the third longest. The shortest chromosome is an acrocentric. The X-chromosome is the longest acrocentric and Y the second shortest. The descending order in length of the chromosome complement is very gradual.

2) *Rattus muelleri validus* (Figs. 3, 4, and 9)

The diploid number is 42 – 12 metacentric, 4 subterminal and 24 acrocentric autosomes, metacentric X and acrocentric Y. The fundamental number is 59.

The X-chromosome is the longest metacentric, probably the longest in the complement. Y is about the 4th shortest acrocentric. The longest subterminal and the longest acrocentric are about the same in total length. The shortest chromosome is probably an acrocentric. The decrease in chromosome length in the complement is gradual.

3) *Rattus edwardsi ciliatus* (Figs. 5 and 10)

The diploid number, 42, is made up of 6 metacentric, 8 subterminal and 26 acrocentric autosomes, acrocentric X and acrocentric Y, with a fundamental number of 56.

The subterminals constitute the longest chromosomes in the complement. The X-chromosome is the longest acrocentric, about 4th or 5th longest in the complement. Y is the shortest acrocentric and also the shortest in the
series. The descending chromosome length in the complement is gradual.

4) *Rattus sabanus vociferans* (Figs. 6, 7 and 11)

The diploid number is 42. The autosome composition is 4 metacentrics, 8 subterminals and 28 acrocentrics. Both the X and Y sex-chromosomes are acrocentric. The fundamental number is 54.

The subterminals comprise the longest chromosomes. The shortest in the complement is an acrocentric. The X-chromosome is the longest acrocentric, about 4th or 5th longest in the complement. The Y-chromosome is the shortest acrocentric. The decrease in chromosome length in the complement is very gradual.

**Discussion**

The techniques (Colcemid treatment, hypotonic pretreatment, etc.) employed in the present study enable critical karyotype analysis. The present investi-
gation shows that the karyotype of these rats is species-specific, that is each species has a definitive karyotype. The four species confirm that the diploid number (2n) is variable within the group—R. bowersii has 40 whilst the

Figs. 5-7. 5, photomicrograph of R. edwardsi ♂. 6, photomicrograph of R. sabanus ♂. 7, photomicrograph of R. sabanus ♀.

Fig. 8. Karyograms of R. bowersii.
other three species have 42. Variability within the genus *Rattus* has already been reported by Makino (1943). His numbers were 42 and 46.

The Fundamental Number (i.e. the total number of major chromosome arms) can be employed to distinguish species possessing the same diploid number—*R. muelleri*, *edwardsi*, and *sabanus* have fundamental numbers of 59, 56 and 54 respectively.

The X-chromosome is also variable in its morphology within the group. *R. muelleri* has a metacentric X; the three other species have acrocentric X. The Y-chromosome seems to be of constant morphology i.e. acrocentric type. Tanaka and Kano (1957) however have reported a metacentric Y for *R. norvegicus* albino.
R. bowersii and R. muelleri are currently grouped under the subgenus Stenomys Thomas, and R. edwardsi and R. sabanus under the subgenus Leopoldamys Ellerman, on the basis of skull characters (Ellerman 1949). The species status of R. edwardsi and sabanus is still not certain. Ellerman (1961) states, “It is not impossible that the whole of the present subgenus (Leopoldamys) could be referred to one species, in which case edwardsi is the prior name.” The present study shows that R. edwardsi and sabanus have distinct though very similar karyotype. The karyotypes of R. bowersii and muelleri are quite dissimilar. On this karyological evidence it can be concluded that R. edwardsi and sabanus are valid species and are closely related, i.e. the subgenus Leopoldamys is valid. R. bowersii and muelleri on the other hand do not show close affinity—different diploid number and X-chromosome type.

The affinity of these and other Malayan rats of the genus Rattus is to be discussed in a future paper.

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