68. Studies on the Karyotype Differentiation of the Norway Rat. XVII

Translocation between the Pair Nos. 9 and 14 in the F-344 Strain Rat developed after $\gamma$-Irradiation and its Genetical Investigations

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Five translocations, namely the t(9;18) in the F-344 strain, the t(4;7) in the WM-strain, the t(11;Y) in the NIG-III strain, the t(1;12) in the WKS-strain and the t(3;8) in the BUF-strain rats which occurred after $\gamma$-irradiation, have already been described in the series of this work (Yosida 1984a–d; Yosida and Hamada 1985). One male with a new translocation between the pair nos. 9 and 14 was obtained in the offspring born after the mating between the $\gamma$-irradiated males and the non-irradiated females of the F-344 strain rats. By the mating between the translocation male and the normal females, we obtained the male and the female offspring with the translocation. We also mated these females and males and obtained the translocation homozygous male and female. The present paper deals with the karyotype analysis of the 9;14 translocation developed in the F-344 strain rat, and also the segregation of the translocation chromosomes in their offspring.

Material and methods. The F-344 strain rats maintained in this institute were used in the present study. Acute dose of 700R of the $\gamma$-ray (Cs$^{137}$) was irradiated to the hindquarter of 6 males and then they were mated to the non-irradiated 7 females. Among them 3 females produced 27 offspring, among which one male showed the 9;14 translocation. The male with the translocation was mated to the normal females and then the male and female rats with the translocation were mated. The chromosomes were observed from the cultured cells of the tail tip tissue by our routine procedure (Yosida 1980), and the conventional Giemsa and the trypsin G-banding stainings were applied.

Results and discussion. 1) The normal karyotype of the F-344 strain rat. The normal F-344 strain rat was characterized by having the usual karyotype with $2n=42$, consisting of 12 acrocentric or subtelocentric autosomes pairs (nos. 1 to 12), 8 metacentric autosome pairs (nos. 13 to 20) and the large acrocentric X and the median sized Y. The pair no. 3 of the Norway rat was polymorphic in respect to the acrocentric and subtelocentric natures, but the F-344 strain rats were characterized by having always the subtelocentric homologous pair.

2) The karyotype of the rat with the 9;14 translocation. Among 27 offspring (9 14: 5 13) born after mating between the irradiated males and the non-irradiated females, one male was remarkably shown to have the translocation.
between the acrocentric 9 and the metacentric 14. The short arm from one of the metacentric no. 14 was broken near the centromeric region, and the broken end was translocated to the centromeric region of one of the acrocentric no. 9. Thus, one of the no. 14 was changed into a small acrocentric, but one of the no. 9 into the submetacentric type (Fig. 1). This relation was clearly demonstrated by the observation of the G-banding karyotype (Fig. 2). Based on such a translocation, the pair nos. 9 and 14 became the heteromorphic combination due to the translocation chromosomes and their partners.

The 9;14 translocation in the present investigation was similar to the t(9;18) which occurred in the same F-344 strain rat after γ-irradiation (Yosida 1984a). In the latter case, the short arm of the metacentric no. 18 was translocated to the no. 9, and thus the submetacentric no. 9 and the acrocentric no. 18

Figs. 1-2. Karyotypes of the 9;14 translocation developed in the F-344 strain rat after γ-irradiation. 1: Conventional staining, 2: G-banding staining. The short arm of the metacentric no. 14 is translocated to the acrocentric no. 9.
were developed. In our serial studies on the artificial induction of the translocation in the rat, 6 translocation types were obtained in 5 different rat strains (Yosida 1984e). The chromosome involving the translocation seemed to be random, because several chromosomes such as pair nos. 1, 3, 4, 7, 8, 9, 12, 14, 18 and Y were included. These chromosomes were involved in the translocation in each time, except the no. 9 in which twice translocations occurred in the same F-344 strain rat. Interesting is the fact that these translocations including the no. 9 always occurred with the short arms of the similar metacentric nos. 14 and 18. Such a translocation occurring in the F-344 strain rat seemed not to be due to the random event.

3) Breeding experiments. The translocation heterozygous males (9;14) were mated to the normal females of the same F-344 strain. By such a mating, 35 offspring (♀ 20 : δ 15) were obtained. They segregated into 17 normal (♀ 10 : δ 7) and 18 translocation heterozygotes (♀ 10 : δ 8). The segregation ratio of these two types was almost 1:1 as expected. By the reciprocal mating, 6 offspring from one litter were obtained. They also segregated into the normal (2) and the heterozygotes (4). In all the 41 offspring they segregated into the normals (19) and the translocation heterozygotes (22). The segregation ratio was not significantly different from the expected one (χ² = 0.22, p = 0.7-0.5) (Table I).

Table I. Segregations of the offspring with the 9;14 translocation born after mating between the translocation heterozygotes (+/t) and the normal specimens (+/+), and between the translocation heterozygous males and females

<table>
<thead>
<tr>
<th>Matings</th>
<th>No. of litters</th>
<th>No. of offspring</th>
<th>No. of specimens examined</th>
<th>Karyotypes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+/+</td>
</tr>
<tr>
<td>+/+</td>
<td>9</td>
<td>35 (♀ 20 : δ 15)</td>
<td>35</td>
<td>17 (10:7)</td>
</tr>
<tr>
<td>+/t</td>
<td>1</td>
<td>6 (3:3)</td>
<td>6</td>
<td>2 (0:2)</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>41 (23:18)</td>
<td>41</td>
<td>19 (10:9)</td>
</tr>
<tr>
<td>+/t</td>
<td>11</td>
<td>30 (14:16)</td>
<td>25 (11:14)</td>
<td>5 (2:3)</td>
</tr>
</tbody>
</table>

The translocation heterozygous males and females thus obtained were mated to know whether or not, the offspring with the translocation homozygotes were viable. By such a mating, 30 offspring (♀ 14 : δ 16) from 11 litters were obtained. Among them the karyotypes were successfully analysed in 25 specimens (♀ 11 : δ 14). They segregated into 5 normals (♀ 2 : δ 3), 17 translocation heterozygotes (♀ 8 : δ 9) and 3 translocation homozygotes (♀ 1 : δ 2) (Table I). Although the translocation homozygotes were few in number, the segregation ratio was not significantly different from the expected one (χ² = 5.02, p = 0.1-0.05).

In the 9;14 translocation of the F-344, the litter size in the F₁ and F₂ type matings was slightly fewer than the normal one (6.5-7.0). In the F₁ type matings (normal × hetero. or its reciprocal), the average litter size was 4.1 and in the F₂ type matings (hetero. × hetero.), it was only 2.7. In case of 9;18 translocation, the average litter size in the F₁ type matings was 6.3 which was almost normal, but in the F₂ type matings it was reduced as similar to the present materials. A remarkable difference between the 9;18 and the 9;14 translocations was whether or not, the translocation homozygotes were produced after mating between the heterozygous male and female. In case of the 9;18 trans-
location, the offspring with the translocation homologous pair had been never obtained even though 114 offspring were analyzed. On the other hand, in case of the 9;14 translocation, the homozygotes were obtained in 3 among 25 specimens. It is questionable at present why the homozygotes of the t(9;14) were viable, but those of the t(9;18) were lethal, although these two translocations were very similar. Some important gene or genes in regard to the viability would be located in the short arm of the no. 18 chromosome.

There was no any evidence to determine whether or not, the translocation between the nos. 9 and 14 was reciprocal, because good markers could not be found in these chromosomes. In the other translocations such as t(1;12) and t(11;Y), the reciprocal events could clearly be demonstrated by the transposition of the Ag-NOR (Yosida 1984d; Yosida and Wada 1985). Referring to these cases, the nos. 9 and 14 and also the nos. 9 and 18 translocations seemed to be the reciprocal events.

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References