**59. Studies on the Karyotype Differentiation
in the Norway Rat. XI**

***Translocation between Pair Nos. 1 and 12 occurred
in a WKS-Strain Rat after γ -Irradiation and
its Transmission to the Offspring^{*)}***

By Tosihide H. YOSIDA

National Institute of Genetics, Misima

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The rats with translocation between pair nos. 9 and 18 occurred in the F-344, pair nos. 4 and 7 in the WM and pair no. 11 and Y chromosome in the NIG-III strain rats and their transmission to offspring have been demonstrated already by the present author (Yosida 1984, a-c). The other new translocation between pair nos. 1 and 12 occurred in the WKS-strain rat after γ -irradiation. The translocation between these chromosomes occurred spontaneously in the Lewis strain rat has already been reported by the present author (Yosida 1980a). In that case, the long arm of the pair no. 12 was broken and the broken end was translocated to the short arm of the pair no. 1. In the present case, however, the long arm of the pair no. 1 was broken and the broken end was translocated to the short arm of the pair no. 12. In this paper, the new translocation between nos. 1 and 12 occurred in the WKS-strain rat after γ -irradiation will be described with a special note on the transmission of the translocation to the offspring.

Material and methods. The WKS-strain rat was obtained in 1970 from the Showa University through the courtesy of Dr. Mitsu-yuki Shimizu. Since then the inbreeding of the rat was done by the present author by brother and sister matings for 36 generations as the WKS-strain. Acute doses of 650R and 700R of γ -rays (Cs¹³⁷) were irradiated to the males of the WKS-strain and then mated to the non-irradiated females. The chromosomes of the offspring thus obtained were examined from the cultured cells of the tail tissues by our routine procedure (Yosida 1980b).

Results and discussion. 1) 1/12 translocation. Among 67 offspring born after mating between the irradiated males and the non-irradiated females, one male showed a translocation between pair nos. 1 and 12. About one fourth of the long arm of the pair no. 1

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chromosome was broken, and the broken end was translocated to the short arm of the pair no. 12 (Fig. 1). Thus, one of the pair no. 1 became shorter than the other normal partner, while one of the pair no. 12 deformed to meta- or submetacentrics. This relation was clearly seen by the G-banding staining (Fig. 2). All 50 metaphases

1

2

Figs. 1-2. Karyotypes of 1/12 translocation occurred in a WKS-strain rat born after mating between the γ -irradiated male and the non-irradiated female. The broken end of the no. 1 chromosome is translocated to the no. 12 chromosome. 1: Conventional Giemsa staining. 2: G-banding staining.

examined so far in this individual showed the 1/12 translocation described above. This means that the translocation was stable and they would be transmitted to the all somatic cells by having the functional centromeres and telomeres in the both chromosomes. Although the reciprocal translocation between these two chromosomes was difficult to demonstrate by the conventional or G-banding stainings, it was clearly shown by the translocation of the nucleolar organizer region (NOR). It was already demonstrated by the present author (Yosida 1979) that one of the NORs in the Norway rat was at the short arm region of pair no. 12 (no. 13 by Yosida's alignment system of *Rattus* species). The Ag-NOR was clearly demonstrated at the telomeric region of the long arm of the deformed no. 1, while it was not seen in the metacentric no. 12, to which the broken end of the no. 1 was translocated (Fig. 3).

The other translocation between pair nos. 1 and 12 occurred spontaneously in the Lewis strain rat has been reported by the present author (Yosida 1980a). In that case the long arm of the pair no. 12

Fig. 3. Metaphase chromosomes by Ag-NOR staining in a cell with the 1/12 translocation. The nucleolar organizer regions (NORs) being near the centromere of the pair nos. 3, 11 and 12 are stained heavily, but one of the no. 12 (12^t) having the translocation do not have the NOR. This NOR is translocated to the telomeric region of one (1^t) of the pair no. 1 (arrow). Enlarged photographs of chromosomes with NORs are shown in the square at the right and below.

was broken and the broken end was translocated to the short arm of the no. 1 chromosome. This was just a reverse phenomenon to the present case, and the NOR was not moved in that time.

2) Transmission of the translocation. The 1/12 translocation male was mated to the normal females of the same WKS-strain rats. The 23 F_1 hybrids ($10\text{♀} : 13\text{♂}$) from 4 litters thus obtained were segregated to 8 normal homozygotes ($5\text{♀} : 3\text{♂}$) and 15 translocation heterozygotes ($5\text{♀} : 10\text{♂}$). The segregation was not significantly different from the expected one ($\chi^2 = 2.3$, $p \div 0.1$) (Table I). In the next generation the normal females were mated to the 1/12 translocation heterozygous males and 10 offspring ($5\text{♀} : 5\text{♂}$) were obtained from 2 litters. They were segregated to 5 normal and 5 translocation heterozygotes as just expected. By a mating between the translocation heterozygous female and the normal male, one litter ($2\text{♀} : 2\text{♂}$) was

Table I. Segregation of offspring in F_1 and F_2 generations born after matings between the normal homozygotes and translocation heterozygotes

Matings	Gener.	Total litter nos.	Total Indiv. nos. (♀:♂)	Karyotypes	
				+/+ (♀:♂)	+/tr (♀:♂)
+/+ (♀) × +/tr (♂)	F_1	4	23(10:13)	8(5:3)	15(5:10)
"	F_2	2	10(6:4)	5(4:1)	5(2:3)
+/tr (♀) × +/+ (♂)	"	1	4(2:2)	1(1:0)	3(1:2)
Total		7	37(18:19)	14(10:4)	23(8:15)

obtained and they were segregated to one normal and 3 translocation heterozygotes. The 37 offspring (18♀:19♂) in total from the above 7 litters which were obtained by mating between the normals and translocation heterozygotes were segregated to 14 normals and 23 heterozygotes. This segregation was also not significantly different from the expected one ($\chi^2=1.2$, $0.2 < p < 0.3$), but the number of translocation heterozygotes was slightly higher than that of the normal karyotype. A similar phenomenon was obtained in the case of 1/12 spontaneous translocation (Yosida 1980c). This might be due to a heterosis in the translocation heterozygotes. An average litter size of the offspring between the normals and translocations was 5.3 which was almost normal range.

The 32 offspring (17♀:15♂) in total 9 litters were obtained by mating between female and male heterozygotes. They were segregated to 12 normals (4♀:8♂), 18 translocation heterozygotes (12♀:6♂) and 2 translocation homozygotes (1♀:1♂). The segregation ratio was significantly different from the expected one ($\chi^2=27.3$, $p < 0.001$). A fewer occurrence of the translocation homozygotes than the expected one has also been in the 1/12 translocation occurred spontaneously, although a considerable number of the homozygotes were observed in that case. Difference between the occurrence of the homozygotes between the spontaneous and induced 1/12 translocations might be due to the movement of the nucleolar organizer region. Average litter size of the hybrids between the translocation heterozygous females and males was 3.5 which were fewer than the normal size. This would be due to reduction of the number of translocation homozygotes.

By the mating between the translocation heterozygous female and the translocation homozygous male, 5 offspring (1♀:4♂) were obtained in one litter. They were segregated to 2 translocation male heterozygotes and 3 translocation homozygotes (1♀:2♂). The segregation ratio was well matched with the expected one. This means that the fertility of the 1/12 translocation male is perfect. A good fertility of the other 1/12 translocation homozygoted was also observed in the spontaneous case (Yosida 1980a).

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