49. *Studies on the Karyotype Differentiation of the Norway Rat. XVI*

*Further Observations on the Segregation of Offspring born after Mating between the 11-Y Translocation Females and Males**

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Translocation between the autosome no. 11 and the Y-chromosome occurring in an NIG-III strain rat after γ -irradiation and the segregation of the offspring born after mating between the normal females and the translocation male have been described in the previous paper (Yosida 1984). As described in that paper the breakage occurred near the centromere of the Y-chromosome, and the long part of the broken end was translocated to the short arm of the autosome no. 11. The Y-element with the centromere was changed into a small dot-like chromosome, while one of the no. 11 deformed to the metacentric shape. Based on the morphological characteristics in the tetravalent in the 11-Y translocation heterozygous male, the translocation was suggested to be reciprocal (Yosida and Wada 1984a). The reciprocal event between these two chromosomes was exactly proved by the observation of the translocation of the nucleolar organizer region (Yosida and Wada 1985). By the cross experiments it had been shown that the male was always determined by the presence of the dot-Y, but the long arm which was translocated to the no. 11 did not have any effect to the male determination. In the present paper the further observation of the segregation of the offspring in the hybrids between the 11-Y translocation heterozygous male and the normal females and also the translocation males and females will be described with special regard to the role of the Y chromosome to the male determination.

Material and methods. The NIG-III strain rats established by the present author were used in this study. A male with 11-Y translocation was obtained by mating between the non-irradiated female and the γ -irradiated male (Yosida 1984). The male with the translocation was mated to the normal females and the males and females with 11-Y translocation were obtained. They were mated and the offspring with several types of the sex chromosome combination were obtained. The chromosomes were observed from the cultured cells of the tail tip by our routine procedure (Yosida 1980).

Results and discussion. 1) The segregation of the offspring born after mating between the normal females and the translocation heterozygous males. The results of the segregation in 133 offspring born after mating between the normal females and the 11-Y translocation heterozygous males have already been reported in the previous paper (Yosida 1984). By adding the results of the further studies the segregation ratio in 141 offspring ($\varnothing 79 : \sigma 62$) was as shown in Table I. As seen in the table, among 79 females 68(86.1%) had

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Table I. Segregation of karyotypes in the offspring born after mating between the normal females (11/11:X/X) and the translocation heterozygous males (11/11-Y:X/dot-Y)

No. of litters examined	No. of specimens examined	Females			Males		
		11/11: X/X	Others	11/11-Y: X/dot-Y	Others	11/11-Y: X/dot-Y	Others
24	141 (♀79:♂62)	68	9(11/11-Y:X/O) 1(11/11:X/O) 1(11/11-Y:X/X)	49	11(11/11:X/X/dot-Y) 1(11/11:X/dot-Y/dot-Y) 1(11/11-Y:X/X/dot-Y)		

Table II. Segregation of the karyotypes in the offspring born after mating between the 11-Y translocation heterozygous females (11/11-Y:X/X or 11/11-Y:X/O) and the males (11/11-Y:X/dot-Y)

No. of litters*)	No. of specimens examined	Females			Males		
		11/11: X/X	11/11-Y: X/X	Others	11/11-Y: X/dot-Y	11-Y/11-Y: X/dot-Y	Others
16	63 (♀31:♂32)	11	16	2(11/11-Y:X/O) 1(11-Y/11-Y:X/O) 1(11-Y/11-Y:X/X)	17	10	4(11/11:X/X/dot-Y) 1(11/11-Y:X/X/dot-Y)

*) Total number of offspring from 16 litters is 77 (♀43:♂34).

the normal chromosome constitution (11/11:X/X), but 9 females had the 11/11-Y:X/O constitution (Fig. 1). The females with the 11/11-Y:X/X and the 11/11:X/O constitutions had been observed in each one of specimens. In the male, 49 (79.0%) among 62 specimens had the 11/11-Y:X/dot-Y, but 11 males had 11/11:X/X/dot-Y (Fig. 2). Each one male with 11/11:X/dot-Y/dot-Y and

Figs. 1-2. 1: Karyotype of a female with the 11/11-Y:X/O constitution ($2n=41$).

2: Karyotype of a male with $2n=43$ including 11/11 and X/X/dot-Y chromosomes.

11/11-Y:X/X/dot-Y was also observed. The karyotypes other than the 11/11:X/X female and the 11/11-Y:X/dot-Y male would be developed by the non-disjunction of the composite of the tetravalent which was organized by 4 elements, 11, 11-Y, X and dot-Y (Yosida and Wada 1984b).

2) The segregation of the offspring born after mating between the translocation heterozygous male and female. As described above the females with

the 11/11-Y:X/X or the 11/11-Y:X/O constitution were obtained from mating between the normal female and the translocation male by the nondisjunction. These females were fertile and then they were mated to the translocation males with 11/11-Y:X/dot-Y. By such matings 77 offspring (♀43:♂34) from 16 litters were obtained. Among them the karyotypes of 63 offspring (♀31:♂32) were successfully examined (Table II). In the females two karyotypes, namely 11/11:X/X and 11/11-Y:X/X, would be expected to appear in an equal number. As expected 11 females had the normal karyotype (11/11:X/X) and the other 16 females had the 11/11-Y:X/X constitution. The remaining 4 females, however, had the unexpected karyotypes, such as 11-Y/11-Y:X/X (1 specimen), 11/11-Y:X/O (2 specimens) and 11-Y/11-Y:X/O (1 specimen). The latter 4 females would be developed by the nondisjunction of the dot-Y element. It is interesting that the number of females with the normal karyotype was fewer than that of the translocation karyotype although the difference was not significant ($\chi^2=0.95$, $0.5 < p < 0.3$).

In the males two karyotypes, 11/11-Y:X/dot-Y and 11-Y/11-Y:X/dot-Y, would be expected to be at an equal number. Among 32 males, 17 specimens showed the 11/11-Y:X/dot-Y constitution, but 10 specimens had the 11-Y/11-Y:X/dot-Y. The other 5 males, however, had the unexpected karyotypes, namely 4 specimens had 11/11:X/X/dot-Y and the remaining one had 11/11-Y:X/X/dot-Y. The latter 5 males should be developed by the nondisjunction of the dot-Y in the male meiosis as we observed (Yosida and Wada 1984b). It is interesting that the number of the males with the 11-Y/11-Y:X/dot-Y combination was fewer than those with the 11/11-Y:X/dot-Y, although the difference was not significant ($\chi^2=1.95$, $0.2 < p < 0.1$). The number of the former type seemed to be due to some detrimental effect in their development. So far examined until the present time, any male with the 11/11:X/dot-Y could not be observed, although 4 males with the 11/11:X/dot-Y were obtained. The males with the former constitution might become the lethal. This remains as the further problem. The males with the other karyotype than the 11/11-Y:X/dot-Y were steril. The fertility of the males with the unexpected karyotypes in the hybrids between the 11/11-Y translocation males and females will be reported elsewhere. Based on the above investigations it is suggested that the male determining gene would be located on the dot-Y. The other large part of the Y which was translocated to the no. 11, however, seemed not to be necessary for the male determination, but it might play some role for the development of the normal and functional male, because the normal male was always determined by only the 11/11-Y:X/dot-Y combination.

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References

- Yosida, T. H.: Cytogenetics of the Black Rat. Univ. Tokyo Press, Tokyo, 456 pp. (1980).
—: Proc. Japan Acad., **60B**, 125–128 (1984).
Yosida, T. H. and Wada, M. Y.: *ibid.*, **60B**, 357–360 (1984a).
—: *ibid.*, **60B**, 361–364 (1984b).
—: *ibid.*, **61B**, 173–175 (1985).