129. Cytogenetical Studies on the Japanese Raccoon Dog. XII

*A Possible Relation between the Karyotypes of the Japanese and European Specimens**

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According to the studies on the karyotypes of the Japanese raccoon dogs (*Nyctereutes procyonoides viverrinus*) by Yosida *et al.* (1983, 1984, 1985) and Yosida and Wada (1984a-d, 1985a-c), the basic chromosome number of these specimens was $2n=38$ consisting of 13 meta- or submetacentric autosome pairs, 5 acrocentric autosome pairs and a metacentric X and a small Y chromosome. All of 39 specimens examined so far by them had the above basic karyotype including always 2, 3 or 4 B-chromosomes in their chromosome complements. Nine specimens among them showed a remarkable karyotype by having the Robertsonian fission of some bialleled autosomes; 8 specimens among them had a single fission of some metacentric autosomes, but the remaining one specimen had the fission of three chromosomes. By the presence of the B-chromosomes and the Robertsonian fission, the chromosome numbers of the Japanese raccoon dogs fluctuated from 40 to 45.

According to Mäkinen (1974) and Mäkinen and Fredga (1980), the raccoon dogs (*N. procyonoides procyonoides*) in Finland, however, were characterized by having $2n=56$ consisting of 5 meta- or submetacentric autosome pairs (nos. 1 to 5), 22 acrocentric autosome pairs (nos. 6 to 27), and a metacentric X and a small Y. Because of the difficulty for obtaining of the European specimens we could not compare directly the karyotypes of European and the Japanese raccoon dogs, but fortunately we could compare them from the data published by Mäkinen and Fredga (1980) on the Finland specimens. They showed clearly the G- and C-band patterns in their specimens. The C-band pattern of the Finland specimens seems to be similar to the Japanese ones, in which the centromeric regions of the chromosomes were stained darkly. Mäkinen and Fredga (1980) noticed on the C-banding pattern of the acrocentric autosome no. 9, because the centromeric region of that pair was not stained differentially as seen in the other autosomes, but stained darkly along the whole length of the chromosomes. By such a peculiar character of the autosome no. 9, they have noticed that the autosome no. 9 would be derived from the others in the C-staining quality. According to our studies on the Japanese raccoon dogs, these two autosomes (no. 9) would not be arranged in the autosomes (A-chromosomes), but would be distinguished as the B-chromosomes (Fig. 1B). If these two chromosomes (no. 9) are discriminated as the B-elements from the autosomes, the karyotype of the Finland raccoon dogs would be formulated as $52A+XY+2B$. The X and Y chromosomes in the Finland specimens seem to be the same as those of the Japanese ones.

As described previously, the autosome number of the basic karyotype of the

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Fig. 1. G- and C-banding patterns of the basic karyotypes in a female Japanese raccoon dog with 4 B-chromosomes. A: G-banding karyotypes. B: C-banding karyotype. Bar corresponds to 10 μ .

Japanese raccoon dogs was 36, consisting of 26 (13 pairs) meta- or submetacentrics and 10 (5 pairs) acrocentrics (Fig. 1A). In the Finland raccoon dogs, however, 10 (5 pairs) autosomes were the meta- or submetacentrics, while 42 (21 pairs) autosomes excluding the pair no. 9 were of acrocentric. In the Finland specimens, 16 meta- or submetacentrics (8 pairs) are reduced from the Japanese ones, while 32 acrocentrics (16 pairs) increased. From such a numerical relation between the chromosomes in the Japanese and Finland raccoon dogs, it could be suggested that 16 acrocentric pairs in the Finland specimens would correspond to 8 metacentrics in the Japanese ones.

When the G-band karyotype of the Japanese raccoon dog (Fig. 1A) is compared with that of the Finland specimens appeared in the paper by Mäkinen and Fredga (1980), the relation between these two karyotypes can be clearly demonstrated. As seen in the table (Table I), pair nos. 1, 4, 9, 12 and 13 biamed chromosomes and nos. 14, 15, 16, 17 and 18 acrocentric pairs in the

Table I. Correspondance of chromosomes between the Japanese
and the Finland raccoon dogs due to the
Robertsonian rearrangements

Chromosome nos. in the Japanese specimens (basic karyotype)	Chromosome nos. in the Finland specimens*
1 (biarmed)	1 (biarmed)
2 (")	20 and 6 (acrocentrics)
3 (")	14 and 7 (")
4 (")	2 (biarmed)
5 (")	22 and 11 (acrocentrics)
6 (")	27 and 15 (")
7 (")	23 and 19 (")
8 (")	26 and 8 (")
9 (")	3 (biarmed)
10 (")	24 and 17 (acrocentrics)
11 (")	21 and 12 (")
12 (")	4 (biarmed)
13 (")	5 (")
14 (acrocentrics)	10 (acrocentrics)
15 (")	16 (")
16 (")	25 (")
17 (")	18 (")
18 (")	13 (")
X (biarmed)	X (biarmed)
Y (")	Y (")
B's (acrocentrics)	9 (acrocentrics)
Total nos. 38+B's	56

* Chromosome numbers are based on the data from Mäkinen and Fredga (1980).

Japanese specimens would correspond to the nos. 1, 2, 3, 4 and 5 biarmed pairs, and nos. 10, 16, 25, 18 and 13 acrocentric pairs in the Finland specimens, respectively. On the other hand, 8 biarmed chromosome pairs such as nos. 2, 3, 5, 6, 7, 8, 10 and 11 in the Japanese specimens would correspond to the acrocentric nos. 20 and 6, nos. 14 and 7, nos. 22 and 11, nos. 27 and 15, nos. 23 and 19, nos. 26 and 8, nos. 24 and 17 and nos. 21 and 12 in the Finland specimens, respectively. The autosome no. 9 in the Finland specimens is equivalent to the B-chromosomes in the Japanese ones, although the length of the no. 9 (B's) in the Finland specimens seems to be slightly longer than the B's in the Japanese ones. As already described, among 39 specimens collected in Japan, 30 specimens (77.0%) had the basic karyotype ($2n=38+B's$), but only 9 (23.0%) showed the Robertsonian fission. Although it is documented by many cytogeneticists that the Robertsonian fission is rare in mammals, a typical case of the karyotype by the Robertsonian fission has been demonstrated in the Mauritius black rats (Yosida *et al.* 1979). Based on the above investigations, we suggested that the karyotype evolution in the raccoon dogs is due to the Robertsonian fission mechanism. If this explanation is allowed to the Finland specimens, they would be derived from the basic karyotype with $2n=38$ by the Robertsonian fission of the 8 biarmed chromosomes, nos. 2, 3, 5, 6, 7, 8, 10 and 11. Among the above 8 biarmed chromosomes, the Robertsonian fission of nos. 5, 6, 8 and 11 has already been observed in the Japanese raccoon dogs (Yosida and Wada 1984). Although the fission of the other chromosomes such as nos. 2, 3, 7 and 10 has not yet been

observed in the Japanese specimens, it would be found in somewhere of that country by the observation of more number of the specimens.

One of the present authors (Yosida 1983) has published an idea of the sequentiality of the chromosome evolution. The evolution of the karyotype in the raccoon dogs would have occurred through the sequential event from one Robertsonian rearrangement to the others. It has been known as a common opinion that the raccoon dog is originated in Guang Dong province of China. From there the raccoon dogs with a few Robertsonian fission would be migrated to Japan through Korea, while the other specimens with many fissions would be migrated to northern China and Siberia, from there to Europe. If the karyotype evolution of the raccoon dogs is considered to be due to the Robertsonian fusion mechanism as suggested by Mäkinen and Fredga (1980), the situation of the evolutionary process would be reversed from the above explanation. At present it is difficult to determine which is a proper explanation for the karyotype evolution in the raccoon dogs, the Robertsonian fission or fusion. This problem would be determined by a wide survey of the materials distributing in China, Korea and Siberia.

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