63. The Chromosomes of the Sumatran Serow
(Capricornis sumatrensis)

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The Sumatran serow (Capricornis sumatrensis) is widely distributed from Northern India, Nepal, Burma, Thailand, Malaysia and Southern China to Sumatra, where this rare animal is now protected by law as an endangered species. The serows, however, are still hunted in the Sumatran mountain retreats for hide and meat (West, 1979).

It has been reported by Dolan (1963) that the Sumatran serows consist of 11 subspecies and are taxonomically closely related to the Japanese serow (Capricornis crispus) and Formosan serow (Capricornis swinhoi). At present, five Sumatran serows (Capricornis sumatrensis, Beckstein, 1799) are in captivity at the Dusit Zoo in Bangkok, Thailand. They are as large as a calf in body size larger when compared with Japanese serows. In addition, they have characteristic features with black hair, long ears and slightly curved thick horns (Fig. 1).

![Fig. 1. Sumatran serow at Dusit Zoo.](image)

The first cytogenetic studies on a male Sumatran serow using blood samples obtained at Dusit Zoo, Bangkok was reported by Fischer and Höhn (1972). The karyotypes showed a diploid number of 2n = 46 including five pairs of metacentrics and the unusual metacentric
sex chromosome without any banding analysis, thereby giving a nombre fondamental (NF) of 58. In the same year, the karyotypes of Japanese serows (*Capricornis crispus*) were investigated by Benirschke et al. (1972). The chromosomes of Japanese serows possessed a diploid number of $2n=50$, consisting of ten metacentrics and 40 acrocentrics including the sex chromosomes. The chromosomes of the Formosan serow (*Capricornis swinhoi*) were examined by Soma et al. (1981), who found that the karyotype had a diploid number of $2n=50$, being identical with those of Japanese serows in banding patterns; thus, the NF of both serows had the same number of 60. In addition, from chromosomal analysis of Rupicaprina, the NF in these rupicaprine species of chamois (Gropp et al., 1970), Rocky Mountain goat (Wurster and Benirschke, 1968) and *Capricornis* all showed the same number of 60. Therefore, it remained questionable why the number of NF in the Sumatran serow showed only 58 and the sex chromosomes consisted of metacentrics, as reported by Fischer and Höhn (1972).

In order to clear up genetic traits of the tribe Rupicaprini, the difference of the chromosome number and the sex chromosome between Sumatran serow and Japanese serow as well as Formosan serow should be investigated with the use of banding analysis.

We were able to obtain skin biopsies from a pair of Sumatran serows at the Dusit Zoo, Bangkok, from where biopsies were kept in sterile culture medium, taken back to Tokyo the next day, and processed successfully. In this paper, we report that the chromosomes of a pair of Sumatran serows are identified clearly by the use of banding techniques.

**Methods.** Biopsies were obtained from earlobes of a pair of Sumatran serows at Dusit Zoo, Bangkok, Thailand, and cultured at our laboratory in Tokyo the next day. The skin cultures were established after three weeks of incubation. After culturing, all air-dried preparations were stained by the conventional method and the trypsin-Giemsa technique (Seabright, 1972), as well as the C-banding technique (Sumner, 1972).

In order to know the possible site of rRNA genes, the nucleolus organizer regions (NORs) were stained by Ag-As technique (Goodpasture and Bloom, 1975). Furthermore, sister chromatid exchanges (SCEs) of the chromosomes were examined after labelling of BrdU.

**Results.** The karyotypes of this pair of Sumatran serows had a diploid number of $2n=48$ with six pairs of metacentrics or sub-metacentrics and eighteen pairs of acrocentrics including the sex chromosomes (Fig. 2). Accordingly, the NF of the Sumatran serow is 60, the same number as those of Japanese and Formosan serows.
The Giemsa banding patterns are depicted in Fig. 3. The elements composed of pairs have homologous banding patterns. As demonstrated in our previous publication of Japanese and Formosan serows (Soma et al., 1981), Giemsa banding patterns of the Sumatran serows were also similar in size and staining when compared to other serows. C-banding patterns of the chromosomes of the Sumatran serows revealed heterochromatin staining of the centromeres of the acrocentrics (Fig. 4). The sex chromosomes of the Sumatran serows
could be identified by large acrocentrics with homologous staining similar to those of Japanese and Formosan serows.

Moreover, sister chromatid exchanges within chromosomes in a male Sumatran serow under treatment with 0.5 \( \mu g/ml \) BrdU showed pair distributions of the arms (Fig. 5).

The NORs in the Sumatran serow were found to occur only in the long arms of no. 4 metacentrics (Fig. 6). Although the localiza-

![Figs. 5-6. 5: Sister chromatid exchanges by BrdU treatment in the chromosomes of a male Sumatran serow. 6: Karyotype of a male Sumatran serow with one NORs in pair no. 4. Arrow indicates the NORs.](image)

...tion of the NORs was found in only one chromosome in this species, it should be studied whether the NORs are locating at the same position of the chromosomes in the Japanese and Formosan serows or not. However, with regard to the presence of a pair of no. 6 sub-metacentrics lacking in other serows, comparative studies of the related genera with the same chromosome number such as Hemitragus might be helpful.

Discussion. The karyotypes of the tribe Rupicaprini which is thought to be taxonomically closely related have been investigated by several authors (Wurster and Benirschke, 1968; Gropp et al., 1970; Fischer and Höhn, 1972; Benirschke et al., 1972; Soma et al., 1980; Soma et al., 1981). From these chromosomal findings, it has been recognized that even though the diploid number of each species is different, the NF in four species, Rocky Mountain goat, chamois, Japanese serow and Formosan serow, is the same number of 60, except for that of the Sumatran serow.

In order to clarify this genetic difference in Capricornis, the karyotypes of a pair of Capricornis sumatrensis were investigated. As a result, the chromosomes of Sumatran serows showed a diploid number of \( 2n=48 \), therefore the NF of this species was also found to be 60. In addition, the sex chromosomes of the Sumatran serows were acrocentrics, identical with those of other serows. As expressed
by Wurster and Benirschke (1968), the Bovoidea seem to employ little other than centric fusion as a mechanism of karyotype evolution. Although the chromosomal constitutions of the Sumatran serows consist of 6 pairs of submetacentrics, interestingly the pair no. 6 submetacentrics lacking, in other serows, may reflect this result of a Robertsonian fusion, thus the Sumatran serow has the same NF number as that of the Japanese serow.

The Himalayan tahr (*Hemitragus*) is generally regarded as a living primitive link between the rupicaprids and the caprids. The karyotypes of this species show 2n=48 consisting of 6 pairs of biarmed and 17 pairs of acrocentric autosomes, a large acrocentric X and a small biarmed Y (Bunch and Nadler, 1980).

Even though the localization of the NORs in the chromosomes of the Sumatran serow is recognized in the arms of no. 4 submetacentrics, further comparative studies among the related species such as a Himalayan tahr might be helpful in clarifying the genetic evolution of *Capricornis*.

In conclusions, it is evident that all *Capricornis* have been genetically derived from the same stock in Asia and it might be presumed that the Japanese serow as well as the Formosan serow are primitive relic species from past epochs in the isolated islands, whereas the Sumatran serows tend to be in the evolutionary pathway on their distributions.

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**References**