of *M. reevesi* to that of *M. muntjak* through repeated fusions and inversions would entail considerable loss of DNA. The figure of 0.724 of the human DNA value for the *M. muntjak* with $2n = 6/7$ indicates that such a loss may have taken place. On the other hand, one would then expect a figure of somewhat more than 0.724, but considerably less than the given figure of 0.948 for the *M. muntjak* with $2n = 8$. These data on DNA values do not support conclusions concerning the path of karyotype evolution, but do offer a basis for speculation.

Figure 3 shows the same karyotype of *M. muntjak muntjak* as shown in Figure 1 but with pair No. 1 superimposed on pair No. 3 to depict the possible evolution of the karyotype of *M. muntjak vaginalis* from that of *M. muntjak muntjak*. This pathway supposes breakage and subsequent fusion of pairs 1 and 3. This would have involved some chromatin loss and appears to be a feasible pathway. Homology of the chromosomes of the 2 animals cannot be ascertained, however, and the *X* chromosome appears to be translocated to a different autosome in each case. In *M. muntjak vaginalis* the autosome involved often displays a marked secondary constriction about a third of the distance from the centromere. This autosome is equal in length by actual measurement, to half of the No. 1 chromosome. In *M. muntjak muntjak* the autosome fused with the *X* is relatively shorter and does not display the secondary constriction. A similar constriction appears in the No. 3 pair. It is thus possible that in transitioning from the karyotype of *M. muntjak muntjak* to that of *M. muntjak vaginalis* the *X* chromosome translocated onto the No. 3 pair and the autosome which had borne the *X* chromosome translocated onto the No. 1 pair. This transition seems more probable, but would have involved less DNA loss than the hypothesis pictured in Figure 3 and is not confirmed by the DNA figures. Transition of the karyotype from that of *M. muntjak vaginalis* to that of *M. muntjak muntjak* would have involved chromosomal fission, and the attainment of additional centromeres and DNA. This is improbable. A fourth alternative would be the separate evolution of the karyotype of each from a common predecessor, possibly *M. reevesi*.

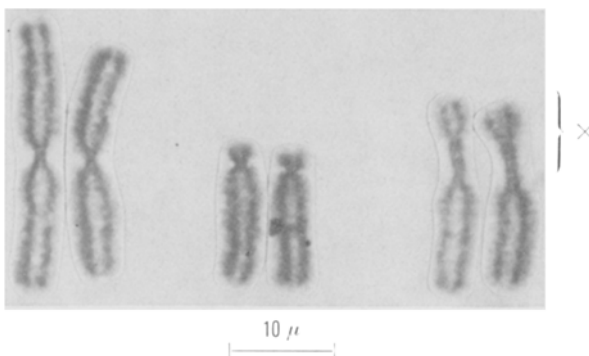

Fig. 2. Karyotype of *Muntjacus muntjak vaginalis*. ×1600.

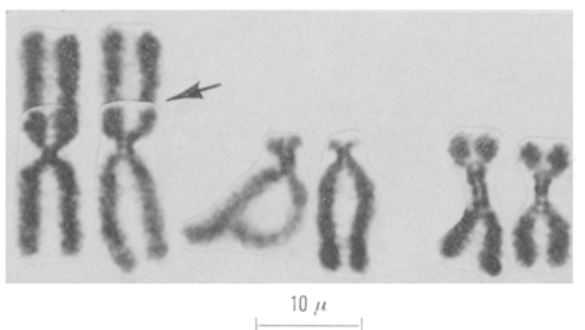

Fig. 3. Karyotype of *Muntiacus muntjak muntjak* with pair No. 1 superimposed on pair No. 3 with junction at arrow. Thus pair No. 1 becomes similar in Figures 2 and 3, but note difference in realative size of the *X*/autosome element in each. ×1600.

The karyotype differences between these subspecies are pronounced enough that one would predict synaptic incompatibility in meiotic division of a hybrid offspring, thus conferring sterility on this individual. Although specimens of *M. muntjak muntjak* are difficult to obtain, confirmation of a diploid number of 8 for this subspecies is essential, and hybridization studies of the two subspecies would be invaluable. If this karyotype is indeed characteristic of this subspecies, then it is possible that a taxonomic revision should be considered and that either subsp. *muntjak* or subsp. *vaginalis* should receive full species status.

Zusammenfassung. Es gibt bemerkenswerte Unterschiede der Karyotypen von *Muntiacus muntjak vaginalis* und *M. m. muntjak*. Jeder hat einen unterschiedlichen DNA-Wert, aber beide Werte sind niedriger als diejenigen des Menschen. Die Karyotypen-Evolution ist nicht abgeklärt, aber die Befunde zeigen, dass eine taxonomische Revision notwendig ist.

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[5] We thank Captain Illar Muul (U.S. Army Medical Research Unit, Kuala Lumpur) for donation of the skin biopsy of *Muntiacus muntjak muntjak*, and K. Imredy, B. Bacon and M. Larson for technical assistance. Supported by NIH Grant No. HD 03298.

On Dicentric Aberration Yields in 50-MeV Proton-Irradiated Human Peripheral Lymphocytes

In space, it is known that protons constitute the major component of ionizing radiation. It has been pointed out by a number of authors[1–3] that radiation biology problems posed by space flights require, in the first place: studies on detrimental effects of protons and heavy ions of various energies; studies on combined effects of these particles and other flight factors; development of effective physical, biological, and pharmacological means of protection; development of appropriate methods for physical and 'biological' dosimetry of ionizing radiations, with a view

to ensuring radiation safety in space. It is considered that, in space, physical measurements should be supplemented and compared with 'quantitative biological indicators', basing on radiobiological phenomena that are better understood. On present knowledge, chromosome aberration analysis appears to be the most valuable criterion for 'biological dosimetry' purposes[4-7]. This paper reports on dicentric yields found in human peripheral lymphocytes after exposing them to 50-MeV protons.

Whole peripheral blood from healthy donors was irradiated directly following vena puncture. The cultivation techniques used have been described in a previous paper[8] and do not differ from those conventionally used for human lymphocytes. Fixation time was at 52 h after phytohemagglutinin stimulation. Exposures were carried out at the Joint Institute for Nuclear Research, Dubna (USSR), at 18–20°C, with protons of 50 MeV given in doses of 25, 50, 100, 250, or 500 rads at a dose rate of 0.62 rad/sec. Dosimetry has been described by AFANASIEV et al.[9]. Analysis applied to metaphases with chromosome sets of 46 centromeres, containing well-spread chromosomes of good speralization.

In human peripheral lymphocytes exposed in vitro at G_0 stage to 50-MeV protons, the multi-break aberrations most frequently seen were dicentrics, minutes, and rings, while one-break aberrations consisted mainly of chromosome fragments. Dicentrics predominated, constituting about 55–65% of multi-break aberrations. Because of higher relative yields of dicentrics and because of certainty in their microscopic identification, this cytological criterion is given preference over other aberration types by a number of authors[4-7,10]. In the present work, too, dicentric yields only have been used in estimating dose-response relationships. The analysis results are presented in the Table and the Figure. The Table gives values observed (Y) and values calculated (Y_c). The figure shows a plot of dicentric yields per cell versus dose. Statistical treatment of experimental findings by least squares analysis indicated that they would best be fitted by a regression curve experssed by the equation $Y = (12.6 \pm 1.60) \times 10^{-5} \times D^{(1.36 \pm 0.027)}$.

The equation describes in the best way dicentric yields produced by 50-MeV proton doses of 25 to 500 rads, with a coefficient of variation of about 20%.

The yield of dicentrics per cell, after irradiation of human lymphocytes with protons 50 MeV

Dose in rad	No. of cells	Dicentrics per cell Y	Y_c
0	1000	0	−0
25	528	0.004	−0.010
50	510	0.027	−0.026
100	492	0.049	−0.066
250	458	0.317	−0.230
500	400	0.490	−0.590
$Y = bD^{+n}$	—	$Y = (12.6 \pm 1.6) \times 10^{-5} \times D^{(1.36 \pm 0.027)}$	
X^2	—	$X^2 = 5.8$	

Y, experimental data; Yc, calculated data

Zusammenfassung. Zur biologischen Dosimetrie wird eine Analyse für die Dizentiks-Ausbeute in Lymphozyten bei in vitro Bestrahlung aus peripherem Menschenblut mit 50-MeV-Protonen durchgeführt. Zur Approximation der experimentellen Befunde erweist sich eine Regressionskurve, entsprechend der Gleichung $Y = (12{,}6 \pm 1{,}6) \times 10^{-5} \times D^{(1{,}36 \pm 0.027)}$ als vorteilhaft.

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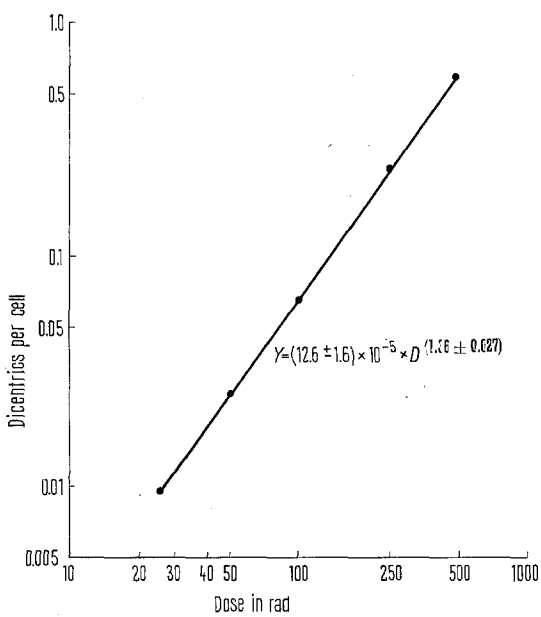

Figure 1. The average number of dicentrics per cell as a function of dose after irradiation with protons 50 MeV.

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