

general. It does not seem impossible that it is just this property which determines the difference in the organization of plants and lower animals on one hand and of the warm-blooded animals on the other. We may in this connexion recall, for example, the great capacity for regeneration of plants and lower animals as compared with higher animals, and the occurrence of both sex and other mosaics in plants and insects and their absence in warm-blooded animals.

Our thanks are due to Prof. A. Turunen, head of the Women's Clinic of the University of Helsinki, for the opportunity of carrying out the present study. A more extensive account of these observations and their theoretical implications will be published elsewhere¹⁰.

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Multiple Sex Chromosomes in the Marsupials

DURING the past thirty years, some twenty species of marsupials have been examined cytologically. In all of them, a typical XY sex-chromosome mechanism has been reported. We have recently re-investigated the potoroo (*Potorous tridactylus*), a common species of rat-kangaroo in Tasmania. In the spermatogonial mitoses, the male shows thirteen chromosomes, whereas the female shows twelve in ovarian mitoses (Figs. 1 and 2). The chromosomes of the female can easily be arranged in homologous pairs, one pair (the X -chromosomes) being conspicuous by their long, nearly median, centromere constriction. In the male, ten chromosomes can be paired, but three have no similar partners. These are the X , with a long sub-median constriction, the smallest of the set (Y_1), and an acrocentric (Y_2). The last two chromosomes are

not represented in the female. In accord with these observations, five bivalents held together by from one to five chiasmata and a trivalent are formed at the first division of meiosis in the male (Fig. 3). The trivalent is made up of the X , pairing in one of its arms with Y_1 , and in the other arm with Y_2 . Orientation on the spindle is always such that Y_1 and Y_2 are directed to one pole, and the X to the other pole. Two types of sperm are produced, a male-determining type with seven chromosomes, and a female-determining with six. The sex-determining mechanism is, thus, of the $XY_1Y_2:XX$ type.

In the prophase stages of meiosis, the Y_2 and its homologous arm in the X behave similarly to the autosomes and usually form two typical chiasmata. The other arm of the X -chromosome, like Y_1 , is strongly heterochromatic, being condensed into an irregular sphere at earliest diplotene. At later diplotene this arm is seen to be made up of two parts, the distal pairing segment being more condensed than the intercalary unpaired region. This behaviour is characteristic of the X -chromosomes of other marsupials that have been investigated¹. It is thus probable that the aberrant mechanism in the potoroo has arisen by translocation between the X -chromosome and an autosome with loss of a centromere.

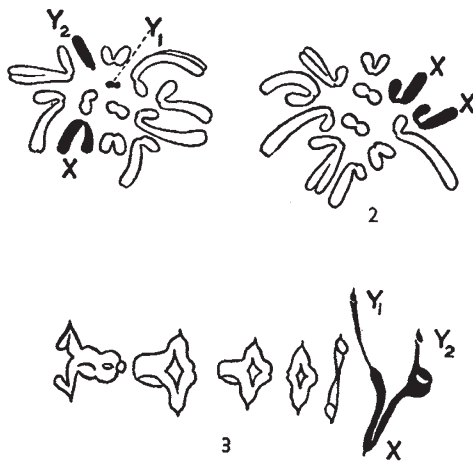
These results are based on the examination of three specimens, a male from Sorell in southern Tasmania, and a male and female obtained in Hobart. The species has previously been investigated by Altmann and Ellery² in animals obtained from Tasmania. They interpreted their observations as showing a typical XY mechanism. It is, perhaps, possible that two sex-determination mechanisms exist in this species. However, since their XY bivalent corresponds in size to the smallest bivalent of our material, this seems unlikely.

It is at present impossible to say how widespread multiple sex-chromosome mechanisms are in the marsupials. As pointed out by Darlington³ and more recently by Matthey⁴, Agar's⁵ results on *Macropus ualabatus* (= *Wallabia bicolor*) are probably to be interpreted as showing the existence of a multiple mechanism in this species. Indeed, the X -chromosome seems to have the same long centromere constriction which is visible in the potoroo. We interpret Agar's figures as showing that the female wallaby has ten chromosomes; and the male eleven, of which three form a trivalent at meiosis as in the potoroo. It is probable that a similar mechanism may also exist in the insectivore *Sorex araneus*, Bovey (cited in Matthey⁴) having described a trivalent at meiosis in the male. The chromosome number in the female of this species is, however, unknown.

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Magnification, 2,000

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