SOME CYTOGENETICAL ASPECTS OF GENUS *TRICHURIS* (NEMATODA)*

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ABSTRACT

Karyological studies have been made during mitosis and meiosis on three species of genus *Trichuris*, viz., *T. ovis, T. globulosa* and *T. trichura*. They show a diploid sumber of 6, 6 and 7 and haploid number of 3, 3, and 4 chromosomes respectively. The sex-mechanism is of the XY-type in the former two species and XO-type in the last species.

In *T. ovis* and *T. globulosa* in addition to the normal chromosomal set of the diploid complement there have been observed 2 small supernumerary chromosomes. These chromosomes divide equationally during mitosis and post redutionally during meiosis. Their role and possible mode of origin has bees suggested and discussed.

INTRODUCTION

IN Super family Trichuroidea (Nematoda) chromosome number has been earlier reported in 3 species (Walton, 1923 and Sharma *et al.*, 1968). During the present investigations *Trichuris trichiura, Trichuris ovis* and *Trichuris globulosa* have been studied for a comparative mitotic and meiotic behaviour of the chromosomes in the genus *Trichuris*. *Trichuris trichiura* is an addition to the existing karyological data on this super-family.

MATERIAL AND TECHNIQUES

The specimens of *Trichuris trichiura, Trichuris ovis* and *Trichuris* globulosa were procured from the intestine of monkey, goat and sheep respectively. The specimens were collected and dissected is Ringer's solution (NaCl = 0·65 g, KCl = 0·025 g, $CaCl_2$ = 0·03 g and H_2O = 100 ml). The male gonads were fixed in acetic alcohol (1 : 3) and stained with Gomori's haematoxylin. Permanent slides were prepared by the quick freeze method (Melander and Wingstrand, 1953). Figures were drawn with the help of a camera lucida.

OBSERVATIONS

(a) Behaviour of mitotic and meiotic chromosomes in the genus Trichuris :

During mitosis and meiosis in *Trichuris trichiura, T. ovis* and *T. globulosa*, the chromosomes go through the usual stages of interphase, prophase, metaphase, anaphase and telophase. In mitosis, studied from the spermatogonial divisions, the chromosomes are acrocentric. They are small in size varying between ·31–1·81 μ and are rod-shaped. The largest pair in *T. trichiura* is the longest of all the other chromosomes amongst these 3 species (Fig. 16). This pair sometimes reveals the presence of a small arm of the acrocentric chromosome. In *T. ovis* and *T. globulosa*, the chromosomes arrange themselves on the metaphase plate in a radial fashion (Figs. 1 and 7, Ph. A and D). At anaphase the chromosomes divide equationally.

Meiosis I is reductional and meiosis II is equational. The chromosomes show an acrocentric nature. At diplotene chiasma formation takes place and the metaphase bivalents reveal the two pairs of sister-chromatids seperated by a terminal chiasma (Figs, 2, 8 and 17). At metaphase II again, usually the sister-chromatids in a chromosome are visible (Figs. 3, 9 and 10). In *T. trichiura*, the two sister-chromatids of the longest pair show a longitudinal split in their longer arms alone. This chromosome then reveals 4 half-chromatids held together at the point of the centromere and the short arm of the acrocentric chromosome continuing further as such (Figs. 18 and 19). At metaphase II, in *T. ovis* and *T. globulosa*, sister-chromatids of one of the chromosomes show precocious movement (Figs. 9 and 10).

Anaphase II is equational for all the chromosomes in all the three species (Figs. 4, 5, 11, 12, 20 and 21, Ph. C).

(b) Chromosome number :

The chromosome number in *Trichuris trichiura, Trichuris ovis* and *Trichuris globulosa* is given in Table I.

(c) Sex-mechanism :

In *Trichuris trichiura*, the sex-mechanism is of the XO–XX type, the sex-chromosome is small rod-shaped. In the remaining two species, *i.e., Trichuris ovis* and *Trichuris globulosa*, however, it is of the XY–XX type and the sex-bivalent cannot be distinguished.

(d) Supernumerary chromosomes (Figs. 1 to 16 and Table II) :

In *T. ovis* and *T. globulosa*, in addition to the normal complement of 6 chromosomes ($2n$), 2 small

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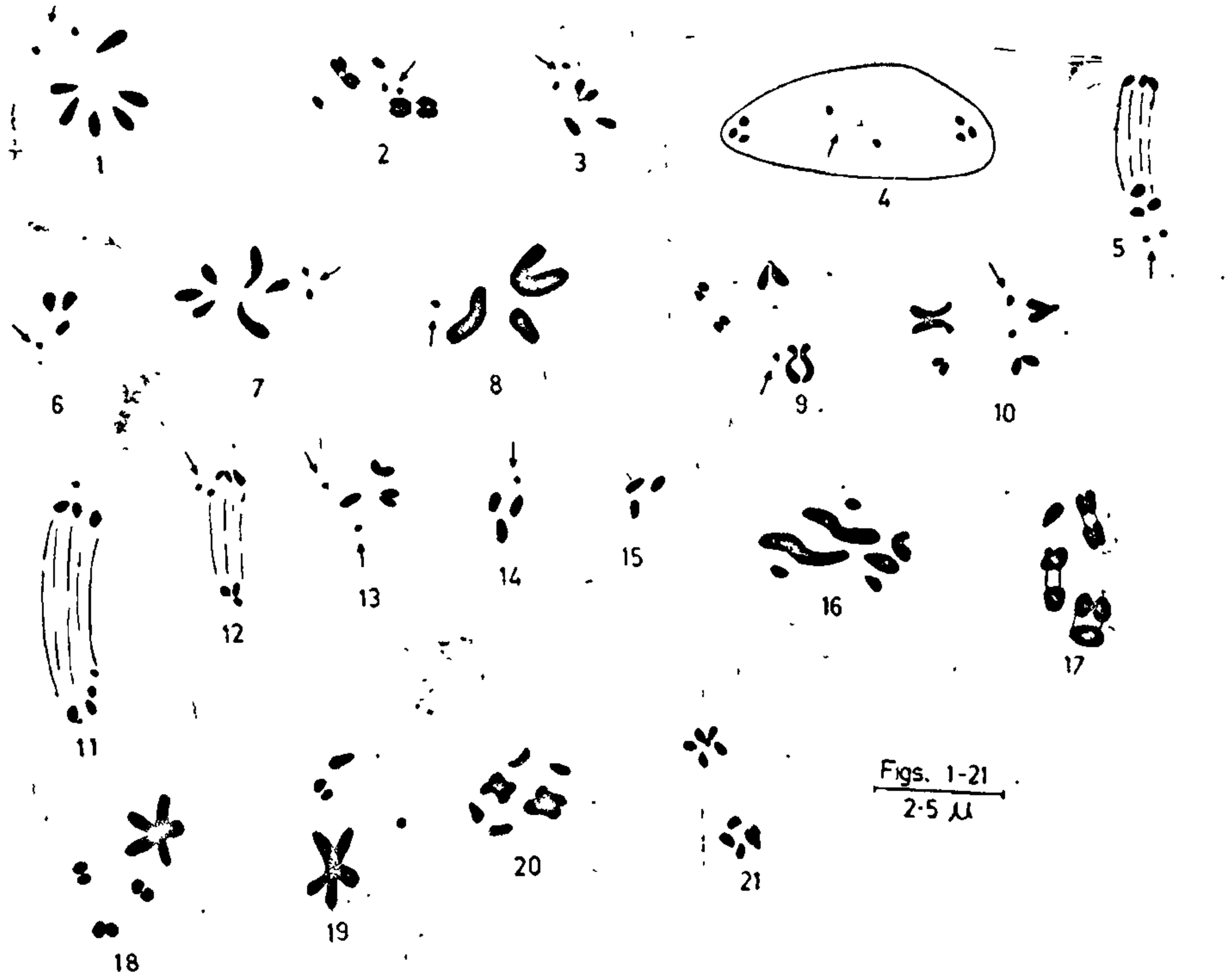
* This work was carried out at Department of Zoology, Punjab University, Chandigarh and comprises a part of the approved Ph.D. thesis,



FIGS. 1–21. Figs. 1–6. *Trichuris ovis*. Fig. 1. Spermatogonial metaphase showing 2 supernumerary thromosomes (arrow). Fig. 2. Metaphase I showing an early disjunction in one of the bivalents and 2 supernumerary chromosomes (arrow). Fig. 3. Metaphase II with 2 supernumerary chromosomes (arrow). Fig: 4. Late anaphase II, supernumerary chromosomes showing a reductional division (arrow). Fig. 5. Late anaphase II, showing 2 supernumerary chromosomes at the same pole (arrow). Fig. 6. Spermatid with 1 supernumerary chromosomes (arrow). Figs. 7–15. *Trichuris globulosa*. Fig. 7. Spermatogonial metaphase showing 2 supernumerary chromosomes (arrow). Fig. 8. Metaphase I showing 2 supernumerary chromosomes (arrow). Figs. 9 and 10. Metaphase II showing an early separation of sister chromatids of a chromosome and 2 supernumerary chromosomes respectively (arrow). Fig. 11. Late anaphase II showing reductional division of supernumerary chromosomes. Fig. 12. Late anaphase II showing random division of suprenumerary chromosomes (arrow). Figs. 13–15. Spermatids showing 2 supernumerary chromosomes, 1-supernumerary chrofosome and no supernumerary chromosome (arrows). Figs. 16–21. *Trichuris trichura* Fig. 16. Spermatogonial metaphase. Fig. 17. Metaphase I. Figs.18 and 19. Metaphase II showing 4 and 3 chromosomes respectively. Figs. 20 and 21. Anaphase II with 3 and 4 chromosomes respectively.

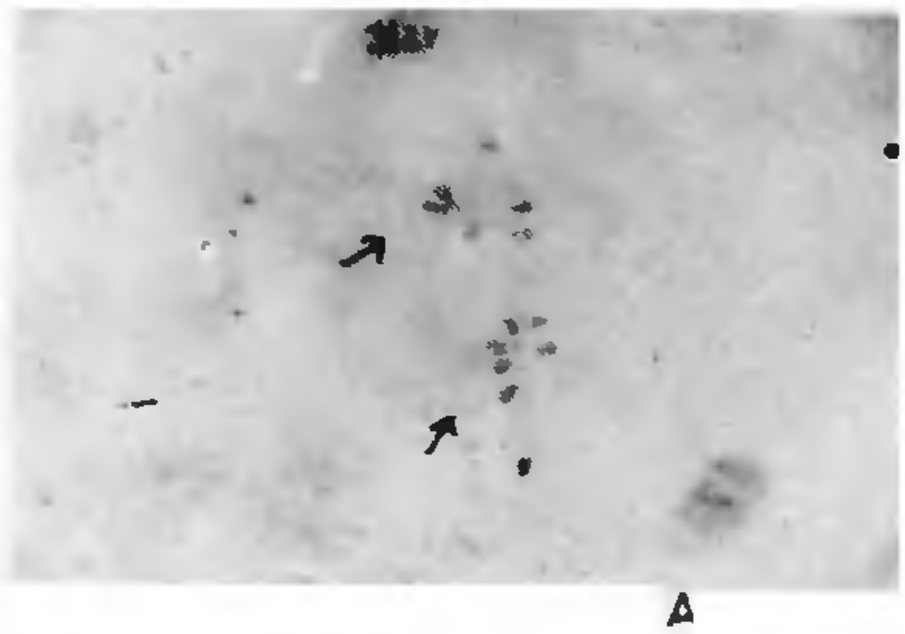
supernumerary chromosomes have also been encountered in some cells of certain individuals. There, number 2 is quite constant in *T. ovis* but in *T. globulosa* there is a slight variation so that plates with a single or without any supernumerary chromosome have also been observed (see Table I). These chromosomes divide equationally at meiosis I but meiosis II is invariably reductional (Figs. 4 and 11, Ph. B asd C). In a few cells, they show ramdom distribution at anaphase II (Figs. 5 and 12).

DISCUSSION

Chromosome number in Trichuroidea

Taxonomically, Trichuroidea has been known by 3 families namely, Trichosomoididae, Trichuridae and Trichinellidae but only the former two have been studied karyologically.

Trichosomoides crassicauda, the only representative of Trichosmoididae known both cytologically and taxonomically, has a haploid number of 4 chromosomes (Walton, 1923).



PH. A–D. A, two gonial metaphase cells of *T. ovis*. B, Anaphase I (*T. ovis*), arrows show position of the 2 supernumeraries at one pole. C, Anaphase II (*T. ovis*), showing reduction division of the supernumeraries (arrows). D, Gonial metaphase (*T. globulosa*) arrows show position of the two supersumeraries one can be seen quite clearly.

In family *Trichuridea*, studied presently, all the 3 species belong to the same genus *Trichuris*. *Trichuris trichiura* has a haploid number of 4 chromosomes and the other two namely *T. ovis* and *T. globulosa* has haploid number 3 of the normal complements plus 2 supernumerary chromosomes. Four is suggested to be the basic number in this super family and presence of supernumerary chromosomes is a step towards evolution. It is discussed separately below.

Supernumerary chromosomes in the genus Trichuris

Amongst animals, the supernumerary chromosomes have so far been reported in two species of *Turbellaria* (Melander, 1950) and in quite a number of insect orders (Wilson, 1907; Stevens, 1908 and 1912; Makino *et al.*, 1938; White, 1949, 1951 and 1954; Ray Chaudhuri and Manna, 1952 and Prasad, 1958). These elements are generally characterised by their smaller size and heterochromatic nature (White, 1954).

The supernumerary chromosomes reported in *T. ovis* and *T. globulosa* are extremely small in size and show a differential staining behaviour. They have been encountered in the gonial metaphase cells also but their presence is more conspicuous in the meiotic metaphase and anaphase stages when they reveal positive heteropycnosity. They are usually 2 in number during gonial and metaphase I stages. They show more constancy in number and meiotic behaviour in *T. ovis* than in *T. globulosa*. It seems that in the former species these supernumerary chromosomes have stabilised themselves whereas in the latter species they are still under the evolutionary flux.

The possible origin of these supernumeraries in the genus *Trichuris* seems to be from the sex-chromosomes. As mentioned earlier, the diploid number of chromosomes in one of the species of this genus (*T. trichiura*) is 7. Similar is the diploid number of *Trichosomoides crassicauda* (Walton, 1923), a number of the closely allied family. By comparing the karyotypes of all these species, what is missing in *T. ovis* and *T. globulosa* (normal $2n = 6$) is the smallest X-chromosome. It seems that by some sort of chromosomal rearrangement between the sex-chromosome and the autosomes, these supernumeraries have originated. White (1954) has suggested a similar mode of origin of the supernumeraries in general.

The regularity of meiotic behaviour in *T. ovis* and *T. globulosa* at least ensures one thing that these supernumeraries are not deleterious or parasitic in their nature (Ostergren, 1945 and 1947). They may be, on the other hand, playing significant roles in the genetic systems of these animals.

TABLE I

Chromosome number and sex-mechanism in the species investigated

Species	2n	Metaphase I	Metaphase II	Sex-mechanism
1. *Trichuris trichiura*	7	4	4, 3	XO – XX
2. *Trichuris ovis*	6 + 2*	3 + 2*	3 + 2*, 3 + 2*	XY – XX
3. *Trichuris globulosa*	6 + 2*	3 + 2*	3 + 2*, 3 + 2*	XY – XX

* Supernumerary chromosomes.

TABLE II

Percentage of cells showing the number and behaviour of chromosomes at the various stages of meiosis

Species	Metaphase I		Metaphase II		Anaphase II		Spermatids
	1*	2*	1*	2*	Reduction division	Random division	
Trichuris ovis	..	50%	..	50%	70%	30%	Majority with 1*
Trichuris globulosa	15%	30%	12%	28%	70%	30%	Majority with 1*

* Number of supernumerary chromosomes.

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