A Comparative Study and Karyotyping of Chromosomes of *Hymenolepis nana fraterna* from Mice and Rats

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Summary

The karyotypes of Hymenolepis nana fraterna *separated from two different hosts, the mouse and the rat, is described. The best time to study the chromosomes was found to be at the stage of cleavage in the oocytes and embryos. A diploid number, 2n=12, was recognised. The absolute and the relative lengths of the chromosomes of individual* H. nana fraterna, *of two hosts origin, the mouse and the rat, were separately measured and compared. They showed similar metric values. In addition to being similar in shape, the chromosomes were found to be telocentric. Different stages of cell division during meiosis and mitosis were also demonstrated.*

Introduction

Relatively, there are not many cytological studies on the members of the class **Eucestoda**. Typically, the small size of the chromosomes has imposed difficulties on the morphological studies of their chromosomes. In this respect, apart from the research carried out on the order **Cyclophyllidea**, there is little information about other orders of this class. Karyological studies on species of the family **Hymenolepididae** have been performed by Jones (1945), Jones and Ciordia (1995), Hossain and Jones (1963), Ward *et al.* (1981), Liu and Lin (1987) and Mutafova and Gergova (1994).

In this communication, the results of studies carried out on the chromosomes of *Hymenolepis nana fraterna* separated from naturally infected mice and rats are presented. Attempts have been made to study the chromosomes at different stages of meiosis and mitosis. Also, the characteristics of chromosomes of the parasites have been compared with each other as well as with those found in the literature.

Materials and methods

The infected mice and rats were killed, their abdominal cavities were opened and the intestines were removed. The intestines were placed in a petri-dish containing normal saline solution and were cut open. The parasites were separated and washed in the saline solution. The studies on chromosomes were carried out according to Hirai and LoVerde (1995) techniques. After preparation of the slides, using Giemsa stain and C-banding, they were studied under a light microscope. Since chromosomal details could be observed best in oocytes and early embryos, the present study was largely confined to these stages. More than 4000 oocytes and cleaving embryos were studied. Same methods, irrespective of the host species, were used for studying the chromosomes of the parasites.

Results

The observations on metaphase cells presented the evidence that the diploid number of chromosomes was 2n=12. Some stages of mitosis are shown in Figs. 1-5. The embryonic cells of the parasites from mice and rats were 13 and 11, respectively. The length of the chromosomes of these cells was measured during the metaphase. The results are shown in Tables 1 and 2. The ideogram of metaphase chromosomes depicting their absolute lengths are drawn in Fig. 6. Due to the diminutive size of the chromosomes of these parasites the centromeres could not clearly be seen, even when the C-banding technique was employed, in the prophase or the metaphase. Therefore, definite results could not be obtained at these stages. However, with the termination of metaphase and the start of anaphase, during the cleavage of the embryos, it could clear be seen that all the centromeres were terminal or very nearly so. This is because the chromosomes are rod-shaped and separation starts from the terminal end of the metaphase chromosomes. This is the case only in chromosomes that have terminal centromeres. Therefore the chromosomes of *Hymenolepis nana fraterna* separated from mice and rats were all assumed to be telocentric. In Fig. 7 the karyograms of the chromosomes of *H. nana fraterna* separated from mice and rats are shown.

Discussion

The diploid number of chromosomes 2n=12 was established by Jones and Ciordia (1955) and Mutafova and Gergova (1994), whereas Jones (1945) had previously reported 10 chromosomes for *H. nana fraterna*. This difference in the number of chromosomes was explained by Hossain and Jones (1963) as to be cytological variations. However, there could have been

technical reasons for the differences. According to the studies carried out on the chromosomes of the genus *Hymenolepis* the diploid number of chromosomes is constantly 12, but the only slight difference is in the morphology of various species (Douglas, 1962; Hossain and Jones, 1963; Proffit and Jones, 1969; Ward *et al.*, 1981; Liu and Lin, 1987; Mutafova and Gergova, 1994). In Table 3 the chromosomes morphological characters described in previous research works and the present study are summarised and compared. Possibly, the morphological differences shown by different workers are due to two factors: Firstly, due to the smallness of the size of chromosomes centromeres can not be clearly discerned and, therefore, studying them is difficult. Secondly, as Mutafova and Gergova (1994) have maintained, these morphological differences might be interpopulative.

The results of the present research, being in accordance with Hossaein and Jones (1963) and Monaloy (1972), reconfirmed that the chromosome number of *H. nana fraterna*, irrespective of being separated from mice or rats, was 12. The lengths of the chromosomes of the parasites derived from the two hosts were compared, using the t-test, and no significant (at 0.05 level) difference was found. According to these data, one can assume that these two groups of parasites have similar karyotype.

Normally, the parasitic strains of *H. nana fraterna* separated from mice develop slower and are less pathogenic in rats. Evidently, parasites develop better in the same kind of host they are separated from (Schmidt, 1988). This shows, more or less, the adaptation of parasites to their host. LoVerde *et al.* (1985) came to the conclusion that in parasites the traits such as pathogenecity, infectivity and drug resistance can be greatly affected by selective pressures exerted by the host. Since these traits are related to a gene or a group of specific genes, the selective pressure that the host exerts may, without drawing a general conclusion, result in differences noticed between these traits in different hosts. In order to survive, parasites that are not static entities but natural population constantly evolve and track the genetic changes in their host environment. In other words, the host exerts a strong selective pressure on parasites forcing them to make a large genetic commitment to co-evolution. Therefore, the co-evolutionary interactions between the host and parasite that play an important role in the development of genetic systems of both natural and laboratory parasite populations should not be overlooked.

By taking the aforementioned points into consideration, one hesitates to suggest that the karyotypes of *H. nana fraterna* separated from two different natural hosts are identical. In order to study the differences between the chromosomes of parasites, at the level of strains, karyotyping studies are not sufficient. Studies should be extended to genes and DNA chains in order to

shed more light on these differences, if such differences exist. This can be an interesting topic for further study and research in the future.

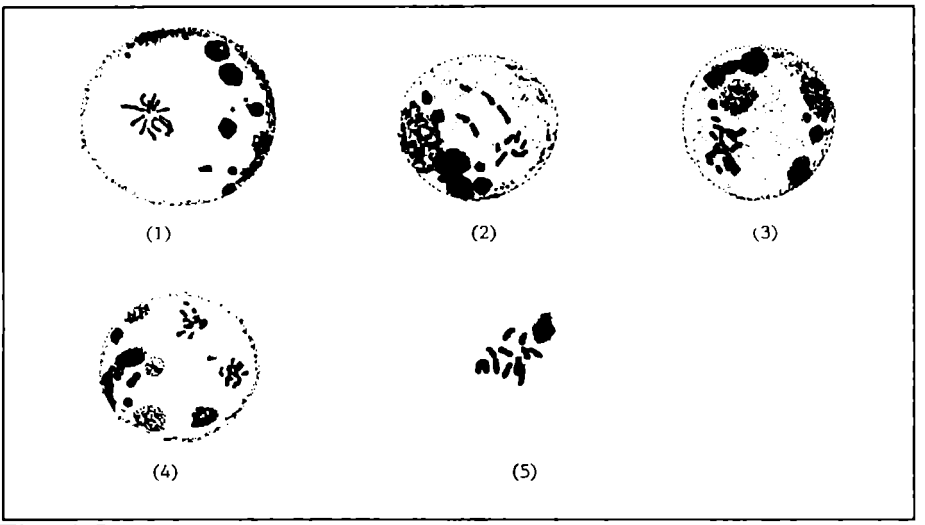
Table 1. *Measurements (mean ± SD) of the metaphase chromosomes of* **Hymenolepis nan fraterna** *separated from mice*

Chromosome No.	Absolute length (μm) X ± SD	Relative length (%) X ± SD	CV
1	3.05 ± 0.55	24.9 ± 4.35	17.40
2	2.46 ± 0.46	19.8 ± 3.70	18.60
3	1.99 ± 0.35	15.9 ± 2.83	17.79
4	1.89 ± 0.28	15.1 ± 2.28	15.10
5	1.65 ± 0.41	13.2 ± 3.37	25.50
6	1.39 ± 0.23	11.1 ± 1.91	17.14

Mean length of 26 chromosomes
Genome length = 12.43 μm

Legends to figures on page 31

Fig. 1. Promtaphase- mitosis (scale in 10 μm).
Fig. 2 Metaphase-mitosis (scale in 10 μm).
Fig. 3. Anaphase-mitosis (scale in 10 μm).
Fig. 4. Early telophase-mitosis (scale in 10 μm).
Fig. 5. Metaphase chromosomesat mitosis (scale in 10 μm).
Fig. 6. Ideograms constructed from absolute lengths presented in Tables 1 and 2.
(a) *Hymenolepis nana fraterna* separated from mice.
(b) *Hymenolepis nana fraterna* separated from rats
Fig. 7. Karyogram: A) *Hymenolepis nana fraterna* separated from mice.
B) *Hymenolepis nana fraterna* separated from rats



Figs. 1-5

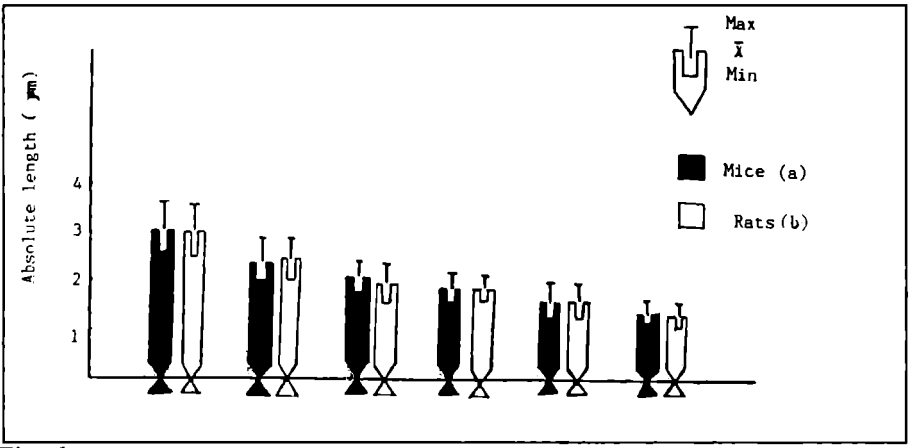


Fig. 6

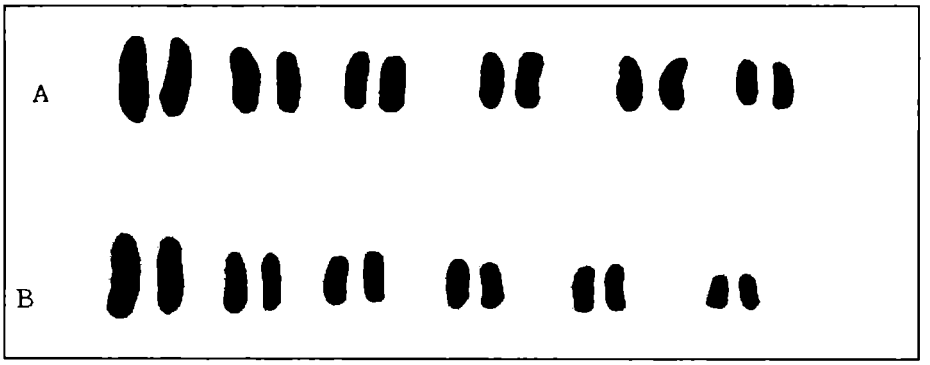


Fig. 7

Table 2. *Measurements (mean ± SD) of the metaphase chromosomes of* **Hymenolepis nana fraterna** *separated from rats*

Chromosome No.	Absolute length (μm) X ± SD	Relative length (%) X ± SD	CV
1	3.07 ± 0.75	24.36 ± 4.60	18.8
2	2.36 ± 0.46	18.75 ± 3.70	19.8
3	2.09 ± 0.36	16.50 ± 2.80	17.4
4	1.93 ± 0.30	15.20 ± 2.40	15.7
5	1.69 ± 0.38	12.67 ± 4.50	35.5
6	1.44 ± 0.26	11.44 ± 2.11	18.4

Mean length of 22 chromosomes
Genome length = 12.59 μm

Table 3. *Summary of findings on characteristics of chromosomes of* **Hymenolepis nana fraterna.**

Authors	Publication date	Diploid No. (2n) of chromosomes	Morphology
Jones	1945	10	Chromosome 1 metacentric, the rest telocentric
Hossain and Jones Monaloy	1963 1972	12	All chromosomes telocentric
Mutafova and Gorgova	1994	12	Chromosome 3 meta or sub-metacentric, the rest telocentric
Present study		12	All chromosomes telocentric

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