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Studies on Rodent Chromosomes VI. Co-existence of *Rattus rattus* with 38 and 42 Chromosomes in South Western India

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Karyological studies on different populations of *Rattus rattus* from various parts of the world have revealed the prevalence of numerical and structural chromosomal polymorphism in this widely distributed species (Yosida *et al.* 1965, 1969; Yosida and Tsuchiya 1969a, Bianchi *et al.* 1969, Capanna and Civitelli 1969, Gropp *et al.* 1970, Ray-Chaudhuri and Pathak 1970, Badr and Badr 1970). These studies have shown that in some populations the 2n chromosome number is 38 and which can be derived by Robertsonian mechanisms of centric fusion from the basic karyotype of *R. rattus* with 2n=42 (see Discussion). Yosida and Tsuchiya (1969a) postulate that the European *R. rattus* have 38 chromosomes and that these have migrated to North and South America and Oceania, while Asian rats have 42 chromosomes. The distribution of these two populations is not presumed to overlap. However, recently while conducting a karyological survey, we have come across a population of *Rattus rattus rufescens* in South Western India which displays a chromosome complement of 38, similar to that described by Bianchi *et al.* (1969) from Argentina. In the same area, another subspecies, *R. rattus wroughtoni* also exists and has the typical *R. rattus* karyotype with 42 chromosomes. Observations on these are reported here.

Materials and methods

Rattus rattus rufescens (Gray) and *Rattus rattus wroughtoni* Hinton were trapped at Sagar, Mysore State (S.W. India). *R.r. rufescens* were trapped from domestic area, while *R.r. wroughtoni* from Bhimaneri forests near Sagar. *R.r. rufescens* is the typical dark-bellied domestic rat most prevalent in Western India; *R.r. wroughtoni* belongs to the group of white-bellied and wild *Rattus rattus* (Ellermann 1961).

Two males and one female of each subspecies were utilized for chromosomal studies. The animals were sacrificed 2½ h after intraperitoneal injection of 0.2% colchicine (0.2–0.25 ml/animal; weight of each animal—100 to 150 gm) and bone marrow chromosomes were prepared by the usual air-dry technique after hypotonic pretreatment for 1 h at 25°C in 0.85% sodium citrate. The preparations were stained with carbol fuchsin.

From each animal at least 50 plates were counted for chromosome number and well spread plates photographed for karyotyping at a final magnification of

about 1800×. Six karyotypes were made for each animal and chromosome lengths measured for comparison.

Observation

Rattus rattus wroughtoni

In all the three individuals (2 males and 1 female) examined, the diploid chromosome number has been found to be 42. The karyotype (Fig. 1 and Table 1) consists of 1 pair of large subtelocentrics; 13 pairs of large, medium and small telocentrics; and 7 pairs of medium and small metacentrics. In male, the Y chromosome is the smallest telocentric, while the X is one of the larger telocentrics. The data on the relative lengths and arm ratios are presented in Table 2.

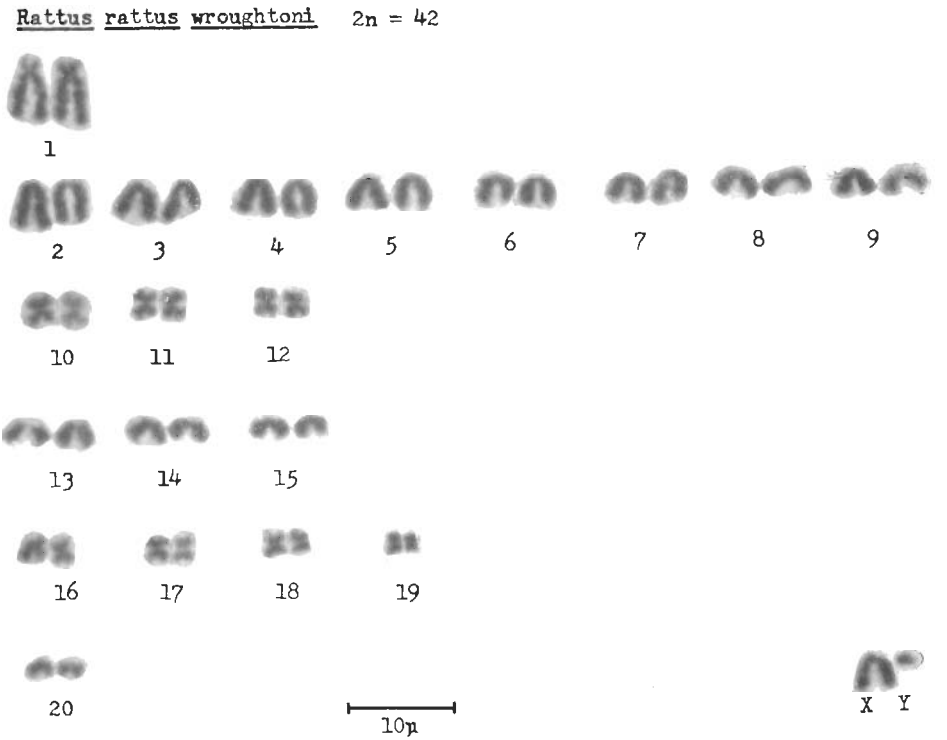

Fig. 1. Karyotype of male *Rattus rattus wroughtoni*.

Rattus rattus rufescens

In the two male and one female specimens examined, the 2n chromosome number has been found to be 38 as compared to the 2n=42 in *R.r. wroughtoni*. The karyotype (Fig. 2 and Table 1) also differs accordingly. In *R.r. rufescens* the complement consists of : 1 pair of large subtelocentrics, 7 pairs of large and medium telocentrics; 7 pairs of medium and small metacentrics and in addition, there are

Table 1. Comparative idiograms of *Rattus rattus wroughtoni* and *Rattus rattus rufescens*

Chromosome	*R.r. wroughtoni* (2n=42)		*R.r. rufescens* (2n=38)	
Type	Pair no.	Total pairs	Pair no.	Total pairs
I. Autosomes				
A. Large metacentric	—	—	1–2	2
B. Large subtelocentric	1	1	3	1
C. Large telocentric	2–9	8	4–8	5
D. Medium metacentric	10–12	3	9–11	3
E. Medium submetacentric	—	—	12	1
F. Medium telocentric	13–15	3	13	1
G. Small metacentric	16–19	4	14–17	4
H. Small submetacentric	—	—	18	1
I. Small telocentric	20	1	—	—
II. Sex chromosomes				
Large telocentric	X		X	
Smallest telocentric	Y		Y	

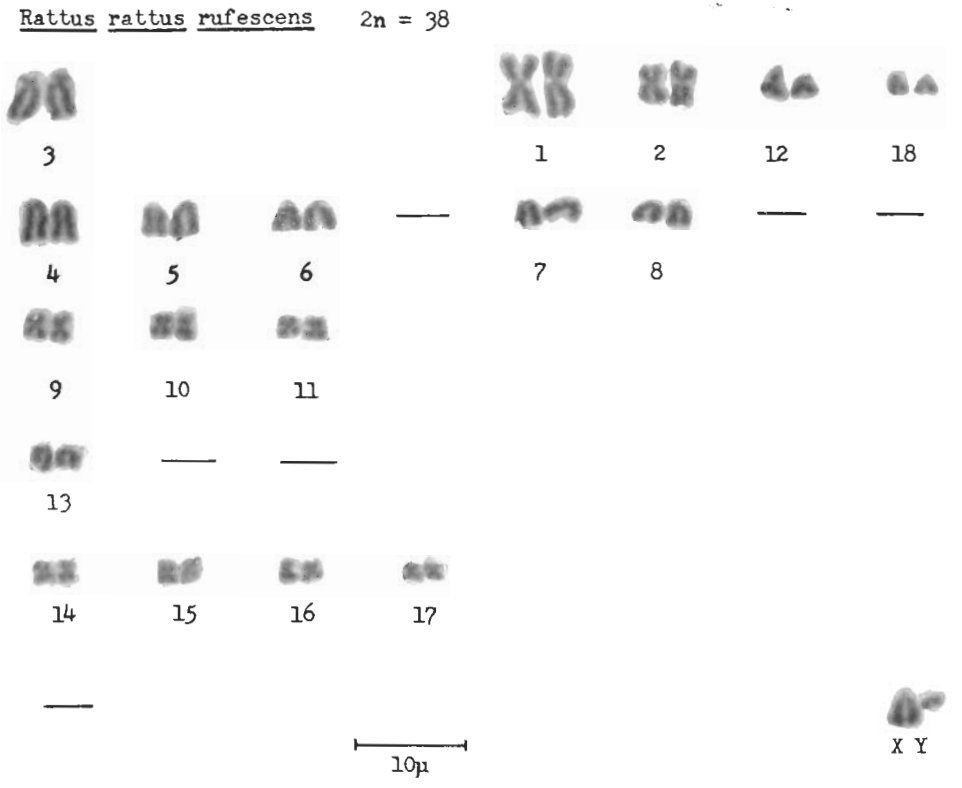

Fig. 2. Karyotype of male *Rattus rattus rufescens*. Horizontal lines indicate the chromosome pairs of *R.r. wroughtoni* karyotype (Fig. 1) presumed to be absent in *R.r. rufescens*. The marker chromosomes (nos. 1, 2, 12 and 18) have been placed in upper right corner. Scale: 10 μ=18 mm.

Table 2. Relative lengths and arm ratios of different chromosomes in *R.r. wroughtoni* and *R.r. rufescens*

Group	A	B	C	D	E	F	G	H	I
R. r. wroughtoni									
Pair no.	— —	1	2 3 4 X 5 6 7 8 9	10 11 12	—	13 14 15	16 17 18 19	—	20 Y
% Length*	— —	10.4	8.9 7.0 6.4 6.2 5.9 5.5 5.0 4.5 4.4	5.0 4.7 4.4	—	4.2 4.0 3.4	4.2 4.0 3.5 3.0	—	2.5 1.9
Arm ratio	— —	4.3	— — — — — — — — —	1.0 1.1 1.1	—	— — —	1.1 1.1 1.1 1.1	—	— —
R. r. rufescens									
Pair no.	1 2	3	4 5 6 XX — 7 8 — —	9 10 11	12	13 — —	14 15 16 17	18	— Y
% Length*	11.1 8.9	9.2	8.3 7.0 6.5 6.1 — 5.5 5.1 — —	4.7 4.4 4.3	4.9	4.3 — —	4.1 3.7 3.2 2.9	3.0	— 2.3
Arm ratio	1.3 1.2	3.8	— — — — — — — — —	1.0 1.0 1.1	1.9	— — —	1.1 1.1 1.1 1.1	1.7	— —

* Percent of haploid autosomal length;
Data based on mesurements on 15 plates in each subspecies.

two pairs of large metacentrics and two pairs of medium and small submetacentrics. These large metacentric and medium and small submetacentric chromosomes are not seen in *R.r. wroughtoni* karyotype. The data on the relative lengths and arm ratios of different chromosomes are presented in Table 2. As in other *R. rattus*, the X is one of the large telocentrics, while the Y is the smallest telocentric.

It may be noted from the data presented in Tables 1 and 2 and the karyotypes in Figs. 1 and 2, that *R.r. rufescens* karyotype differs in several ways from that of *R.r. wroughtoni*. Besides the presence of the marker chromosomes (pairs nos. 1, 2, 12 and 18, see Fig. 2), six pairs of telocentrics of *R.r. wroughtoni* are absent in *R.r. rufescens*, namely, 3 pairs of telocentrics of group C, two pairs of group F and one pair of group I.

Discussion

Chromosomal polymorphism in *Rattus rattus* has been reported from different continents (Yosida *et al.* 1965, 1969, Yosida and Tsuchiya 1969a, Bianchi *et al.* 1969, Capanna and Civitelli 1969, Badr and Badr 1970, Gropp *et al.* 1970, Ray-Chaudhuri and Pathak 1970, Yong and Dhaliwal 1970). So far, *Rattus rattus* populations with 38 chromosomes have been reported from Oceanian regions (Yosida *et al.* 1969a), Argentina (Bianchi *et al.* 1969), Italy (Capanna and Civitelli 1969), Texas (Barker 1969—quoted in Yosida and Tsuchiya 1969a) and Cairo (Badr and Badr 1970). As far is known, the present report is the first on *R. rattus* with 38 chromosomes from India, or even Asia (see Yosida and Tsuchiya 1969a).

The karyotype of *R.r. wroughtoni* is very similar to the karyotype of *Rattus rattus* described by Yosida *et al.* (1965). The only point of difference between the two karyotypes is in the largest chromosome pair no. 1. Yosida *et al.* found this to be heteromorphic pair with one telocentric and one subtelocentric chromosome. Yosida and Tsuchiya (1969a) have also noted polymorphism for this autosome pair in different Japanese populations of *Rattus rattus*. In the present study this pair of chromosome has been found in all the three individuals of *R.r. wroughtoni* (as also in *R.r. rufescens*) to be subtelocentric. As suggested by Capanna and Civitelli (1969) the normal morphology of this chromosome probably is subtelocentric, but in certain populations telocentric or telocentric/subtelocentric conditions may be more adaptive (Yosida and Tsuchiya 1969b).

R.r. rufescens karyotype described here differs from *R.r. wroughtoni* in having two large metacentric and two submetacentric chromosomes; furthermore, the number of telocentric chromosomes in *R.r. rufescens* is only 7 pairs, while in *R.r. wroughtoni* there are 13 pairs. The *R.r. rufescens* karyotype with 2n=38 can be easily derived from *Rattus rattus* karyotype with 2n=42 by assuming Robertsonian changes and pericentric inversions : centric fusion of two pairs of larger telocentrics (of group C) in 42 complement will produce the larger metacentric of the 38 complement, while a similar centric fusion between two medium telocentric chromosome pairs (of group F) will give rise to the second large metacentric chromosome seen in *R.r. rufescens*. The two smaller submetacentrics of *R.r. rufescens* can be derived by pericentric inversions in two telocentric pairs (one of group C and one of group

I, see Table 2). These changes also account for the reduction in chromosome number in *R.r. rufescens*. It may be pointed out, however, that it is not possible to say with certainty which particular chromosomes are involved in these changes, since the telocentric chromosome pairs form a graded series. Nevertheless, similar changes have been visualized by Bianchi *et al.* (1969), Capanna and Civitelli (1969) and Badr and Badr (1970) to explain the derivation of 38 complement from the 42 complement in *Rattus rattus*.

Earlier reports (as discussed above) of 2n=38 chromosomes in *Rattus rattus* refer to the subspecies *R.r. rattus* from different parts of the world. The present population has been identified as *R.r. rufescens*. It is also very interesting to note that Yosida and Tsuchiya (1969c) have reported 2n=38 in *Rattus fuscipes* from Australia and 2n=40 in *Rattus bowersi*. The karyotype of *R. fuscipes* is similar to that of *R. rattus* with 2n=38, while *R. bowersi* karyotype is intermediate between 2n=42 and 2n=38 *R. rattus* karyotypes. *R. bowersi* has only one large metacentric pair, corresponding to the smaller of the two large metacentric pairs, characteristic of 2n=38 karyotypes. These observations suggest that, indeed the 2n=38 karyotypes in *R. rattus* complex have been derived from the basic 2n=42 karyotypes by the process of centric fusion.

Occurrence of *R. rattus* with 2n=38 in India is also remarkable. As mentioned earlier, 2n=38 karyotype in *R. rattus* has been supposed to be absent from Asian regions (Yosida and Tsuchiya 1969a). This population of 2n=38 in Sagar may have been introduced by human agency from other continents or may have evolved endemically. This population has been identified as *R.r. rufescens*, compared to *R. r. rattus* of other localities and this may suggest an endemic origin of this karyotype. However, it remains to be seen whether in Sagar area *R.r. rufescens* populations with 2n=42 chromosomes are present or not, though *R.r. rufescens* with 2n=42 chromosomes are present in other parts of India (Ray-Chaudhuri and Pathak 1970, Rao *et al.* in the press). Detailed population study of this complex from Sagar and other localities of India would be rewarding.

Finally, a comment about the systematics of *Rattus rattus* complex: the classification of *Rattus rattus* and allied species and subspecies has been based largely on morphological criteria (Ellermann and Scott-Morisson 1951). It is worthwhile to reexamine the taxonomy of this group in the light of increasing knowledge of chromosomal constitution of different populations of *Rattus rattus* and allied species.

Summary

Chromosomes of two subspecies of *Rattus rattus*, namely, *R.r. wroughtoni* and *R.r. rufescens*, from Sagar, Mysore State, South Western India, have been examined. *R.r. wroughtoni* has 42 chromosomes typical of *Rattus rattus*, while *R.r. rufescens* shows 2n=38. The karyotype of the latter is similar to that described by other workers for *Rattus rattus* populations with 2n=38 from other parts of the world. This is the first report of *Rattus rattus* with 38 chromosomes from India. It is proposed that the 2n=38 karyotype is evolved from the basic *Rattus rattus* karyotype with 2n=42 by centric fusion and pericentric inversions.

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Post script:

Since this paper was in press, we have seen two reports, one concerning the banding pattern in black rats by Yosida and Sagai (1972) where they have beautifully demonstrated the chromosomes involved in Robertsonian translocation i.e. Nos. 4 and 7 and Nos. 11 and 12. This point was left vague in our report (see discussion). The other refers to a paper by Rajiva and Sharma (1972) who also report a 2n=38 karyotype from South India (Nagpur, Kerala) which appears to be similar to the other 2n=38 karyotype reported from the different part of the world. This is in conformity with our observations. Besides, the serum transferrin profiles

by acrylamide gel electrophoresis (unpublished data) also appear to be similar to those reported for Italian species with 2n=38 karyotype.

References to be appended:

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