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# Genetic Reorganization in *Treron phoenicoptera*

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**ABSTRACT**

Cytological investigation was carried out on Himalayan green pigeon, *Treron phoenicoptera* (Latham). The bone-marrow extract of twenty two male and eighteen female individuals yielded four hundred mitotic metaphase plates for cellular investigation. The diploid count varied from 72 to 80 with a prominent peak at 74 shown by 43.04% of the cells scored. Among the forty individuals examined, nine divergent karyotypes irrespective of sex were encountered. In natural populations of the bird, it appears that polymorphism existed due to two independent pericentric inversions - one in the largest pair of autosomes hereafter, designated as I and another in the fifth autosomal pair (second largest pair of the genome), alluded to as II.

**Keywords:** Chromosomal polymorphism, Genetic reorganization, Inversion, Structural reaarangement.

## 1. Introduction

Genetic reorganization leads to the occurrence of two or more genetically distinct forms of species together in the same locale at the same time. Since the phenotypes are usually easy to score and their expressions are often controlled by major genes - genes having a large effect upon the phenotype as compared to the environment - such restructuring of genetic material provide convenient tool to study polymorphism in natural populations [1].

Critical information of chromosomal variability in birds is not abundant because there is a paucity of comparative documentation of intraspecific and interspecific karyotypes [2,3]. Most of the investigations on the karyology of birds are based on the chromosomes from a very few individuals, often only one or two samples of a species. Wherever considerable number of specimens from a bird population has been analyzed, chromosomal polymorphism of one or the other type has been encountered [4,5].

## 2. Material & Methods

The Yellow legged Himalayan green pigeon belongs to Order - Columbiformes, Family - Columbidae. In all, forty specimens were sampled during suitable seasons from different populations of *Treron phoenicoptera*. Full-grown specimens were stressed with colchicine (NBC Cleveland) solution, injected intraperitoneally in the form of 0.1% aqueous solution. The bone-marrow was hauled out using a hypodermic plunger containing 0.56% KCl solution, pre-incubated at 37 ºC. The cells were fixed in 1:3 aceto-alcohol and stained in Giemsa (merk) solution.

The computational plan designed, after Levan *et.al.* [6], provided Percentage Relative Length (% $_L{}^R$) and Arm Ratio (r) as follows:

$$\text{Percentage Relative Length } \%\, _L{}^R = \frac{\text{Length of any macrochromosome}}{\text{Total macrochromosomal length}} \times 100$$

$$\text{Arm ratio (r)} = \frac{\text{Length of long arm}}{\text{Length of short arm}}$$

## 3. Results

A comprehensive investigation of cell plates revealed major reshuffles in the largest chromosomal pair (henceforth referred to as chromosome - I) and the fifth autosomal pair (hereafter labeled as chromosome - II), which have given rise to nine distinct genotypes.

### 3.1 Standard Karyotype ($I^m I^m II^m II^m$)

This was the most recurrently noticed karyotype, common to six males and five females, and hence it has subjectively accepted as the standard one. There were seven pairs of macrochromosomes, divisible into five groups.

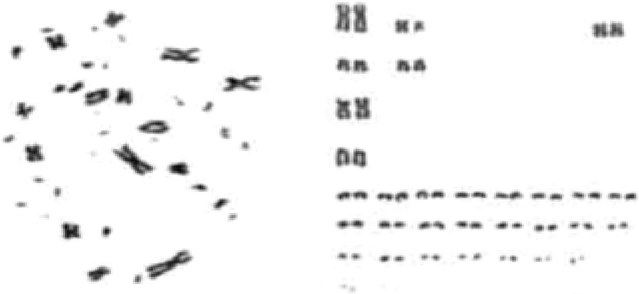

**Fig 1:** Metaphase plate & Standard Karyotype ($I^m I^m II^m II^m$) of *Treron phoenicoptera* (male)

**Group I** included two large autosomal pairs (chromosomes 1 and 2) with their centromere in median region. Chromosome 1 is the largest member of the karyotype constituting 24.63% of the TML. Chromosome 2 is fifth in the order of size ($_L^R$ = 10.73%) and is slightly smaller than Z.

**Group II** comprised two pairs of sub-metacentric elements - chromosome 3 and 4 with similar size ($_L^R$ = 10.02% and 8.98%) and overlapping ranges of arm ratio ($_I^C$= 30.95 & 30.48).

**Group III** consisted of chromosome 5 - the second largest pair, with a sub-terminally located centromere. This chromosome has been marked as 'II' in upcoming discussions. It was 6.37µ long and constituted 18.88% of the TML.

**Group IV** was represented by a single pair of telomeric chromosome (chromosome - 6). It ranked third in the order of size with an absolute length of 5.04 µ ($_L^R$ = 14.94% of TML).

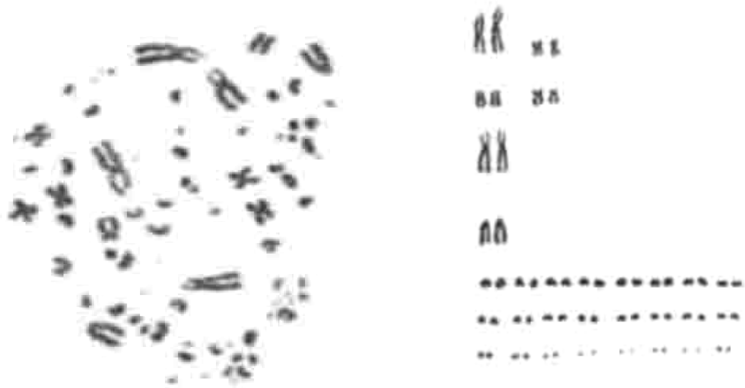

**Fig 2:** Metaphase plate & Standard Karyotype ($I^m I^m II^m II^m$) of *Treron phoenicoptera* (female)

**Table 1:** Morphometric data of macrochromosomes has been given hereunder:

| Chromosome Number | % Relative Length | Centromeric Index | Chromosome Type |
|---|---|---|---|
| 1 | 24.63 ± 0.32 | 42.12 ± 0.87 | m |
| | 24.91 ± 0.69 | 21.95 ± 0.73 | st* |
| 2 | 10.73 ± 0.96 | 45.39 ± 0.23 | m |
| 3 | 10.02 ± 0.53 | 30.95 ± 0.49 | sm |
| 4 | 08.98 ± 0.34 | 30.48 ± 0.96 | sm |
| 5 | 18.88 ± 0.42 | 41.03 ± 0.95 | m |
| | 19.98 ± 0.25 | 19.02 ± 0.58 | st* |
| 6 | 14.94 ± 0.56 | 12.50 ± 0.35 | t |
| Z | 11.82 ± 0.72 | 49.19 ± 0.55 | M |
| W | 06.67 ± 0.13 | 40.45 ± 0.44 | m |

In all chromosome morphs, the mechanism of sex determination was strictly ZZ-ZW. Both the sex chromosomes were metacentric (Z: $_I^C$ = 49.19; W: $_I^C$ = 40.45) However, Z was a large macrochromosome whereas, W was the largest amid the microchromosomes ($_L^R$ = 7.33% of TML). The remaining thirty pairs of chromosomes had indistinct identity and were clubbed together as microchromosomes. They comprised 42.87% of the total genome.
The chromosome complement of eighteen male and eleven female pigeons, displayed marked variations from the so-called standard karyotype and have been referred as aberrant or inverted karyomorphs:

**3.2 Inverted Karyotype ($I^mI^mII^mII^{st}$)**
Three males and one female were found to exhibit this type of karyological configuration

**Fig 3:** Metaphase plate & Inverted Karyotype ( $I^mI^mII^mII^{st}$) of *Treron phoenicoptera* (male)

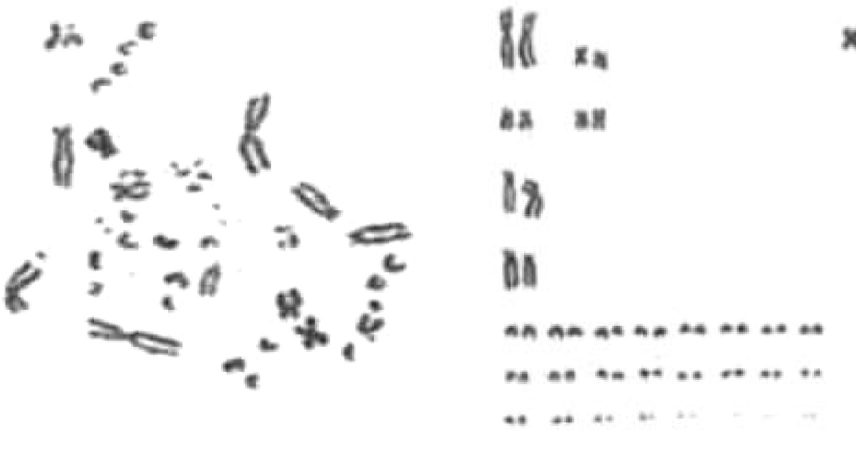

**Fig 4:** Metaphase plate & Inverted Karyotype ($I^mI^mII^mII^{st}$) of *Treron phoenicoptera* (female)

Here, both the homologues of the chromosome I seem to be replica of standard karyotype ($I^mI^m$). However, one of the members of the chromosome II had been transformed into a subtelocentric element ($II^{st}$) presumably due to a pericentric inversion. The rest of the karyotype was in agreement with the one referred as standard.

**3.3 Inverted Karyotype ( $I^mI^mII^{st}II^{st}$)**
One male and two females possessed this type of karyotype where both the members of chromosome pair I ($I^mI^m$) were similar to chromosome $I^m$ of the standard karyotype but owing to pericentric inversions in both the homologues of chromosome II, there was a remarkable shift in their position of centromere without any corresponding change in their relative lengths.

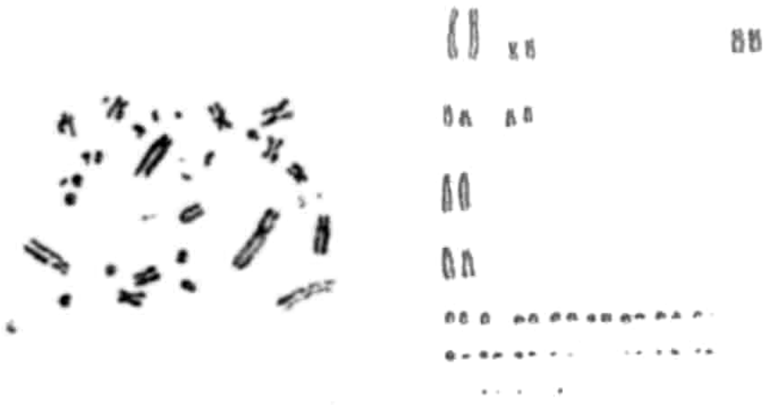

**Fig 5:** Metaphase plate & Inverted Karyotype ($I^mI^mII^{st}II^{st}$) of *Treron phoenicoptera* (male)

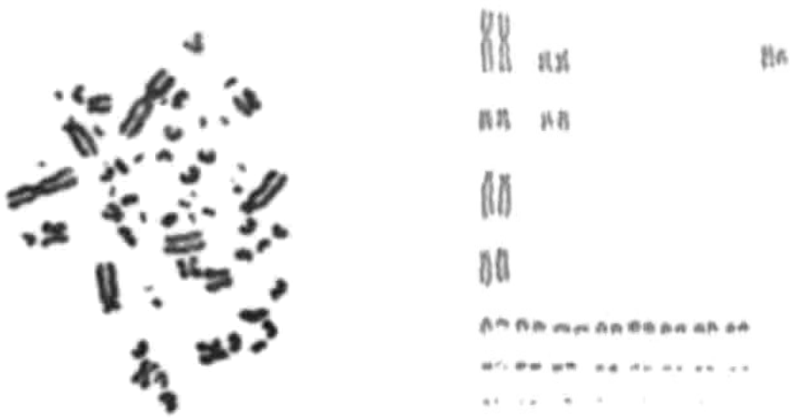

**Fig 6:** Metaphase plate & Inverted Karyotype ($I^mI^mII^{st}II^{st}$) of *Treron phoenicoptera* (female)

**3.4 Inverted Karyotype ($I^mI^{st}II^{st}II^{st}$)**

This chromosome complement depicted sequential digression in the karyotype. Here, the centromere of only one homologue of chromosome pair I retained its original morphology ($I^m$), while all the remaining three chromosomes, in question, appeared to have transformed into sub-telocentric elements (Chromosome $I^m$ $II^m$ $II^m$ $\rightarrow$ $I^{st}$ $II^{st}$ $II^{st}$).

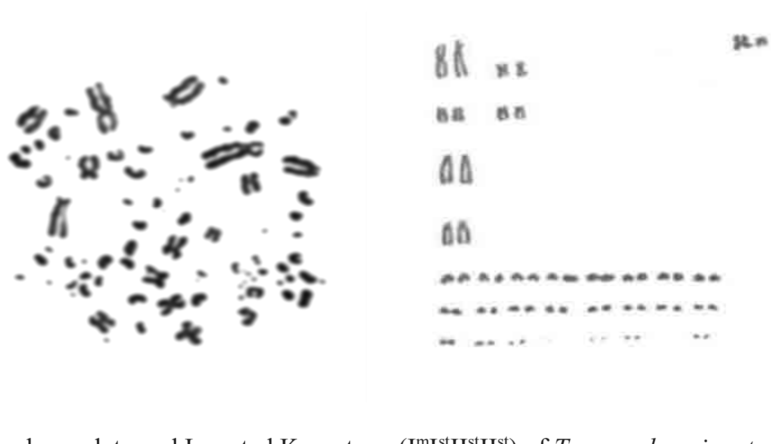

**Fig 7:** Metaphase plate and Inverted Karyotype ($I^mI^{st}II^{st}II^{st}$) of *Treron phoenicoptera* (female)

**3.5 Inverted Karyotype ( $I^mI^{st}II^mII^{st}$)**

This seemed to be an intermediate state of reshuffle wherein, one homologue, each of the chromosomal pairs I & II had preserved their original metacentric shape. Nonetheless, as a result of two separate inversions, their homologous counterparts had undergone a change in the position of their centromeres. This karyotypic configuration was encountered in lone male procured from Chhattarpur district.

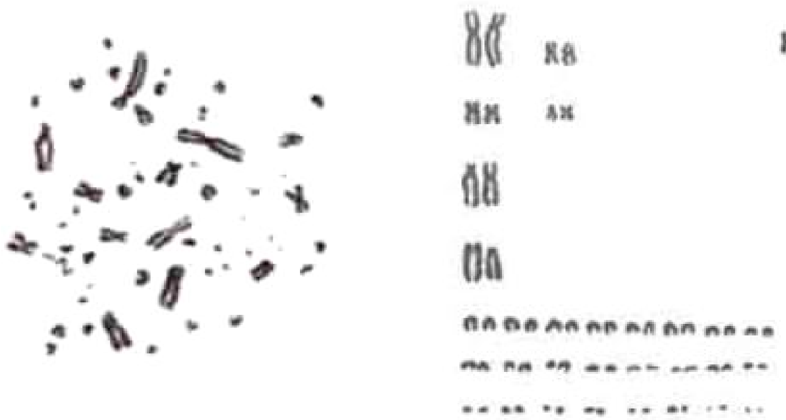

**Fig 8:** Male metaphase plate & Inverted Karyotype ($I^mI^{st}II^mII^{st}$) of *Treron phoenicoptera* (male)

**3.6 Inverted Karyotype ( $I^mI^{st}II^mII^m$)**

In this type of structural chromosome variant, the chromosome pair II ($II^m$ $II^m$) maintained a *status quo* with respect to relative length as well as centromeric index. *Albeit*, one of the homologue of the largest chromosome pair ($I^m$ $I^m$) converted into $I^{st}$.

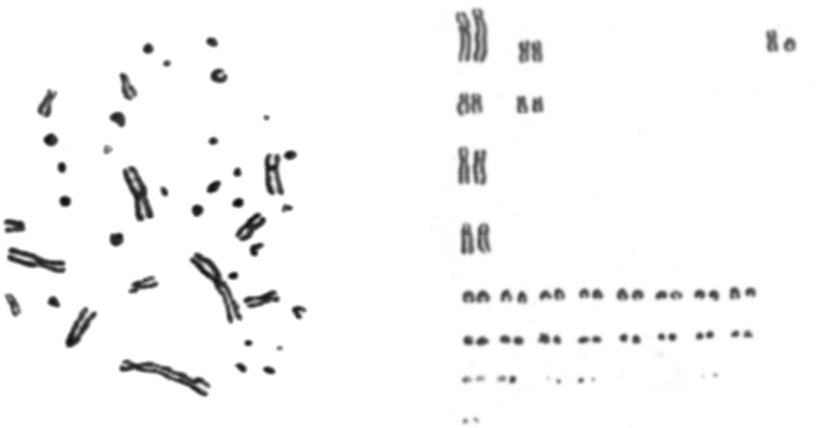

**Fig 9:** Metaphase plate & Inverted Karyotype ($I^mI^{st}II^mII^m$) of *Treron phoenicoptera* (female)

**3.7 Inverted Karyotype ( $I^{st}I^{st}II^mII^m$)**

In a female specimen collected from Tawa area, no changeover was observed in chromosome pair II. Conversely, both the elements of chromosome pair I underwent alteration with regard to the location of centromere.

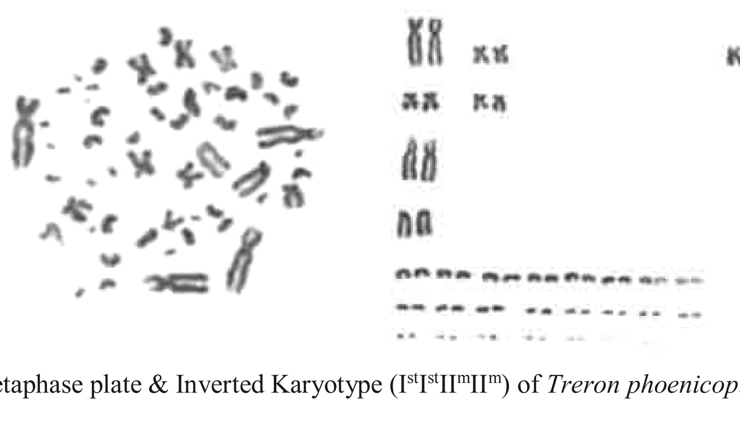

**Fig 10:** Metaphase plate & Inverted Karyotype ($I^{st}I^{st}II^mII^m$) of *Treron phoenicoptera* (female)

**3.8 Inverted Karyotype ( $I^{st}I^{st}II^{m}II^{st}$)**

This type of chromosome morph came into view as a further alteration of the karyotype $I^{st}$ $I^{st}$ $II^{m}$ $II^{m}$. At this time, the chromosome pair II was found to be heteromorphic. Of the four autosomes, under discussion, three had gone through pericentric inversion.

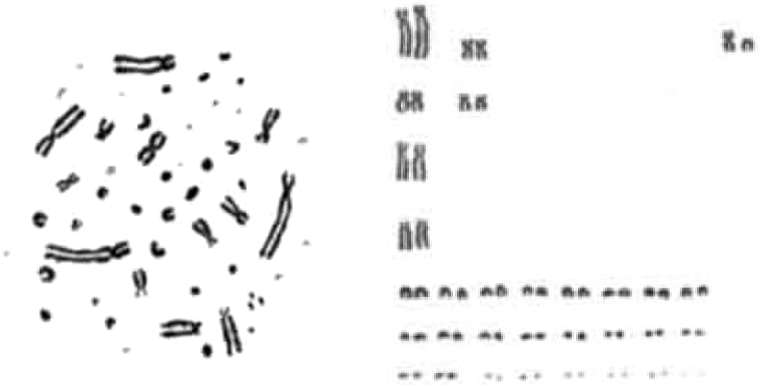

**Fig 11:** Metaphase plate & Inverted Karyotype ($I^{st}I^{st}II^{m}II^{st}$) of *Treron phoenicoptera* (female)

**3.9 Inverted Karyotype (IstIstIIstIIst)**

This was the rarest of all the variants (one in twenty two).

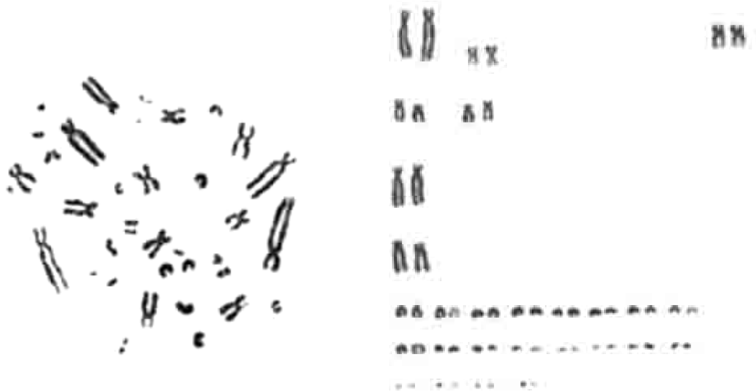

**Fig 12:** Metaphase plate & Inverted Karyotype ($I^{st}I^{st}II^{st}II^{st}$) of *Treron phoenicoptera* (male)

Variations noticed in this type of chromosome complement were unique in the sense that all the four homologues corresponding to the pairs I & II had been altered from the original metacentric type into sub-telocentric type.

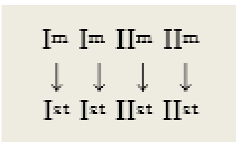


**Fig 13:** *Conversion of 'm' into 'st'*

**4. Discussion**

In birds, an alternation of centromeric position in a chromosome does not seem to be rare [7]. The first instance of chromosomal polymorphism was observed in Ontario, Canada when Thorneycroft [8,9] observed six different karyotypes in a natural population of *Zonotrichia albicollis* because of pericentric inversion involving chromosome pairs 2 and 3. He reported a similar polymorphism in dark eyed *junco*, *Junco hyemalis*, and in cedar wax-wing, *Bombycilla cedrorum*, in the year 1968.

An inversion polymorphism of submetacentric chromosome 3 and 5 was reported from Brazilian population of *Zonotrichia capensis* [10,11,12,13]. The fact that morphs of the respective chromosomes are of equal lengths support this contention.

Sheilds [14,15] asserted an occurrence of two independent inversions in chromosome 2 and 5 in several species of *junco* viz. *Junco hyemalis*, *J. oreganos*, *J. aikeni*, *J. caniceps* and *J. phaenotus*. Bass [16] documented another fringillids - *Cardinalis cardinalis* to be polymorphic, due to pericentric inversion in the chromosome - 5. A heteromorphism for the chromosome - 1 seems to be widespread throughout the range of distribution of *Carduelis chloris* as the same inversion was encountered in Sweden [17] Italy [18] and even in Australia [19].

However, these cases were restricted to only three species - Emberizidae, Fringillidae and Estrilidae, that too of one and only order - Passeriformes. The present report comes out to be first illustration of inversion polymorphism outside the order Passeriformes.

Garg [20] made a preliminary survey of six individuals of T. phoenicoptera and came across three distinct karyotypes (ImIm/IstIst, IIstIIst/IImIImand a hybrid of the two - ImIst/IIstIIm).

The present study was carried out on forty individuals and it was astounding to have nine diverse combinations, owing to pericentric inversions in chromosome - 1 and 2. Presence of such an extensive polymorphism in *T. phoenicoptera* should, aptly be described as an incidence of 'multiple chromosomal heteromorphism'.

**5. Acknowledgment**
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