

*Full Length Research Paper*

# Chromosome study in few species of Acridids (Acrididae: Tryxalinae): Karyotypic analysis and distribution patterns of constitutive heterochromatin

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**Chromosomes with detailed karyotypic information (nature, number, size, relative length, length of X-chromosome, nature of X-chromosome) and C-banding patterns of few species of grasshoppers belonging to sub-family Tryxalinae are discussed. The karyotypes comprises of acrocentric chromosomes with complement number  $2n = 23$  (male). Constitutive heterochromatin distribution was found at centomeric, interstitial, terminal sites along with thick and thin bands among all the species except in *Acrida turrita* which possessed only centromeric C-bands. The number and location of C-bands in Acridids exhibit intra specific variations. In the present communication the karyotypic analysis and C-banding patterns are analyzed for further differences between genera belonging to the same sub-family.**

**Key words:** Acrididae, orthoptera, C-banding.

## INTRODUCTION

Orthoptera has been considered as a classical material for karyological investigations. The size and number of their chromosomes are such that both qualitative and quantitative studies on chromosomal anomalies can be detected easily (Turkoglu and Koca, 2002). The karyotype is found to have a cytotaxonomic value. Acridoid group is known for its karyotypic uniformity or conservatism (Aswathanarayana and Ashwath, 2006).

The introduction of C-banding technique offers a simple mean of defining constitutively heterochromatic regions. C-banding technique has made it easier to assess the changes in constitutive heterochromatin and have revealed the existence of remarkable degree of C-band variations within species (King and John, 1980; Lopez-Fernandez and Gosalvez, 1981). Hsu (1974) hypothesized that the heterochromatin has passive role of body guard i.e. it is used by the cell as a body guard to protect the vital euchromatin by forming a layer of dispensable shield on the outer surface of nucleus. This heterochromatin is subjected to both qualitative and quantitative variations. Many studies on the C-bands

have been done in Acridoids which are known to possess high level of chromosomal variations. The number and location of C-bands in Acridids exhibit both intra- and interspecific variations (Yadav and Yadav, 1993). The present communication deals with the chromosome complement and distribution of constitutive heterochromatin along with the differences between genera belonging to same sub-family are discussed.

## MATERIALS AND METHODS

The males of few species of Acrididae were collected in and around Guru Nanak Dev University campus, Amritsar (Punjab). The testis was excised following standard Colchicine-Hypotonic-Cell suspension-Flame dry technique (Yadav and Yadav, 1983). The flame dried slides were treated for C-banding following method of Sumner (1990) with slight modifications. The chromosomes were classified after Levan et al. (1964).

## RESULTS

The perusal of Table 1 revealed that among the four species studied, all belong to sub-family Tryxalinae and these are *Acrida turrita* Linn., *Acrida exaltata* Walk.,

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**Table 1.** Nature of chromosomes and morphometric characters in some species studied.

S/No.	Species	Male 2n number	Chromosome size			*Range of relative length of autosomes	Length of X-chromosomes	Nature of chromosomes			Nature of X-chromosome
			L	M	S			m	sm	a	
<b>Sub-family: Tryxalinae</b>											
1	<i>Acrida turrita</i>	23	3	6	2	(19.9 ± 0.39) - (144.2 ± 0.48)	199.0 ± 2.26	-	-	All	Largest
2	<i>Acrida exaltata</i>	23	3	6	2	(35.1 ± 0.36) - (128.9 ± 1.32)	148.4 ± 0.42	-	-	All	Largest
3	<i>Phlaeoba infumata</i>	23	3	6	2	(38.0 ± 0.72) - (128.2 ± 0.46)	141.0 ± 1.18	-	-	All	Largest
4	<i>Phlaeoba antennata</i>	23	3	6	2	(23.2 ± 0.32) - (139.0 ± 1.02)	151.1 ± 1.05	-	-	All	Largest

L: Long, M: Medium, S: Small, m: metacentric, sm : submetacentric, a: acrocentric \* relative length of shortest and longest autosomes.

*Phlaeoba infumata* Brunn., *Phlaeoba antennata* Brunn. The diploid chromosome number was found to be 23 and sex-determining mechanism was found to be XO: XX type among all the species investigated. Table I shows the various morphometric characters of all the species investigated. It was ascertained that the chromosome morphology is acrocentric for all the species. X-chromosome is the marker as it is the largest element among all the species studied. Figures 1 to 4 showing spermatogonial metaphase of four species respectively.

Table 2 is showing the position of constitutive heterochromatin among male grasshoppers studied. It was observed that the centromeric bands of constitutive heterochromatin were found among all the species under study. The interstitial bands were seen in *A. exaltata*, *P. infumata*, *P. antennata* only. Terminal bands were seen in all the species investigated except in *A. turrita*. Thick bands were present in all the species while thin bands were seen in three species of hoppers excluding *A. turrita*. Figures 5 to 8 showing C-

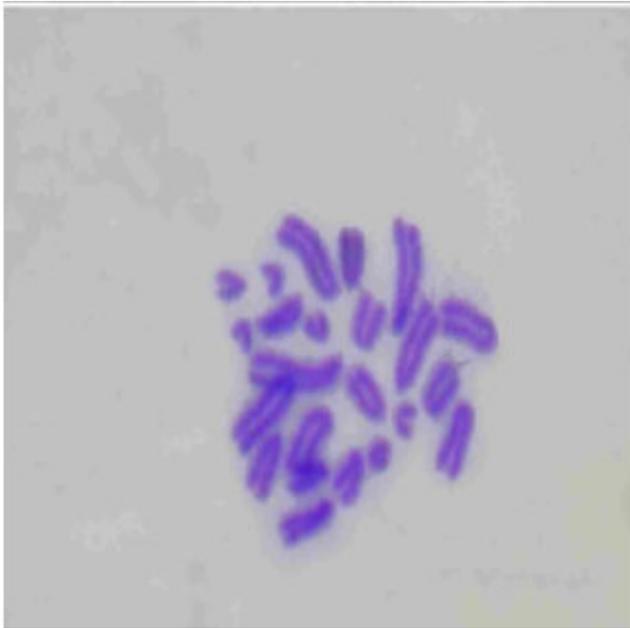
banded spermatogonial metaphase of the species.

## DISCUSSION

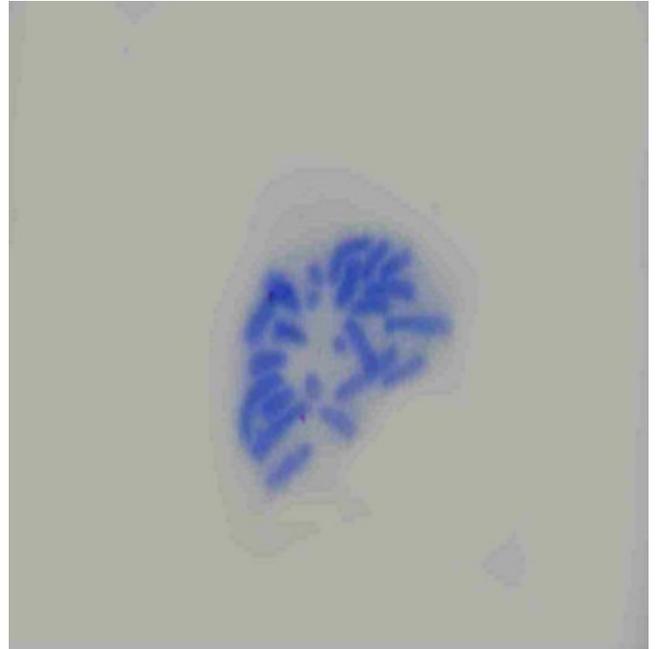
The karyology of every species is unique in itself and provides an identity to species (Channaveerappa and Ranganath, 1997). The short horned grasshoppers are characterized by possessing acrocentric chromosomes. Due to great cytogenetic uniformity the short horned hoppers are considered as an example of "Karyotypic conservatism" (Aswathanarayana and Ashwath, 2006).

In the present study, 4 Acridids have been investigated which belong to sub-family Tryxalinae. It is revealed that hoppers belonging to family Acrididae have 23 chromosome numbers. The sex-determining mechanism is found to be XO/XX type among all the studied species. Yadav and Yadav (1986) reported similar results in relation to chromosome number and

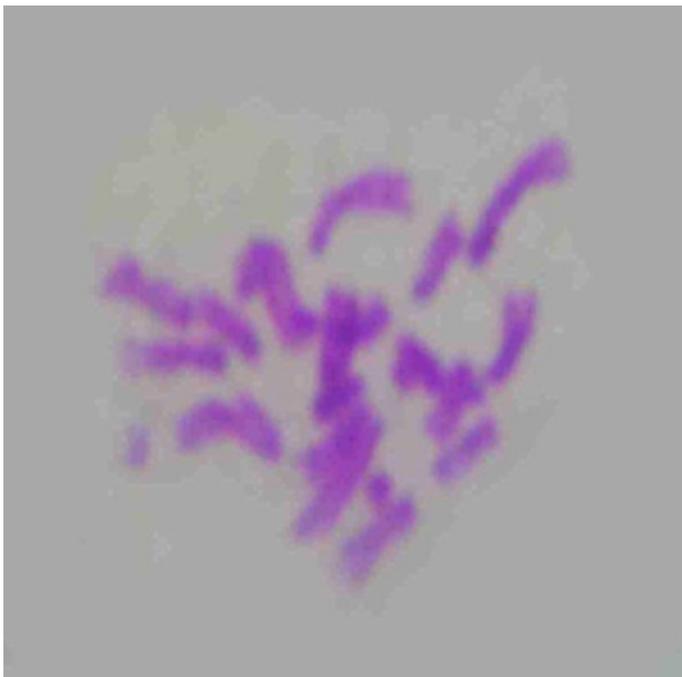
sex-mechanism among Haryana population of Acridoideans. While studying the chromosomes of 11 species of grasshoppers from Simla (H.P), Sharma and Gautam (2002) also revealed similar results. So, the short horned grasshoppers of different regions are showing cytogenetic uniformity regarding chromosome number and sex-determining mechanism. During the present investigation, the chromosomes are found to be acrocentric in nature. Upto six metacentrics through fusions have been reported in Tryxalines *Myrmeleotettix maculates* (John and Hewitt, 1966) and *Stauroderus scalaris* (John and Hewitt, 1968). Meanwhile, Aswathanarayana and Ashwath (2006) observed a series of structural changes involving 6<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup> pair exhibiting hetero and homomorphism in *Gastrimargus africanus orientalis*. Mayya et al. (2004) reported short arms in chromosomes of *Aiolopus thalassimus tumulus* and *Acrotylus humbertianus*. Whereas, no such change have been reported in present study. The X-chromosome is found to be largest of all the other chromosomes among the 6 species



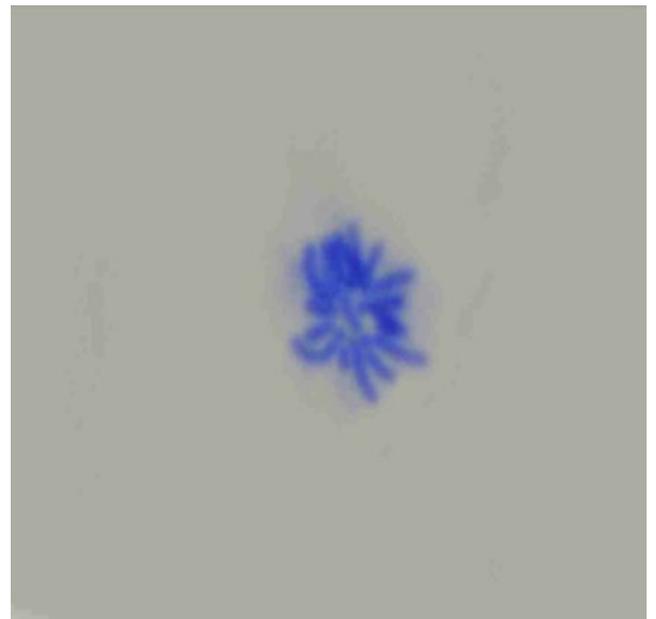
**Figure 1.** Spermatogonial metaphase of *Acrida turrita*



**Figure 3.** Spermatogonial metaphase of *Phlaeoba infumata*



**Figure 2.** Spermatogonial metaphase of *A. exaltata*.



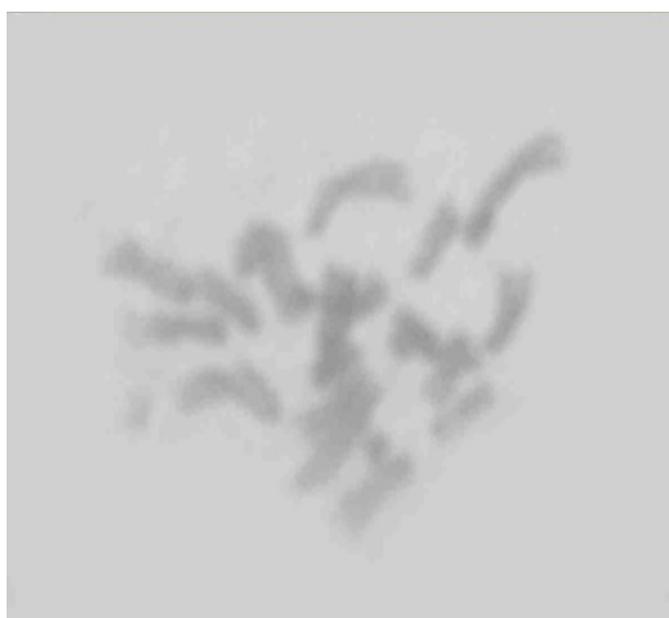
**Figure 4.** Spermatogonial metaphase of *P. anteenata*.

investigated. Mayya et al. (2004) also reported the X-chromosome to be largest in all the species except in *A. thalessimus tumulus* and *Spathosternum prasiniferum*. The C-band represents the constitutive heterochromatin in the homologous chromosome of a Yasminieh, 1971). C- banding pattern in various species

of grasshoppers provide important clues that have karyotype. This type of DNA consist of short repeated chromatin and said to be genetically inert (Yunis and polynucleotide sequences. C-bands exhibit centromeric, interstitial and terminal sites. It is a variant state of occurred during the course of evolution. Many studies have shown a remarkable degree of C-band variation.

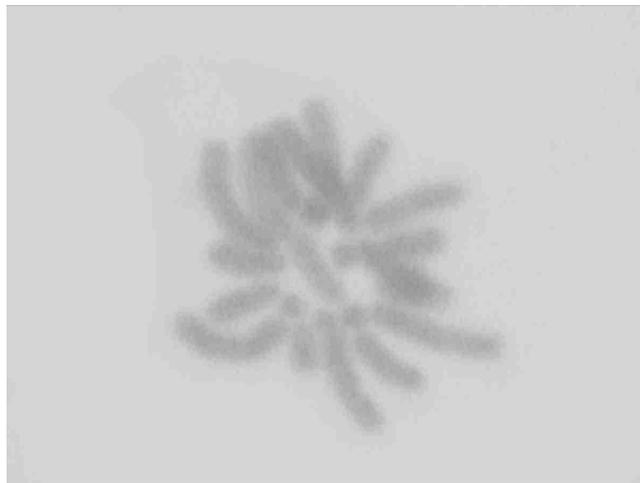
**Table 2.** Showing the position of C-heterochromatin in male grasshopper species under present investigation.

Species	C-banding sites				
	Centromeric	Interstitial	Terminal	Thick band	Thin band
<b>Super-Family: Acridoidea</b>					
<b>Sub family: Tryxalinae</b>					
1. <i>Acrida turrita</i>	1-11,X	—	—	1,4,6,7	—
2. <i>Acrida exaltata</i>	1-11,X	1,X	1,2,4	1,2,3,4,5,6,7,8,9,X	3,4
3. <i>Phlaeoba infumata</i>	1-11,X	3,5,7,X	1,6,7	1,2,3,5,6,7,X	1,4
4. <i>Phlaeoba antennata</i>	1-11,X	2	4,5	1,2,3,4,X	1,3,6

**Figure 5.** C-banded spermatogonial metaphase of *A. turrita*.**Figure 6.** C-banded spermatogonial metaphase of *A. exaltata*



**Figure 7.** C-banded spermatogonial metaphase of *P. infumata*.



**Figure 8.** C-banded spermatogonial metaphase of *P. anteenata*.

In the present study, C-bands are also found to be present in three locations that is centromeric, interstitial and terminal. But their extent is found to vary among the species studied. All the four species of Acridids studied possess centromeric C-bands. Yadav and Yadav (1993) and Mayya et al. (2004) reported the prevalence of centromeric bands in short horned grasshoppers as a very common feature. Kumaraswamy and Rajasekarasetty (1976) reported centromeric C-bands in *A. turrita*. Aswathanarayana and Ashwath (2006) also revealed centromeric bands in *A. turrita*. According to Yadav and Yadav (1993), restriction of C-heterochromatin to centromeric regions is considered to facilitate whole arm translocation.

C-bands found within the centre of the body of

chromosome is termed as interstitial C-band. In the present study, interstitial C-bands are seen in all the species of grasshoppers except in *A. turrita*. The interstitial C-bands were also encountered in 10 species of their study by Yadav and Yadav (1993). Mayya et al. (2004) revealed the presence of interstitial C-bands at different locations on chromosomes among Acridoid species. These interstitial bands are found to be inactivated centromere in some species of *Hieroglyphus nigrorepletus* (Yadav and Yadav, 1993). These interstitial C-bands might have an effect on the expression of the flanking euchromatic segment (Aswathanarayana and Ashwath, 2006). Terminal bands were exhibited by all the species except *A. turrita*. Similarly, the absence of terminal bands was also reported in *A. turrita* by Yadav

and Yadav (1993). On the other hand, our studies revealed the presence of centromeric, interstitial, terminal bands along with thick and thin bands.

The comparison of interspecific C-banding patterns of the same sub-family has no clear correlation. The species from the same genus have not shown uniformity in their C-banding patterns (John and King, 1977; Santos and Giraldez, 1982) which has attributed to dynamic nature of heterochromatin (Yadav and Yadav, 1993). Same situation has been seen in present study the species from same sub-family differ in their C-band distribution (*A. turrita*, *A. exaltata*). Likely, such comparisons are such that one cannot be sure that chromosomes of similar relative lengths are necessarily homologous in all genomes (King and John, 1980). Perhaps the only exceptions are the X and the megameric chromosomes which presumably have a common origin within the Acrididae (White, 1973). The immediate tendency for C-heterochromatin to vary in grasshoppers has been considered by many reports (Santos et al., 1983; Yadav and Yadav, 1983) and present report.

The pattern and distribution of C-heterochromatin distribution varies among Acridoid taxa, especially karyologically conservative ones. These variations are to be governed by some hidden mechanism of change, other than gross chromosome rearrangements operating in the process of speciation.

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## REFERENCES

- Aswathanarayana NV, Ashwath SK (2006). Structural polymorphism and C-banding pattern in a few Acridid grasshoppers. *Cytology*, 71(3): 223-228.
- Channaveerappa H, Ranganath H (1997). Karyology of few species of south Indian acridids. II Male germ line karyotypic instability in *Gastrimargus*. *J. Biosci.*, 22(3): 367-374.
- Hsu TC (1974). Procedures for inducing C-bands and G-bands in mammalian chromosomes. *Mammalian Chromosomes Newslett.*, pp. 151: 88.
- John B, Hewitt GM (1966). Karyotype stability and DNA variability in the Acrididae. *Chromosoma (Berl.)*, 20 : 155-172.
- John B, Hewitt GM (1968). Patterns and pathways of chromosome evolution within the Orthoptera. *Chromosoma (Berl.)*, 25: 40-47.
- John B, King M (1977). Heterochromatin variations in *Cryptobothrus chrysophorus* II Patterns of C-banding. *Chromosoma*, 65: 59-79.
- Kumaraswamy KR, Rajasekarasetty MR (1976). Pattern of C-Banding in *Acrida turrita* (Acrididae: Orthoptera). *Curr. Sci.*, 45(21): 762-763.
- King M, John B (1980). Regularities and restrictions governing C-band variation in Acridid grasshoppers. *Chromosoma*, 76: 123-150.
- Levan A, Fredga K, Sandberg AA (1964). Nomenclature for centromeric position of chromosomes. *Hereditas*, 52: 201-220.
- Lopez-Fernandez C, Gosalvez J (1981). Differential staining of a heterochromatic zone in *Arcyptera fusca*. *Experientia*, 37: 240.
- Mayya S, Sreepada KS, Hegde MJ (2004). Non-banded and C-banded Karyotypes of ten species of short-horned grasshoppers (Acrididae) from South India. *Cytologia*, 69(2): 167-174.
- Santos JL, Giraldez R (1982). C-heterochromatin polymorphism and variation in chiasma localization in *Euchorhippus pulvinatus gallicus* (Acrididae: Orthoptera). *Chromosoma*, 85: 507-518.
- Santos JL, Arana P, Giraldez R (1983). Chromosomal C-banding pattern in Spanish Acridoidea. *Genetica*, 61: 65-74.
- Sumner AT (1990). *Chromosome banding*. U. Hymen ed. London, Boston, Sydney, Wellington, pp. 39-104.
- Sharma T, Gautam DC (2002). Karyotypic studies of eleven species of grasshoppers from north-western Himalayas. *Nucleus*, 45(1-2): 27-35.
- Turkoglu S, Koca S (2002). Karyotype, C- and G- band patterns and DNA content of *Callimemus* (= *Bradyporus*) *macrogaster macrogaster*. *J. Insect Sci.*, 2(24): 1-4.
- White MJD (1973). *Animal cytology and evolution*. Third edition, Cambridge University Press.
- Yunis JJ, Yasminieh WG (1971). Heterochromatin, Sat- DNA and cell function. *Science*, 174: 1200-1209.
- Yadav JS, Yadav AS (1983). Analysis of hopper chromosomes with banding techniques. I. *Phlaeoba infumata* (Brunn.) (Tryxalinae: Acrididae) and *Atractomorpha crenulata* (F.) (Pyrgomorphae: Acrididae). *Biology*, 29(1): 47-53.
- Yadav JS, Yadav AS (1986). Chromosome number and sex-determining mechanisms in thirty species of Indian Orthoptera. *Folia Biol.*, 34(3): 277-284.
- Yadav JS, Yadav AS (1993). Distribution of C-heterochromatin in seventeen species of grasshoppers (Acrididae: Orthoptera). *Nucleus*, 36(1-2): 51-56.

