

Original Research

Meiosis and Chromosome Complement of *Atractomorpha lata* (= *A. bedeli*) (Mochulsky, 1866) (Orthoptera: Pyrgomorphidae) Collected in Cameroon.**Authors:**

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ABSTRACT:

This article presents detailed information on the meiotic process and karyotype of *Atractomorpha lata* (= *A. bedeli*), a Pyrgomorphidae grasshopper endemic to the West and North-West Regions of Cameroon. It includes chromosome number, morphology and chromosome lengths. The meiotic process in the species was normal and chiasmate with a mean chiasma frequency of 12.874 ± 0.29 . The percent rod shaped bivalents present was significantly higher ($P < 0.05$) than percent ring shaped bivalents. Percent bivalents with 1, 2 and 3 chiasmata were in the series: 1 chiasmata > 2 chiasmata > 3 chiasmata. The X chromosome revealed the reversal type of heteropycnosis. The detailed karyotype of *A. lata* from Cameroon (Africa) is here described for the first time. The species has a diploid karyotype of 23 and the sex mechanism is XX –XO. Short chromosome arms were visible in mitotic Metaphase chromosomes hence the chromosomes in the species were acrocentric. The karyotype revealed three large, five medium and one small chromosomes (3LL – 5MM – 1SS). Chromosome lengths varied from 8.40 to 2.10 μ m and the haploid set was 56.39 μ m long. The X chromosome was 5.6 μ m and medium in size.

Keywords:

Atractomorpha lata, Pyrgomorphidae, karyotype, meiosis.

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Article Citation:

Seino Richard Akwanjoh, Dongmo Tonleu Ingrid, Dongmo Alain and Manjeli Yacouba. Meiosis and Chromosome Complement of *Atractomorpha lata* (= *A. bedeli*) (Mochulsky, 1866) (Orthoptera: Pyrgomorphidae) Collected in Cameroon. Journal of Research in Biology (2014) 4(3): 1311-1316

Dates:

Received: 16 Apr 2013 **Accepted:** 23 May 2013 **Published:** 03 Jun 2014

Web Address:

[http://jresearchbiology.com/
documents/RA0352.pdf](http://jresearchbiology.com/documents/RA0352.pdf)

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INTRODUCTION

Atractomorpha lata (=A. bedeli) is a common grasshopper found in the West and North-West Regions of Cameroon. Though this species has been reportedly a pest of rice and Medicinal plants on the Asian continent (Anonymous, 1972; Kobayashi *et al.*, 1972; Lee *et al.*, 2007), it is yet to be implicated with pest activities in Cameroon or on the African continent.

Karyotype is an important asset of a species and can serve for identification purposes (Channaveerappa and Ranganath, 1997). It is also a useful tool in cytotaxonomic, evolutionary and phylogenetic studies (Verma and Agarwal, 2005). A review of Sannomiya (1973), John and King, (1983) and Yao *et al.*, (2004), revealed that some *Atractomorpha* species have karyotypes with chromosome numbers that vary from $2n = 19$ to 38 acro-telocentric chromosomes. This variation in chromosome number is due principally due to the presence of supernumerary chromosomes. Up to 19 B, chromosomes have been reported in some populations of *Atractomorpha* species.

There is a paucity in literature of cytogenetic information for Cameroonian (African) *Atractomorpha* species. This report is therefore a first description of the karyotype and meiotic process in the African *A. lata* (=bedeli) collected from Cameroon.

MATERIALS AND METHODS

Ten male individuals used for this study were collected on the Campus of the University of Dschang, Cameroon. Two of the insects were pre-treated with colchicine to ensure that mitotic chromosomes were obtained while the others were not so treated in order to easily obtain meiotic chromosomes (Tepperberg *et al.*, 1997).

Mitotic and meiotic chromosomes were respectively obtained from individuals treated with 1% colchicine and untreated individuals of *A. lata*. Chromosome smears were prepared with the Lactic

Propionic Orcein squash technique of Seino *et al.*, (2012a). Testes fixed in 3:1 Ethanol: Acetic acid were squashed on clean microscope glass slides and stained with 2% lactic – propionic orcein.

The meiotic process was assessed by examination of stages and substages present. Chiasma frequencies were counted from ten cells in Diplotene/Diakinesis in ten individuals. Mitotic Metaphase chromosomes were measured directly from the Lietz photomicroscope with the help of the ocular and stage micrometres. Chromosome morphology was determined from the presence of minute short arms and confirmed using the shapes of the chromosomes in first meiotic anaphases and second meiotic metaphases and anaphases. Chromosome size groups were determined from Relative Chromosome Lengths (RCL) and separated using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Meiotic process

The meiotic stages observed in this species are Prophase -1 (Zygotene, Pachytene, and Diplotene), Metaphase -1, Anaphase -1, Telophase-1, Metaphase- 2 and Anaphase -2 (Figure.1). In Diplotene (Figure. 1d), chiasmata were present. There was no precocious movement of chromosomes in Anaphase- 1(Figure. 1f). As per the criteria of Verma and Agarwal, (2005), the meiotic process in this species was judged as normal and chiasmate. This type of meiotic process is reportedly ancestral and characteristic for the Orthoptera (White, 1973; Hewitt, 1979). Chiasma frequency per cell varied from 11 – 16 with a mode of 13 and a mean of 12.84 ± 0.29 . A perusal of Table 1 revealed the mean percent rod shaped bivalents (69.2%) to be significantly higher ($P < 0.05$) than the mean percent ring shaped bivalents (32.9%). Also the mean percent bivalents with 1, 2 and 3 chiasmata were in the series: 1 – chiasmata (67.1%) > 2 – chiasmata (23.1%) > 3 – chiasmata

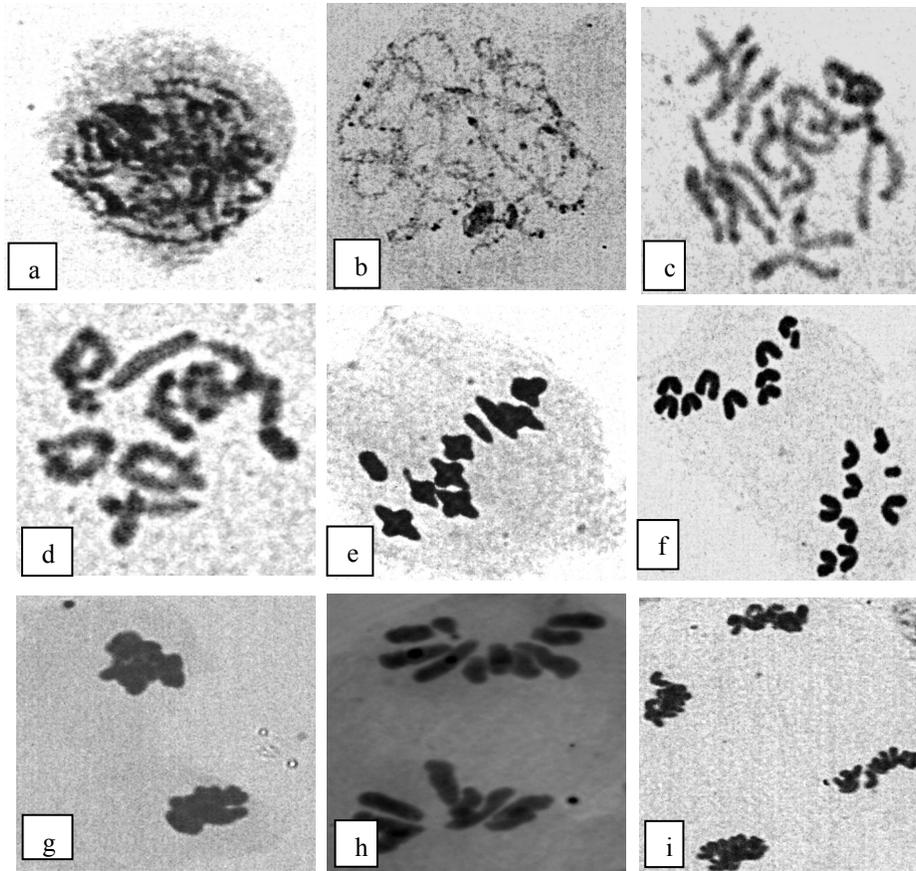


Figure 1: Meiotic stages in *Atractomorpha lata*: a) Leptotene; b) Zygotene; c) Pachytene; d) Diplotene; e) Metaphase- 1; f) Anaphase -1; g) Early Telophase -1; h) Anaphase -2; i) Telophase -2; Arrow = X- chromosome; ch = chiasma; ct = centromere

(9.7%). Similar observations have been reported for *Taphronota thaelephora* and *Dictyophorus griseus* (Seino *et al.*, 2012 a and b). The X chromosome stained darker than the autosomes in Prophase-1 but stained lighter than the autosomes in Metaphase-1 and Anaphase-1, therefore exhibiting the reversal type of heteropycnosis. Reversal heteropycnosis has been considered characteristic of the Orthoptera grasshoppers (White, 1973; Hewitt, 1979).

Karyotype

Few karyotype studies have been done on African Pyrgomorphidae in general and of species from Cameroon in particular. Mitotic Metaphase chromosome counts revealed 19 chromosomes in males (Figure. 2). There were also 9 bivalents and one univalent X chromosome in Diplotene and Metaphase -1. Therefore

the diploid chromosome number for *A. lata* was 19 ($2n=19$) with the $XX♀ - XO♂$ sex determining mechanism. This is another example of the characteristic Pyrgomorphidae karyotype since Pyrgomorphidae species show karyotype uniformity with 19 chromosomes (White, 1973; Hewitt, 1979; Seino *et al.*, 2012 a & b). The chromosome number recorded for *A. lata* in this study is in agreement with that recorded for *A. bedeli* (Sannomiya, 1973; 1978) and seven *Atractomorpha* species (*A. sinensis*, *A. burri*, *A. yunnanensis*, *A. peregrina*, *A. sagittaris*, *A. psittacina* and *A. lata*) in Guizhou (Yao *et al.*, 2004). However presence of B chromosomes (varying from 1 – 7) in the Tofuwato – Japan population of *A. Bedeli* (=lata) reported by Sannomiya (1973) is not found in this Cameroonian population.

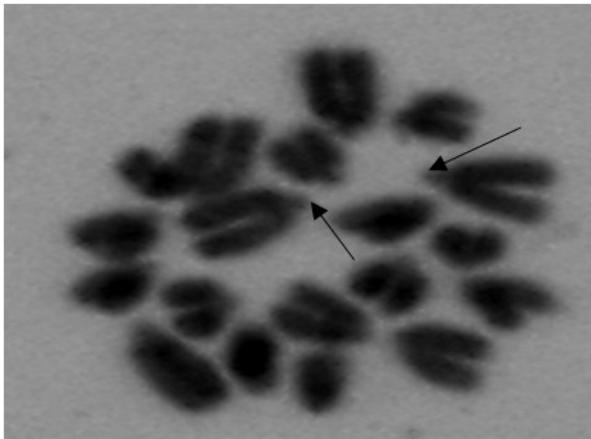


Figure. 2: Mitotic Metaphase chromosomes in *A. lata*. Short chromosome arms (arrowed) are visible in most of the chromosomes

The chromosomes of *A. lata* were all characterised by being a simple rod type with a near terminal attachment at the tapering ends. Short chromosome arms were present in most of the chromosomes (Figure.2). Centromeres were therefore in the near terminal regions of the chromosomes. As per the criteria of Levan *et al.*, (1964), the chromosomes in *A. lata* collected in Cameroon were therefore acrocentric in morphology. The acrocentric nature of these chromosomes was confirmed by the V-shaped nature of the chromosomes in Anaphase -1 (Figure 1 f) and the I -shaped nature of the chromosomes in Anaphase- 2 (Figure. 1i) (William and Ogunbiyi, 1995). No secondary constrictions were observed.

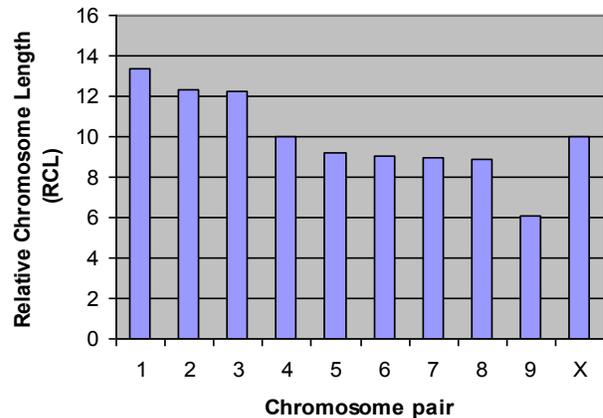


Figure. 3: Idiogram of karyotype of *A. lata*. The chromosomes occur in size groups of long, medium and short (3LL: 5MM: 1SS). The X chromosome is medium.

The individual chromosomes were also characterised by length. A perusal of Table 2 revealed that chromosomes in *A. lata* ranged from 7.52 to 3.42 μ m and the total haploid length (including the X chromosome) was 56.39 μ m. The X chromosome was 5.6 μ m long. The chromosomes were occurred in three sizes; long, medium and short (Figure. 3) (Table 3). There were 3 long, 5 medium and 1 short chromosome pairs (3LL: 5MM: 1SS). The X- chromosome was medium (Table 3). Chromosomes in most Orthoptera grasshoppers occur in size groups of long, medium and short (White, 1973; Seino *et al.*, 2012 a and b). This report is in agreement with the report of Yao *et al.*, (2004) who also observed the chromosomes of seven

Table 1: Mean chiasma frequency per cell, percent rod and ring shaped bivalents and percent bivalents with 1-, 2- and 3- chiasmata determined from ten cells in Diplotene of *Atractomorpha lata*.

| | Mean Cell Chiasma Frequency | Rod shaped bivalents | | Ring shaped bivalents | | Bivalents with 1- chiasma | | Bivalents with 2 -chiasmata | | Bivalents with 3 -chiasmata | |
|----------------|-----------------------------|----------------------|------|-----------------------|------|---------------------------|------|-----------------------------|------|-----------------------------|-----|
| | | X | % | X | % | X | % | X | % | X | % |
| <i>A. lata</i> | 12.84 \pm 0.29 | 0.692 | 69.2 | 0.329 | 32.9 | 0.671 | 67.1 | 0.231 | 23.1 | 0.097 | 9.7 |

Table 2: Mitotic Metaphase chromosome lengths (μ m) and long: short arm ratio in *Atractomorpha lata*

| | chromosome | | | | | | | | | | |
|---------------------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|--|
| | 1 μ m | 2 μ m | 3 μ m | 4 μ m | 5 μ m | 6 μ m | 7 μ m | 8 μ m | 9 μ m | 10 μ m | |
| Total length | 7.52 | 6.93 | 6.91 | 5.65 | 5.18 | 5.08 | 5.04 | 5.03 | 3.42 | 6.1 | |
| Long arm | 6.49 | 5.91 | 5.92 | 5.04 | 4.22 | 4.20 | 4.03 | 4.22 | 2.8 | 5.3 | |
| Short arm | 1.03 | 1.02 | 0.99 | 0.61 | 0.96 | 0.88 | 1.01 | 0.81 | 0.62 | 0.8 | |
| Long arm: short arm ratio | 6.60 | 5.79 | 5.98 | 8.26 | 4.40 | 4.77 | 3.99 | 5.21 | 4.52 | 6.63 | |

Table 3: Morphometric characters of the karyotype of *A. lata* collected from Cameroon

| Species | Total number of chromosomes per cell in the male | Sex determining mechanism | Number of chromosome per size group | | | Total chromosome length (µm) (Haploid set) | Morphology of chromosomes | Length (µm) of X chromosome | Size of X chromosome |
|----------------|--|---------------------------|-------------------------------------|--------|-------|--|---------------------------|-----------------------------|----------------------|
| | | | Long | Medium | Short | | | | |
| <i>A. lata</i> | 19 | XX-XO | 3 | 5 | 1 | 56.39 µm | All Acrocentric | 5.63 µm | Medium |

♀ - ♂

Atractomorpha species collected in Guizhou to occur in three size groups of long medium and short. However, the X chromosome in this study was medium in size while in the Guizhou species of *Atractomorpha* the X chromosome was the longest chromosome in the genome.

The apparent absence of B chromosomes in this study does not dismiss the existence of supernumeraries in Cameroonian populations of *A. lata* (= *bedeli*). The presence of B chromosomes are known to vary with population (Camacho et al., 2000). During this study no meiotic and karyotype aberrations were detected.

ACKNOWLEDGEMENTS

We are deeply indebted to Mr Akongte Peter, MSc student in the Department of Animal Biology of the University of Dschang, Cameroon, who collected the specimens used for this study. Our sincere thanks go to Professor Mpoame Mbida, Head of the Applied Ecology Laboratory (LABEA), Department of Animal Biology in the University of Dschang, Cameroon, for laboratory facilities.

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