Observations on the Meiotic Process in the African Pest Grasshopper *Taphronota thaelephora* Stal. (*Orthoptera : Pyrgomorphidae)*

R. A. Seino*; D. A. Focho and F. A. Njukeng.***
* Department of Animal Biology
** Department of Plant Biology,
Faculty of Science, University of Dschang
P.O. Box 67, Dschang, Cameroon

ABSTRACT

Taphronota thaelephora Stal. is a grasshopper pest of food and cash crops in the West Province of Cameroon. This grasshopper is however little known in scientific records probably because it is a pest of minor consequence. This pioneer cytogenetic investigation was therefore designed to characterize the species. Testes from 20 adult males collected from Mbouda, in the West Province of Cameroon, in December 2000, were used to prepare slides by the lactic-propionic orcein squash technique. The resulting squashes were then examined for the meiotic process, the number and morphology of the chromosomes and the behaviour of the X - or sex chromosome in meiosis. The meiotic process in the species was normal with chiasmata being formed at diplotene of prophase -1. A mean chiasma frequency of 14.10 ± 1.0 per cell was obtained. There was also no precocious movement of chromosomes in anaphase separations. The results further revealed a karyotype of 9 + XO bivalents (2N=19 chromosomes). Minute short arms were visible in metaphase -1 bivalents. The chromosomes in anaphase -1 and metaphase -II were V-shaped while those in anaphase -II were I- shaped. These indicated that the chromosomes in *T. thaelephora* are acrocentric in morphology. The X - or sex chromosome was the largest in the karyotype and it exhibited the reversal type of heteropycnosis.

Key words: Taphronota thaelephora, pest grasshopper, meiotic process

RESUME

Taphronota thaelephora Stal. est un criquet peste affectant les cultures vivrières at les culture de rentes dans la province de l'Ouest Cameroun. Ce criquet peste est toutefois peu connu dans la littérature scientifique probablement parce que sa nuisance n'a que des conséquences mineures. Cette étude cytogénétique pionnière a donc pour but de caractériser l'espèce. Des testicules provenant de 20 mâles adultes capturés en décembre 2000 à Mbouda dans la province de l'Ouest Cameroun ont été utilisés pour préparer des lames par la technique de l'écrasement a l'orciene lactique – propionique. Les lames ainsi obtenues ont été examinées en vue d'observer le processus de méiose, le nombre et la morphologie des chromosomes, le comportement du chromosome X ou chromosome sexuel au cours de la méiose. Le processus méiotique chez l'espèce était normal avec les chiasma se formant à la diplotène de la prophase – 1. Une fréquence moyenne des chiasmas de 14.10 ± 1.0 par cellule a été obtenue. Il n'y avait pas aussi de mouvement précoce de chromosome durant les séparations de l'anaphase. Les résultats ont ensuite revelés un caryotype de 9 + XO bivalent (2N = 19 chromosomes). De menus bras courts étaient visibles sur les bivalents de la métaphase – 1. Les chromosomes à l'anaphase – 1 et métaphase – 2 étaient en forme de V alors que ceux de l'anaphase – 2 étaient en forme de I. Cela a indiqué que les chromosomes de *T. thaelephora* sont acrocentriques dans la morphologie. Le chromosome – X ou chromosome sexuel était le plus grand dans le caryotype et montrait une hétéro pycnose de type renversé.

Mots clés : Taphronta thaelephora, criquet peste, processus de méiose

Corresponding author : R. A. Seino
P.O. Box 67 Dschang, Cameroon
E-mail : raseino@yahoo.co.uk

Introduction

Taphronota thaelephora is an African grasshopper that lives near the Gulf of Guinea. It prefers man-made environments and thrives on cultivated farms. This grasshopper is polyphagous and feeds on both food and cash crops commonly cultivated in the West Province of Cameroon (Nonvieller, 1984; Nembot, 1999). It does not gather into large voracious groups and therefore is a pest of minor consequence. It, however, has the potentials of becoming a veritable pest of agricultural importance in the near future.

The cytology of African Pyrgomorphidae has received only passing interest. Much of the available information on the group comes from *Zonocerus variegates*, probably because this species is a veritable and obnoxious pest of food and cash crops (Toye, 1970; Taylor, 1972; Anya, 1973; Bernay *et al*, 1975; Modder, 1984; Chapman *et al*, 1986). Oyidi (1967a, 1967b) investigated aspects of meiosis in this grasshopper and reported chiasma frequency to decrease with age and vary with seasonal change. Lasebikan and Olorode (1972) observed meiotic aberrations such as pseudo-chiasmata and lagging X -chromosomes in some populations of *Z. variegatus* in Nigeria. Nwakiti (1983) studied the F1 between wet and dry season populations and reported meiosis to be normal. Faluyi and Olorode (1988) described the karyotype and development related phenomena such as endopolyploidy, mitotic reduction and differential heteropycnosis in *Z. variegatus* from spermatogonial cells in nymphal stages.

This article is a pioneer report on the cytogenetics of *T. thaelephora*. It describes chromosome number and morphology, chiasma frequency and the behaviour of the X -chromosome in the spermatogenesis of this species.

Materials and Methods

Twenty adult males of *T. thaelephora* collected in December 2000 from Mbouda located in the West Province of Cameroon, were used for the study. They were dissected in insect saline (68.0% NaCl) to remove the testes which were then fixed in 3:1 ethanol-acetic acid and squashed in 2.0% lactic-propionic orcein stain. Chromosome number was determined by counting chromosomes in 5 intact metaphase -1 cells in each of 20 individuals examined. Chiasmata were counted in 5 cells in each of 10 individuals while chromosome morphology was determined by examining drawn-out bivalents in metaphase -1 for minute short arms and the shapes of chromosomes in anaphase -1, metaphase -II and anaphase -II. Photographs were made from slides that were temporarily preserved by sealing the edges of the coverslides using transparent nail polish.

Results and Discussion

i) The meiotic process

The following stages and substages were recorded during this study: zygotene, pachytene, diplotene, metaphase -1, anaphase -1, metaphase -II and anaphase -II (Figs 1-7). In diplotene, chiasmata were present. Chiasma frequency per cell varied between 11 and 16. The modal and mean chiasma frequencies per cell were 14.00 and 14.10 $\pm$ 1.0 respectively. Anaphase -1 and -II separations were normal. No precocious movement of any chromosome was recorded. These observations indicated that meiosis in this species was normal and chiasmate.

ii) Chromosome number

A meiotic chromosome number of 10 which included 9 bivalents and the univalent X -chromosome was obtained (Figs 4a & b). This indicated a diploid chromosome number of 19 and a sex determining mechanism that is XX - XO, which are characteristic of the pyrgomorphoid grasshoppers (White, 1951, 1973; Nwakiti, 1983; Faluyi and Olorode, 1988).

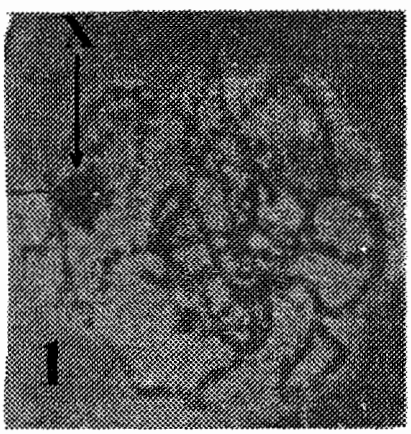
iii) Chromosome morphology

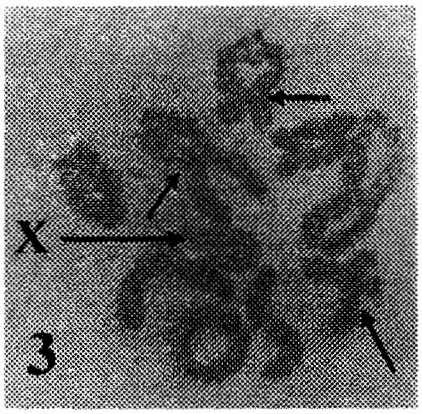
Minute second chromosome arms were visible in drawn out metaphase -1 bivalents (Fig 4b). Similar minute second arms have been reported for acridoid acrocentric chromosomes by White (1951). The chromosomes in anaphase -1 (Fig 5) and metaphase -II (Fig 6) were V-shaped and made up of 2 visible arms. In anaphase -II (Fig 7) the chromosomes were I -shaped. These indicated that the chromosomes in *T. thaelephora* were acrocentric in morphology.

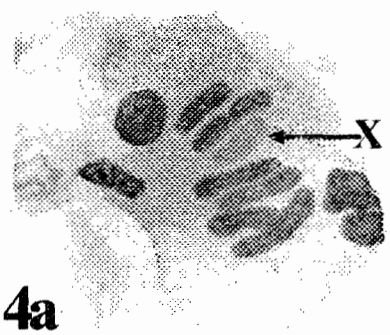
iv) The X-chromosome in meiosis

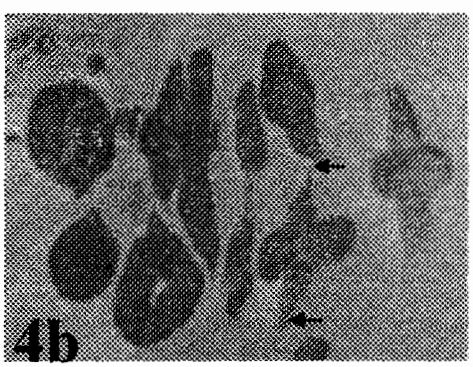
During zygotene, the X -chromosome could be identified as a small darkly stained mass found towards the periphery of the nucleus (Fig 1). In pachytene (Fig 2) and early diplotene (Fig 3) this chromosome assumed a U -shape, had a smooth outline and stained darker than the autosomes hence it was positively heteropycnotic. In metaphase -1, the X -chromosome was now rod-shaped and stained lighter than the autosomes, therefore being negatively heteropycnotic. The two chromatids of the chromosome were visible but not distinct during this stage. In anaphase -1 (Fig 5) there was repulsion between sister chromatids which were, however, still held together towards one end by the centromere, thus conferring a V -shape on the chromosome. The X -chromosome appeared as the largest chromosome in the karyotype. It stained lighter than the autosomes and was therefore negatively heteropycnotic.

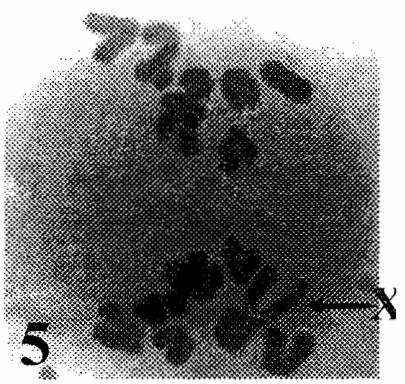
In metaphase -II (Fig 6) and anaphase -II (Fig

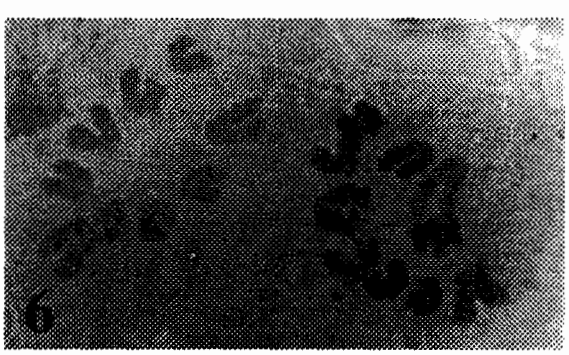












Figs. 1-7 : Meiotic stages in *Taphronota thaelephora* Stal. Figs 1, 2 & 3 are prophase-I sub-stages in which the X-chromosome is positively heteropycnotic. Fig 3 (diplotene) shows chiasmata (arrowed). Figs 4a & 4b are metaphase-I. The X-chromosome is negatively heteropycnotic in Fig 4a while Fig 4b shows minute second chomosome arms (arrowed). Fig 5 is anaphase-I in which the X-chomosome is largest and negatively heteropycnotic. Figs 6 & 7 show metaphase-II and anaphase-II chomosomes which are V- and I-shaped respectively.

7), the X -chromosome in *T. thaelephora* stained to the same intensity as the autosomes and could therefore not be identified on this basis. These observations indicated that the X -chromosome in *T thaelephora* exhibits the reversal type of heteropycnosis since it was positively heteropycnotic in prophase -1 and negatively heteropycnotic in metaphase -1 and anaphase -1. This behaviour has been variously shown to be characteristic of X -chromosomes in Acridomorphoid grasshoppers (White, 1973; Faluyi and Olorode, 1988; Seino, 1989).

Conclusion

This study revealed that meiosis in *Taphronota thaelephora* Stal. is normal and chiasmate. It has a karyotype made up of 19 acrocentric chromosomes and exhibits the XX - XO type of sex determination. The X -chromosome is the largest in the karyotype and it exhibits the reversal type of heteropycnosis.

Acknowledgements

We are grateful to Dr Zoli of the Animal Parasitology Laboratory (Belgian Corporation) University of Dschang for allowing us use his photomicroscope to take the pictures here presented.

Our thanks also go to Dr Nguetsop Victor of the Department of Plant Biology, University of Dschang for translating the Abstract of this article into French.

References

ANYA, A.O. (1973) : Ecology of the variegated grasshopper, *Zonocerus variegatus* (Orthoptera: Acrididae, Pyrgomorphidae) on Nsukka Plateau, Nigeria *Entomologia Experimentalis et Applicata* 16: 64-76.

BERNAY, E.A. CHAPMAN, R.F., Cook, A.G., McVeigh, I.K. and Page W.W. (1975): Food plants in the survival and development of *Zonocerus variegatus* L. *Acrida*, 4: 33-46.

CHAPMAN, R.F., PAGE W.W., and COOK A.G. (1986): Bionomics of the variegated grasshopper (*Zonocerus variegatus*) in West and Central Africa. *Annual Review Entomology*, 31: 479-505.

FALUYI J.O. and OLORODE, O. (1988): Mitotic chromosome studies in nymphal and adult populations of *Zonocerus variegatus* L. (Orthoptera: Pyrgomorphidae). *Journal of African Zoology*, 102: 475-480.

LASEBIKAN A.B. and OLORODE O. (1972): Morphological variation and cytological aberrations in natural populations of *Zonocerus variegatus* L. (Orthoptera: Pyrgomorphidae). *Bulletin of Entomological Society, Nigeria*, 3: 127-133.

MODDER, W.W.D. (1984): Diurnal variation in the feeding and gut activity in nymphs of the African pest grasshopper *Zonocerus variegatus* L. (Acridoidea: Pyrgomorphidae). *Insect Science and its Application*, 5: 527-531.

NEMBOT, E. (1999): Comportement nutritionnel du criquet peste *Taphronota thaelephora* Stal. (Acridomorphoidea: Pyrgomorphidae). Mémoire de Maîtrise; Université de Dschang, Cameroun. 66pp.

NONVEILLER G.V. (1984): Catalogue des insectes du Cameroun d'intérêt agricole (apparition, répartition et importance). PRIFAS Montpellier. 210pp.

NWAKITI O.C. (1983): Meiosis in the male insect *Zonocerus variegatus* (Orthoptera: Pyrgomorphidae). *Zool. Anz.* 210: 78-85.

OYIDI O. (1967a): Variation and variability in the Orthopteran insects. I. The influence of age on chiasma frequency in *Zonocerus variegatus* (Acrididae). *Journal of the West African Science Association* 12: 131 – 138.

OYIDI O. (1967b): Variation and variability in the Orthopteran insects. 2. Notes on the Biological Status of *Zonocerus variegatus* L. (Acrididae). *Journal of the West African Science Association*. 13 159-164.

SANNOMIYA, M. (1973): Cytogenetic studies on normal populations of grasshoppers with special reference to B-chromosomes – 1 *Actractomorpha bedeli*. *Chromosoma* 44: 99-106.

SEINO, R. A. (1989) : Cytogenetic characterization of seven species of Acridomorphoid grasshoppers. M. Phil. dissertation. University of Lagos, Nigeria. 167pp.

TAYLOR, T. A. (1972): On the probable origin of wet and dry season forms of Z. variegatus L. in Nigeria with some biological notes. *Bulletin of Entomological Research*, 61: 661 – 668.

TONYE, S.A. (1970): The structure of the eggs of Zonocerus variegatus L. (Orthoptera : Acridoiodea). *Revue Zoologica , Botanica Africa*, 81: 19 – 28.

WHITE, M.J.D. (1951): Cytogenetics of orthopteroid insects. *Advances in Genetics*, 4: 268 – 330.

WHITE, M.J.D. (1973): Animal cytology and evolution. Third Edition. Cambridge University Press. 961p.

Received 01/05/2002
Accepted 19/07/2002