

## Chromosome Behavior in the Spermatogenesis of *Oxya yezoensis* (an Orthopteran)

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### Introduction

The present paper dealing with the spermatogenesis of *Oxya yezoensis* is a part of a series of genetic-cytological studies on the species-formation of the genus *Oxya* (an orthopteran), together with my previous studies on that of *O. velox* (Oka, 1928), *O. japonica* and *O. intricata* which will be reported in near future.

The general features of the spermatogenesis of this species are found so similar to those of *O. velox* and *O. japonica*, that only those features which are to be compared with those of other species are noted in this paper.

*Oxya yezoensis* Shiraki is found only in Hokkaido, and no other species is found there. The material studied in the present paper was collected in early September, 1929, in rice fields near the city of Sapporo, Hokkaido. I received kind help in every way on that occasion from the members of the Entomological Institute and Zoological Institute, Faculty of Agriculture, Hokkaido University. Especially, my hearty thanks are offered to Prof. S. Makino who sent me the fixed material for chromosome study of this species. Prof. H. Furukawa, an orthopterologist, has kindly helped me to identify the species.

### Material and Method

*Oxya yezoensis* (Fig. 1) is a distinct species, being distinguished by its small body size and short tegmina (anterior wings), in comparison with *O. japonica* (Fig. 2) and *O. velox* (Fig. 3), in fully grown males and females, and the tegmina rarely exceed half the caudal femora in length or the body length, while in *O. japonica* the tegmina do not exceed the caudal femora in length or the body length, but nearly equal to it.

The structure of the testis is the same as those of *Oxya velox* and *Oxya japonica*, and the microscopical preparations of the species were made in the same way as in the case of *Oxya velox*.

### Spermatogenesis

*Primary Spermatogonia.* A primary spermatogonium has large

oval nucleus, and contains in its cytosome a young idiosome staining faintly with basic dyes as in the cases of other species studied. The size of the cell seems to be a little smaller than that of other species. The cell is not enclosed in the cyst, but is attached to the blind end of each follicle in the testis.



Fig. 1. Fully grown male (left) and female (right) of *Oxya yezoensis* Shiraki, the tegmina attain about half the length of the caudal femora, or the body length.  $\times$  ca I.

*Secondary Spermatogonia.*  
It is to be noted that the number of multiplication divisions involved in this generation is eight, and this number is found to be common with the three species.

Figure 4 shows the polar

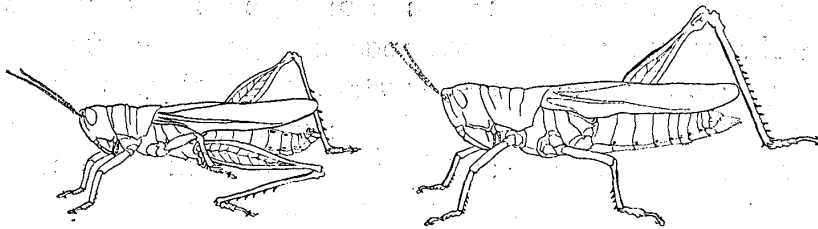


Fig. 2. Fully grown male (left) and female (right) of *Oxya japonica*.  $\times$  ca I.

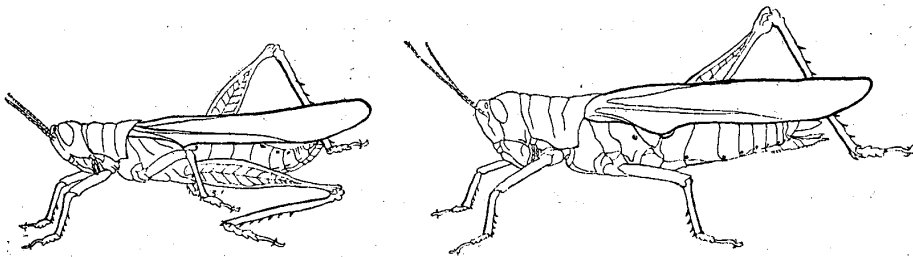


Fig. 3. Fully grown male (left) and female (right) of *Oxya velox*.  $\times$  ca I.

view of the metaphase-chromosome complex showing twenty-three chromosomes of diploid number, in which a single heterochromosome can be distinguished by its very slender and rough contour (Figs. 4-6). The homologous pairs can easily be distinguished among the remaining twenty-two autosomes.

As is shown in the following table, the eleven pairs of homologous chromosomes can be classified into five groups, distinguished by their size and shape as in the case of *O. velox*, and each group of these is found to correspond respectively to that classified in the case of *O. velox*, that is:

- ( I ) 1 pair of the smallest rod-chromosomes, corresponding to ...  
.....( I ) in *O. velox*
- ( II ) 3 pairs of small rod-chromosomes, corresponding to .....  
..... ( II ) „
- ( III ) 4 pairs of rod-chromosomes, corresponding to .....  
..... ( III ) „
- ( IV ) 2 pairs of long rod-chromosomes, corresponding to .....  
..... ( IV ) „
- ( V ) 1 pair of the longest rod-chromosomes, corresponding to ....  
..... ( V ) „

A single heterochromosome.

The small rod-chromosomes tend to lie in the central space of the rossete-like metaphase-chromosome complex as the secondary spermatogonium becomes smaller with successive multiplication divisions. In the metaphase of earlier divisions of this generation, the central space

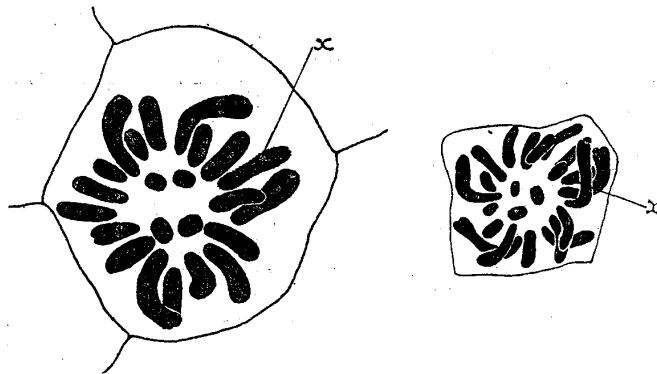


Fig. 4. Metaphase-chromosome complex of the spermatogonial generation, showing one heterochromosome (x) and twenty-two autosomes. Left (x ca 1500). Right (x ca 950).

of the metaphase-chromosome complex is vacant and the small chromosomes are always found being held between and near the proximal ends of other large chromosomes.

As was noted in the cases of *O. velox* and *O. japonica*, it has been ascertained also in this species that the homologous chromosomes come to lie side-by-side or nearly so, in a synaptic arrangement, as the successive divisions of the multiplication generation are repeated over and over, and as the

daughter nuclei become smaller. Finally, in the telophase of the daughter nuclei resulting from the last secondary spermatogonial division, the homologous chromosomes begin to disintegrate, maintaining their

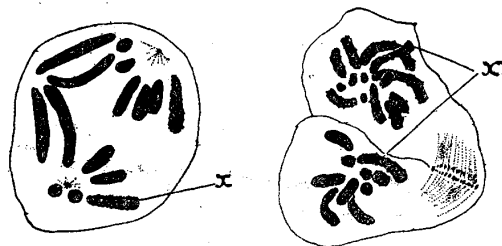


Fig. 5 (left). Side view of the anaphase of the spermatogonial division. x ca 1500.

Fig. 6 (right). Late anaphase of the daughter cells of a spermatogonium. The mid-body is clearly seen. x ca 1500.

synaptic arrangement, each contained in a chromosome vesicle. The polar view of the disintegration stage clearly shows the reduced number of chromosome vesicles. The features of this process are the same as in the cases of *O. velox* and *O. japonica*.

*Spindle-fibre Attachment.* All the gonial chromosomes are attached by the spindle-fibres at their terminal ends, that is, they are telomitic at their proximal or inner ends as is clearly found in the side view of

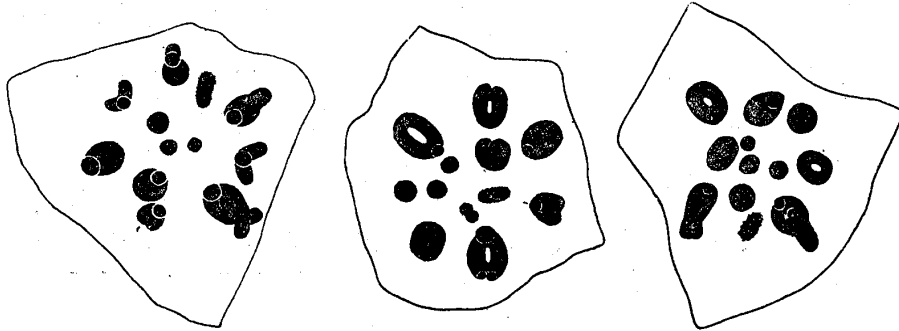


Fig. 7. Metaphase-tetrad complex of the heterotypic division, containing one dyad heterochromosome and eleven autosomal tetrads.  $\times$  ca 1500.

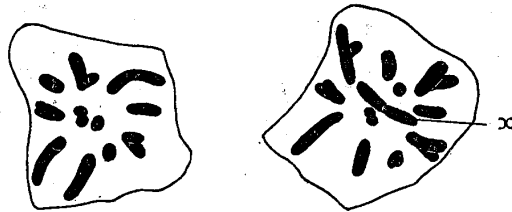


Fig. 8. Metaphase-dyad complex of the homotypic division, containing eleven dyad autosomes only (left), and one heterochromosome and eleven dyad autosomes (right).  $\times$  ca 950.

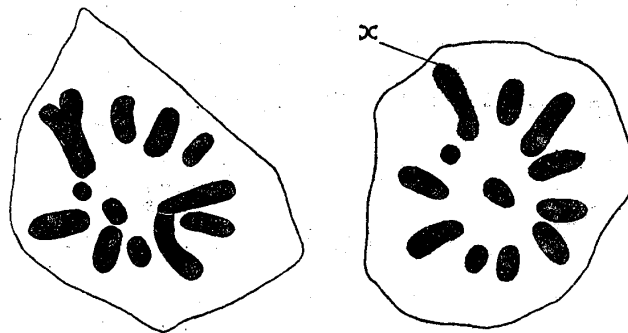


Fig. 9. The same as above.  $\times$  ca 1500.

the anaphase-chromosome complex (Fig. 5) and in the metaphase-chromosome complex. This again is quite similar to the situation found in *O. velox* and *O. japonica*.

The behavior of the idiosome and other cytoplasmic inclusions is the same as that in other species.

*Primary Spermatocytes.* The daughter nuclei derived from the last multiplication division of the secondary spermatogonia enter into the disintegration stage of the meiotic phase, the nuclear membrane being recovered as a mass of chromosome vesicles, in which the mates are enclosed in a synaptic arrangement, gathered at one pole of the daughter cells.

The size of the nucleus at the beginning of the disintegration stage seems to be the smallest as compared with those of the same stage in other species.

The heteropycnosis of a heterochromosome takes place in the same way as in the cases of *O. velox* and *O. japonica*.

The nucleus of primary spermatocytes grows larger and larger as its development advances further to the diffusion, leptotene, zygotene and pachytene stages, and it finally reaches to the maximum size at the end of pachytene stage. The cytosome, on the other hand, remains nearly undeveloped, and a small amount of cytoplasm is found along the periphery of cytosome, almost all of the space of which is occupied by the greatly enlarged nucleus.

It is to be noted that the size of the nucleus at the pre-cryptosome stage is definite and characteristic to the species. In *Oryza yezoensis* it is about  $20.6 \mu \left( \frac{30 \text{ mm}}{1450} \right)$ , while in *O. velox* it is about  $24.1 \mu \left( \frac{35 \text{ mm}}{1450} \right)$  and in *O. japonica* it is about  $22.9 \mu \left( \frac{33.3 \text{ mm}}{1450} \right)$ .

The cryptosome-stage noted by McClung (1927) has been observed to occur in this species, as in the cases of *O. velox* and *O. japonica*.

*Diakinesis.* The modes and kinds of tetrad-formation in each pair of homologous chromosomes have been carefully traced from the pachytene stage up to the anaphase of the spermatocyte for the purpose of comparing them with those of the other species studied. They are found to be the same as in the cases of *O. velox* and *O. japonica*.

Figure 7 is polar view of the metaphase-tetrad complex of a heterotypic division, and there are found one dyad heterochromosome, and eleven tetrad autosomes.

*Spindle-fibre Attachment.* All the eleven tetrad autosomes and one dyad heterochromosome are attached to the spindle fibres at their terminal ends, that is, they are telomitic.

*Pre-heterokinesis.* In the pre-heterokinesis of this species the dyad heterochromosome precedes the autosomes, as in the cases of *O. velox* and *O. japonica*, and there result at the end of this heterotypic division two kinds of daughter nuclei, one containing only eleven dyad autosomes, and the other containing eleven dyad autosomes and one dyad heterochromosome.

*Tetrad-complex.* The tetrads can be classified into five groups, distinguished by their modes and kinds of tetrad-formation, as in the case of *O. velox*, and each group of these is found to correspond respectively to that classified in the case of *O. velox*, that is:

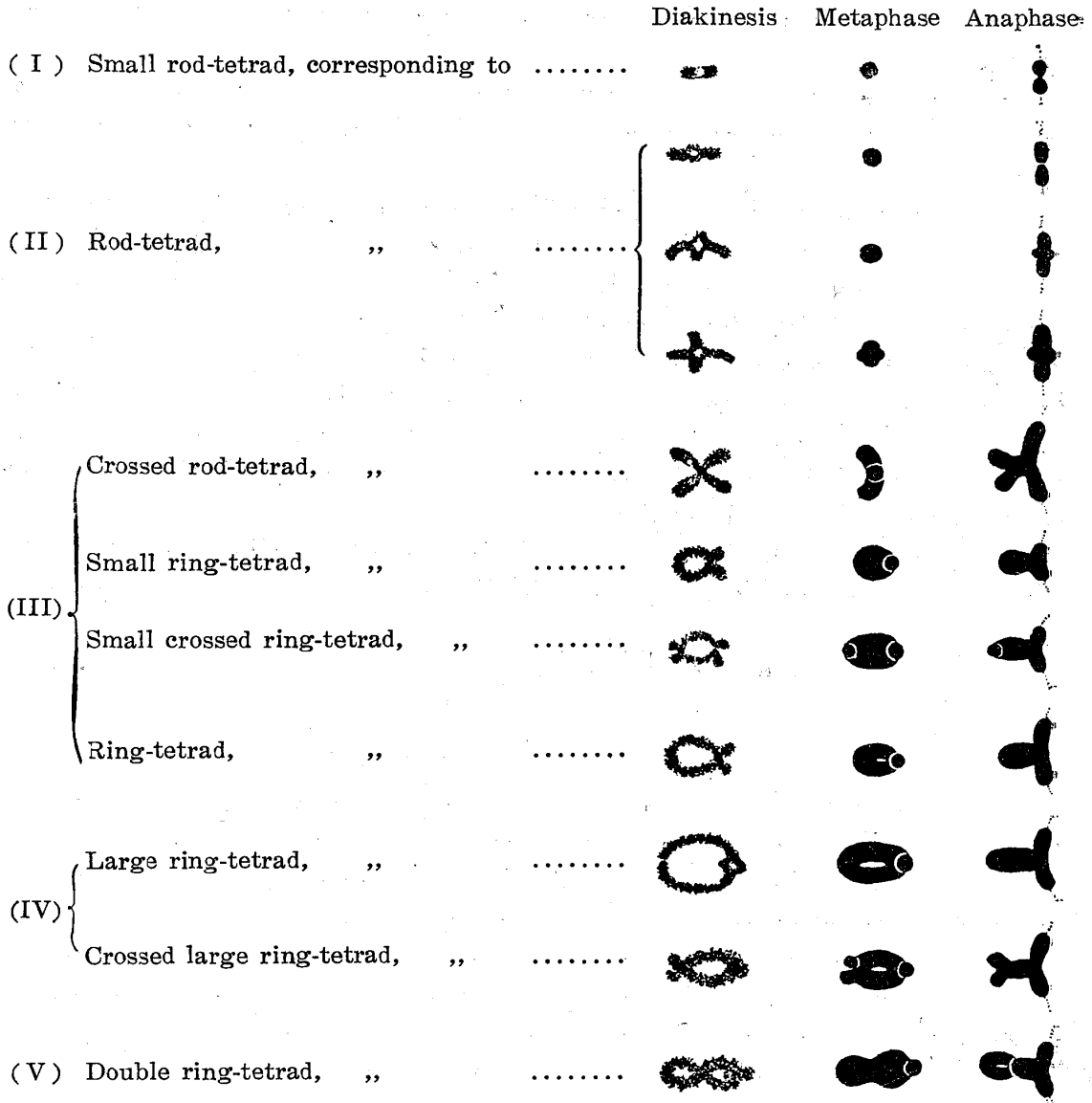


Fig. 10 Tetrad-complex in *O. velox*

The dyad heterochromosome shows its slender and rough contour in this stage, but not so slender as it is in the gonial division. It is to be noted that the dyad heterochromosome lies often in the center of the metaphase-tetrad complex as in the cases of *O. velox* and *O. japonica*.

*Secondary Spermatocytes.* Figures 8 (right) and 9 (right) are the metaphase-dyad complex at the equatorial plate of homeotypic division showing twelve dyads, in which one is the heterochromosome, and Figures 8 (left) and 9 (left) are the metaphase-dyad complex at the

equatorial plate of the homeotypic division containing eleven dyad autosomes.

*Spindle-fibre Attachment.* The spindle-fibre attachment to the dyads in the homeotypic division is consistently telomitic at the proximal or inner end.

### Summary

1. The chromosome behavior in the spermatogenesis of *Oxya yezoensis* Shiraki (an orthopteran) was studied, in the fall of 1929, as a partial fulfilment to my genetic-cytological studies on the species-formation in the genus *Oxya*, together with those studies on that of *O. japonica* and *O. velox* reported in previous paper.

2. *Oxya yezoensis* is found only in Hokkaido, where no other species of *Oxya* is found.

The material for the present studies was collected, in early September of 1929, in rice fields in the suburbs of the city of Sapporo.

3. The diploid number of chromosomes found in the spermatogonial division is twenty-three, of which one is the heterochromosome. The number of chromosomes is found to be the same as that of *O. velox* and *O. japonica*.

4. The spindle-fibre attachment to the chromosomes in the spermatogonial divisions is consistently telomitic and at their proximal or inner end.

5. The number of multiplication divisions of the secondary spermatogonia is eight, and is found to be the same as in other species.

6. The size of the nucleus at the pre-cryptosome stage of the spermatocytes is about  $20.6 \mu$  and found to be the smallest in comparison with that of the other species, that is; in *Oxya japonica* it is about  $22.9 \mu$  and in *O. velox* it is about  $24.1 \mu$ .

7. The haploid number of chromosomes found in the metaphase of the heterotypic division of the spermatocytes is twelve, being composed of eleven autosomal tetrads and one heterochromosome dyad.

8. The kinds and modes of tetrad-formation in this species have been carefully studied in the pachytene stage, diakinesis, metaphase and anaphase stages of meiosis, and classified into five groups shown in the tables. These were compared with those of *O. velox* and *O. japonica*, with the intention of finding any specific differences between the species studied.

9. The spindle-fibre attachment to the eleven tetrads and one dyad in the heterotypic division of meiosis is all telomitic.

10. The heterochromosome shows heteropycnosis during the spermatogonia and spermatocytes, and its behavior in the pre-heterokinesis is precessive, these features being the same as in the cases of *O. velox*

and *O. japonica*.

11. The haploid number of chromosomes found in the homeotypic division of the secondary spermatocytes is eleven in one of the daughter cells and twelve in the other, which contains the heterochromosome.

12. The spindle-fibre attachment is telomitic and at the proximal end in all the chromosomes of the secondary spermatocytes.

### Literature

- Oka, T. 1928 Chromosome behavior in the spermatogenesis of *Oxya velox* (An Orthopteran). (Japanese with English résumé). *Dobutsugaku Zasshi* (Zool. Mag. Tokyo), 40: 321-342.

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