Immunocytological analysis of chromosomes in meiotic prophase I of the paleotetraploid frog *Xenopus laevis*

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The African clawed frog *Xenopus laevis* (Pipidae, Anura, Amphibia) is a model object of cell and evolutionary biology. The karyotype contains 36 meta-, submeta- and subtelocentric chromosomes (Schmid, Steinlein, 2015). *X. laevis* is a species, the evolution of which was accompanied by ancient polyploidization and which is a paleotetraploid (4x=2n=36), consisting of two sets of 18 chromosomes or 9 chromosomal quartets (Matsuda et al., 2015). Each quartet includes two homeologous pairs of homologous chromosomes.

An immunocytological study of meiotic chromosomes in this species reflects the specifics of chromosome synapsis in quartets. Here, for the first time, the results of an immunocytological analysis of the chromosome behavior in the meiotic prophase I based on synaptonemal complexes (SC) are presented.

At the zygotene stage, partially synapted chromosomes form a classic “bouquet” figure: their telomeric ends are grouped near one of the nucleus poles (Fig. 1a, 2). In pachytene, chromosomes are completely synapted. All 18 SC bivalents are much longer than the chromosomes of most mammals. The longest SC bivalent was 64 μm, which is 8–10 times longer on average than the pachetene chromosomes of a mole voles. SCs are often intertwined in the spread meiotic nuclei (Fig. 1b, 2). Using immunodetection of kinetochore proteins, we found that some SCs have non-cooriented centromeres, as was noted earlier (Loidl, Schweizer, 1992). In diplotene, homologous chromosomes are desynapted. Desynaptic regions and SYCP3 fragmentation of axes are shown (Fig. 1c).

Rad51 protein is a marker of DNA double strand break repair marker (DSBs). Rad51 foci are distributed throughout the meiotic nucleus with the largest number in the regions of telomere attachment to the nuclear envelop at the zygotene stage. In early pachytene, the number of Rad51 signals significantly decreases and they are detected within the SC (3-6 signals per SC bivalent). In mid pachytene, single signals are observed.

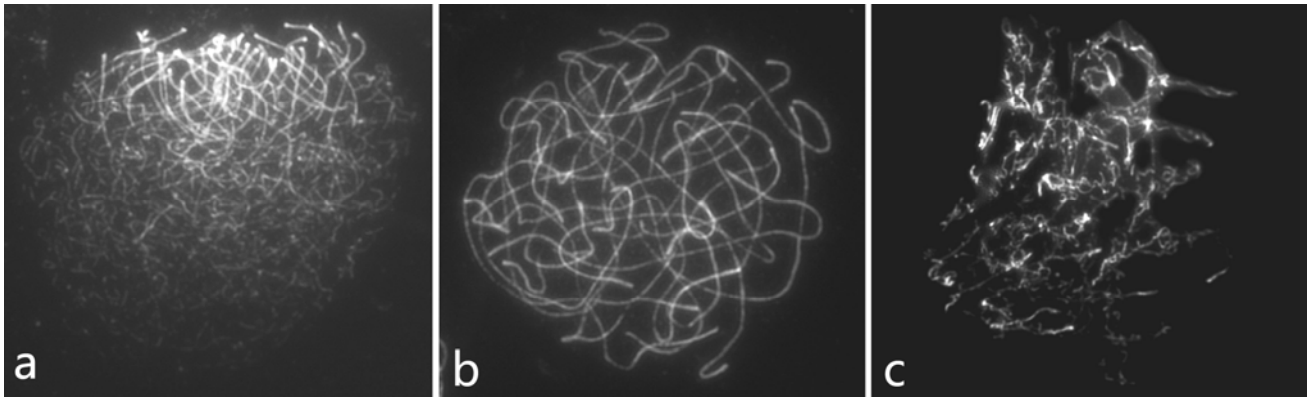

Fig. 1. *Xenopus laevis* spermatocytes at different stages of prophase I. a. Zygotene stage. Chromosome bouquet; b. Pachytene stage; c. Diplotene. White signal corresponds to the distribution of the major protein of SC - SYCP3. Magnification × 1000.

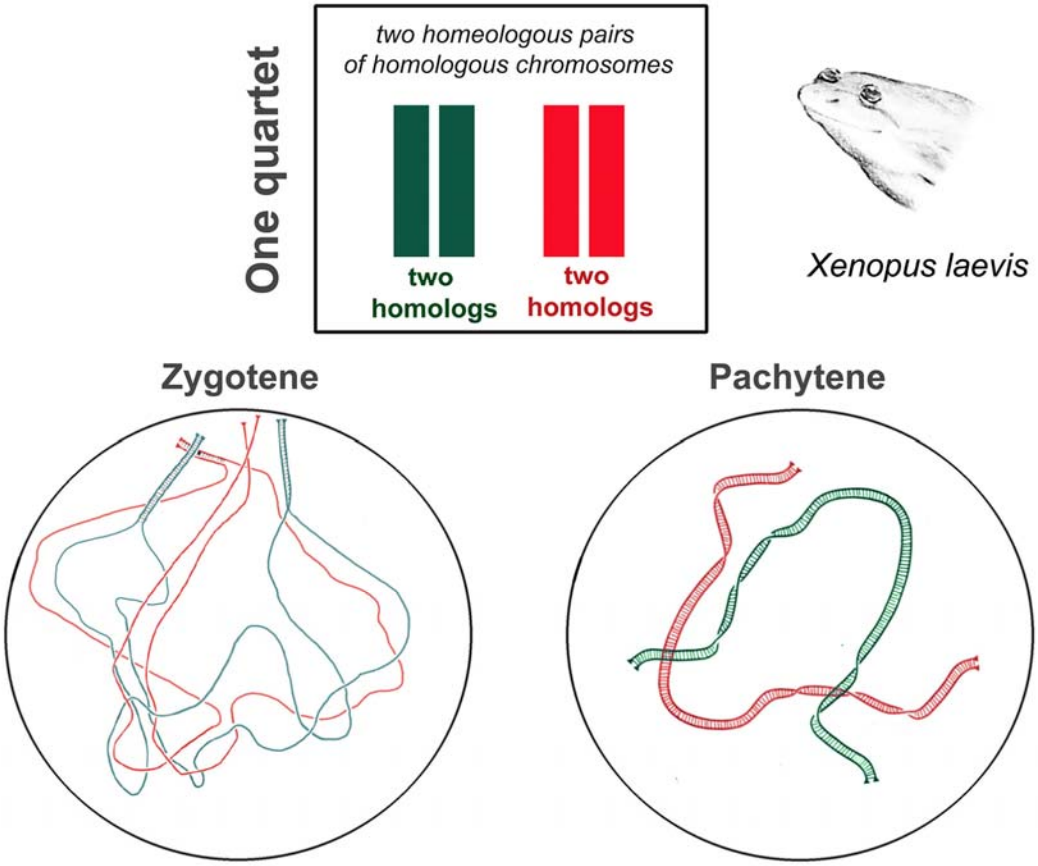

Fig. 2. Representation of chromosome synapsis in Xenopus. Chromosome telomeres are grouped near one of the nucleus poles at the zygotene ("bouquet" stage). In pachytene, SCs are formes by homologs. Homeologous synapsis is absent.

Our data confirm the results of the electron microscopic studies of the SCs (Loidl, Schweizer, 1992). It has been established that the homeologous chromosomes of different pairs have no synapsis with each other. It is likely that enough time has passed since the *X. laevis* tetraploid karyotype of was created and that homeologs have accumulated differences and are unable to enter into a homeologous synapsis.

Otherwise, multivalent configurations had to be formed. Recent data suggest that the frog allotetraploid karyotype was formed about 17-18 million years ago (Session et al., 2016). Centromeres discoorientation in the SCs, according to Loidl and Schweizer (1992), may be due to the fact that different frog subspecies/lines with slight differences in the centromere position can be used in laboratory hybridization.

SCs studies will be continued.

References

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These studies will be presented at the scientific conference "Genetics - the fundamental basis of innovations in medicine and selection" (26-29 September 2019, Rostov-on-Don, Russia).