ACTA SOCIETATIS
BOTANICORUM POLONIAE
Vol. 50, nr 1—2: 99—101
1981

Formation and development of sperms in angiosperms

S S. TATINTSEVA

The Botany Institute of the Turkmen Academy of Sciences, Laboratory of Plant Cytology, Ashkhabad, USSR

Abstract

Spermiogenesis has been studied in a large number of Angiosperm species characterizing different levels of phylogenetic system. The formation and development of male gamets can be described as formation of sperm cells that undergo ontogenesis which stimulates changes up to full maturity of the pollen grain. The process of ontogenesis is aimed at creating a suitable delivery system by the pollen tube to a female gamete.

Up to now the question of formation and development of sperms in the pollen grain of angiosperms remains unsettled. The literature data of recent years show that the quesion has not been given necessary consideration and the latest data are of rather casual character. This has led to a firmly established idea that sperms in the pollen grain of angiosperms remain during formation in the stage of incomplete mitotic cycle, namely in the telophase stage. Crepis, grasses and others belong to plants with incomplete mitotic cycle in sperms. The basic criterion of the incompleteness of the mitotic cycle is the absence of cytoplasm and nucleolus in sperms. Even the presense of cytoplasm (without nucleolus) allows some authors (Batygina, 1974; Bannikova, 1975) to support "the telophatic theory" of sperm formation. Modern information on mitosis cytology makes this theory doubtful (Mazia, 1963). It was established on some species of *Poaceae* and *Asteraceae* (Tatintseva, 1968, 1975) that sperms complete their mitotic cycle in the pollen grain. Spermiogenesis results in forming sperm-cells with all the typical elements. It was noted that sperms pass a peculiar formation cycle — ontogenesis. During the ontogenesis sperms undergo a number of changes: they stretch greatly, at that moment some cytoplasm can be seen only at the cell ends. In mature pollen grains cytoplasm in sperms is not seen in light microscope while in electronograms of *Poaceae* and *Asteraceae* sperms (unpublished data) show a clearly visible layer of cytoplasm surrounding the nucleus.

The process of disappearing of the nucleolus in sperms can be described as extrusion. The phenomenon has been described in animal reproductive cells. The process of nucleolus disappearance has been studied

most completely in sperms of *Elytrigia repens* (L.) Desv., *Aegilops squarrosa* L. As a rule the large nucleolus places itself near the nuclear envelope. "Jards" around the nucleolus are wide and stretched in a certain direction is if forming excretory canals. The nucleolus fragmentates and its small fragments go out of the sperm by the canals. As is seen in electronograms whole nucleolus can also go out remaining in the sperm cytoplasm. It is characteristic that the form of the sperm end beside a goneout-nucleolus is concave and looks like a mirror reflection of the nucleolus. The process of nucleolus disappearance and sperm cytoplasm diminution are almost synchronous. Nucleolar extrusion studies allow us to come to the conclusions: that the phenomenon of extrusion might be general for the range of its spreading is rather wide — from *Protozoa* to higher organisms and that nucleolar extrusion is necessary as a way to deliver sperms from surplus RNA.

Our present studies on spermiogenesis extend to a large number of angiosperm species characterizing different levels of the phylogenetic system. Species of the following families have been studied: *Poaceae* — *Elytrigia repens* (L.) Desv., *Bromus oxyodon* Schrenk., *Aegilops squarrosa* L., *Aristida karelinii* (Trin. et Rupr.) Roshev.; *Asteraceae* — *Heteropappus canescens* (Nees) Novopokr., *Crepis rhoeadifolia* Bieb.; *Boraginaceae* — *Onosna dichroanthum* Boiss., *Lappula barbata* (M. B.) Guerke; *Zygophyllaceae* — *Tribulus terrestris* L.; *Plumbaginaceae* — *Psylliostachys suvorovii* (Rgl.) Roshk.; *Dipsacaceae* — *Scabiosa rotata* M. B. and *Chenopodiaceae* — *Suaeda arcuata* Bunge, *Haloxylon persicum* Bunge *ex* Boiss., *Climacoptera turcomanica* (Litv.) Botsch., *Salsola pellucida* Litv., *Salsola ruthenica* Iljin. The sperm form has been studied in the mature pollen grain. This problem was raised because the sperm form is described differently in voluminous literature on embryology.

Speaking of various sperm forms one means changes that sperms undergo from the moment of their formation to the moment of their merging with female gametes. Some authors (Poddubnaya-Arnoldi, 1976; Batygina, 1974; Grati, 1971; Kordyum, 1967) show that sperm form, depending on pollen age, may be round, elliptic, sickle-like, spiral, long, etc. The sperm heteromorphism in mature pollen grains is explained differently. Bannikova (1975) supposed that sperm form should change depending on a place in the pollen grain. Grati (1971) explains sperm form by different physiological states and different qualities of cells. The author concludes that a precise morphological classification of sperms is impossible. Makhanetz (1968) and Litvinenko (1970) described an unusual sperm form — an arrow with a bifurcate end. The first author singles out this sperm form as an individual type and attributes the discovered quality difference in sperms to the double fertilization. The same sperm form was

discovered in some species of *Poaceae* and *Asteraceae* families (Tatintseva, 1975). After having performed a detailed investigation we came to the conclusion that in a mature pollen grain of the angiosperms the sperm form is uniform and can be described as an arrow with double-blade end.

We came to the conclusion that in sperm morphological organization we can see organization principles of the bodies called in hydro- and aerodynamics "ideal" or laminarized (Martynov, 1968). Such bodies are rounded in front and end smoothly in a double-blade tail. The same peculiar features are typical of fish bodies (Aleejev, 1963). Comparing the morphological structure of fish caudal fins with sperm double-blade ends it can be concluded that the basis of these structures is formed by the same function which damps vertical flow during body movements in liquids and other media. In pollen grains sperms moving together with cytoplasm flow overcome a certain resistance. During the process they might aquire the ideal hydrodynamic form described above. It may be supposed that the sperm form developed evolutionarily, as such forms are widely spread in nature.

In the development of angiosperm male gametes forming sperm cells undergo ontogenesis which stimulates changes up to mature pollen grain. The whole ontogenesis is aimed at creating a suitable structure to be delivered by the pollen tube to female cells.

REFERENCES

Aleejev J. G., 1963. The functional base of fish external structure. Publishing House of the A. S. USSR.

Bannikova V. P., 1975. The cytoembryology of interspecial incompatibation of plants. Kiev. "Naukova dumka".

Batygina T. B., 1974. Embryology of the *Triticum*. "Kolos".

Grati V. T., 1971. The development of the male gametophyte of some representatives of the *Agropyron*. Cyto-karyological study of cereals Moldavia, pp. 15-25.

Kordyum E. L., 1967. Cytoembryology of the *Umbelliferae* family. Kiev, "Naukova dumka".

Litvinenko S. P., 1970. Cytoembryological and histochemical study of *Bromus inermis*. Doctor. thesis. Kiev.

Martynov A. K., 1958. Exerimental aerodynamics. Moskva.

Makhanetz I. A., 1968. A study of male gamets and vegetative nucleus of diploid and tetraploid rye in pollen tubes and embryo sack. Vses. sympos. po embryolog. Kiev, pp. 137-138.

Mazia D., 1963. Mitosis and the physiology of cell division.

Poddubnaya-Arnoldi V. A., 1976. Cytoembryology of Angiosperms. Moskva "Science".

Tatintseva S. S., 1968. Spermiogenesis in pollen grain of *Sorghum (Sorghum caffrorum* J.). Izv. AN TSSR, ser. biolog. 3: 26-31.

Tatintseva S. S., 1975. Formation and development o spermia in some Angiosperm. I. *Poaceae (Gramineae)*. II. *Asteraceae (Compositae)* Bot. Zhur. 12; 1707-1720.