

## Sperm ultrastructure of two *Yoldia* species (Yoldiidae, Nuculoida, Bivalvia) from the Sea of Japan

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**ABSTRACT.** The sperm ultrastructure of *Yoldia notabilis* Yokoyama, 1922 and *Y. keppeliana* Sowerby, 1904 was examined. Sperm cells of *Y. notabilis* and *Y. keppeliana* have classic morphology: they consist of a spherical head, midpiece and a flagellum. The head consists of the acrosome and the nucleus, the midpiece containing spherical mitochondria and centrioles. Average dimensions of *Y. notabilis* sperm head are 3.6  $\mu\text{m}$  and 2.8  $\mu\text{m}$  (length and width), *Y. keppeliana* — 3.8 $\times$ 2.6  $\mu\text{m}$ . Periacrosomal material of both species is poorly developed. The basic difference between *Y. notabilis* and *Y. keppeliana* sperm cells is the number of mitochondria: *Y. notabilis* has 5 or 6 and *Y. keppeliana* — only 5. A slight difference of the sperm cells in the head form and in the number of mitochondria may indicate the recent separation of the species, probably as a result of reproductive isolation.

paper the sperm ultrastructure of two prolate *Yoldia* species from the Peter the Great Bay (Sea of Japan) are described.

### Materials and methods

Mature specimens of *Y. notabilis* and *Y. keppeliana* were collected in August and September from the depth of 20-60 m using a drag in the Peter the Great Bay of the Sea of Japan. For transmission electron microscopic study, the sperm was fixed in 2.5% glutaraldehyde in sea water, postfixed in 2% osmium tetroxide in a 0.15 M cacodylate buffer with sucrose, dehydrated with alcohol and acetone and embedded in an Epon-araldite mixture. The sections were cut with a Reichert Ultracut microtome, stained with lead citrate and uranyl acetate and observed with a Jeol-100B electron microscope.

### Introduction

Bivalve mollusks *Yoldia notabilis* Yokoyama, 1922 and *Y. keppeliana* Sowerby, 1904 belong to the primitive subclass Protobranchia. The developmental biology of these species is of great interest because of their larval stage. *Yoldia* species have an untypical for bivalves feeding larva, the veliger. Additionally, they have a specific lecithotrophic larva — endolarva. After gastrulation some ectodermal cells form the so-called larva-gown. The gown consists of 5 rows of large cells, 3 of which carry cilia corresponding to prototroch [Ivanova-Kazas, 1995]. Also *Yoldia* eggs are larger than eggs of other bivalve species, thus correlating with the presence of lecithotrophic development.

Peculiarities of the development and the egg morphology of species specifically affect the morphology of their sperm [DrozdoV et al., 2001; Jespersen, Lützen, 2001; Yakovlev et al., 1998]. There are no species with identical sperm. This property of male gametes is used to distinguish similar species [DrozdoV, Reunov, 1986a] and to specify taxonomic ranks such as families and orders [Eckelbarger, Grassle, 1987; Ferraguti et al., 1994; Hodgson, 1995; Pashchenko, DrozdoV, 1998; Tyurin, DrozdoV, 2002].

There are several thousand species of bivalve mollusks known, but the morphology of the sperm has been described only for several dozens. In this

**Abbreviations:** AC — acrosomal vesicle, DC — distal centriole, FL — flagellum, M — mitochondrion, N — nucleus, PC — proximal centriole, asterisk — periacrosomal material, arrow — membrane.

### Results

The head of *Y. notabilis* sperm cell is spherical (Figs. 1, A; 2, A). Its size (with midpiece) is 3.6  $\mu\text{m}$  long and 2.8  $\mu\text{m}$  wide. The sperm cell of *Y. keppeliana* is slightly elongated because of larger mitochondria (Figs. 1, D; 2, B). The size of its head (with midpiece) is 3.8 $\times$ 2.6  $\mu\text{m}$ .

Anteriorly the head is crowned with the acrosome that looks as a cap and consists of acrosomal vesicle and amorphous poorly developed periacrosomal material. The size of the acrosome in both species is 1  $\mu\text{m}$  long and 1  $\mu\text{m}$  at the base.

The nucleus is spherical. It has strongly electron-dense chromatin. The posterior part of the nucleus has slight invaginations. These invaginations are regions of contact with mitochondria.

The midpiece consists of a pair of centrioles arranged perpendicular to each other. The centrioles are surrounded by mitochondria (Fig. 1, B, C, E). The number of mitochondria differs in described species. *Y. notabilis* may have 5 or 6 mitochondria, *Y. keppeliana* — only 5. The axoneme of flagellum