Spermatozoa and spermatogenesis in a monoplacophoran mollusc, Laevipilina antarctica: ultrastructure and comparison with other Mollusca

Received: 13 September 1994 / Accepted: 17 November 1994

Abstract Ultrastructural features of spermatozoa and spermatogenesis are described for the first time in a monoplacophoran and compared with data for other conchiferal molluscs. Spermatozoa of Laevipilina antarctica Wardn and Hain, 1992, are of the structurally simple, aquasperm type, featuring a conical acrosome, a compact nucleus with lacunae, a short midpiece and a single flagellum. The acrosomal vesicle shows an electron-dense inner zone, and a basal invagination (subacrosomal space) contains granular material but no axial rod. The nucleus exhibits a shallow indentation apically which contains subacrosomal material, and five (sometimes four) indentations posteriorly which partially accommodate the five (rarely four) midpiece mitochondria. Two centrioles are present, the distal connected to the annulus by satellite fibres and acting as a basal body for the flagellum (axoneme probably 9+2 structure). Spermatogonia, characterized by an oblong nucleus and one or two nucleoli, line the basal membrane of the testis wall; spermatids of varying stages of maturity occupy the remainder of the testis. Acrosome and flagellum production is already well advanced in spermatids and probably commences at the spermatocyte stage. Cytoplasmic bridges occur in all developmental stages, most visibly in spermatids. The spermatid chromatin condenses in large tracts, leaving electron-lucent lacunae. Mitochondria collect posteriorly and form, presumably by fusion, the five (or four) larger, spherical mitochondria which gather around the centrioles.

Introduction

Even before the historic report of living monoplacophorans by Lemche (1957), the class was well known from its extensive fossil record in the lower Paleozoic (for discussions see Knight and Yochelson 1960; Salvini-Plawen 1981, 1985). Although the origin of the Mollusca remains a vigorously debated issue, it seems likely that the Monoplacophora acted as the source for all other classes of the Conchifera (Gastropoda, Cephalopoda, Bivalvia, Scaphopoda) (Salvini-Plawen 1981, 1985; Haszprunar 1988). Today, the Monoplacophora (Tryblidiida) are known from 20 species spread over 7 genera (Neopilina, Micropilina, Vema, Laevipilina, Monoplacophorus, Rokopella, Adenopilina) living principally in the abyssal realm and only occasionally venturing into shallower water (Lemche and Wingstrand 1959; Menzies 1968; Rokop 1972; McLean 1979; Wingstrand 1985; Cesari et al. 1987; Warén 1988; Marshall 1990; Warén and Bouchet 1990; Haszprunar 1992, 1993; Warén and Hain 1992; Haszprunar and Schaefer 1995 a,b). The animals are rare, often small, and easily overlooked during sample-sorting. The absence of well-fixed specimens has hitherto prevented ultrastructural studies of monoplacophorans.

Ultrastructural studies of mature and developing molluscan spermatozoa have, apart from their cytological interest, also provided a useful source of additional characters for taxonomic and phylogenetic analysis (e.g. Giusti 1971; Popham 1979; Healy 1982, 1988, 1989 a, 1993 a,b, 1995; Healy and Willan 1984, 1991; Kohnert and Storch 1984 a,b; Koike 1985, Hodgson and Bernard 1988; Hodgson et al. 1988). With the exception of the Monoplacophora, all other extant classes of Mollusca have been investigated for sperm and/or spermatogenic features at the ultrastructural level, although to varying degrees of completeness. Lemche and Wingstrand (1959) showed, using light microscopy, that the spermatozoon of Neopilina galatheae possesses a short, rounded head. Aside from this, nothing else is known concerning sperm morphology in monoplacophorans. Similarly, knowledge of spermatogen-