UG CBCS Semester-1

Polystomelta crispa (Elphidium crispum)

Not all Protozoa are naked, some are enclosed in shells. The most common shelled protozoans arc foraminiferans belonging to the order Foraminiferida (L., *forae*, pores + *ferre*, to bear). Their shells are typically many-chambered and perforated all over with small pores, through which extend long and fine pseudopodia. Almost all the members of the order are marine. When they die, their shells fall in a steady rain to the ocean floor and contribute to the formation of bottom sediments, called ooze.

Many foraminiferans exhibit the phenomenon of dimorphism, i.e., individuals of a single species occur in two distinct forms, which differ in the structure of shell, number of nuclei and mode of reproduction. *Elphidium (=Polystomella)* is a typical representative of the dimorphic forms. The most common species is *Elphidium crispum*, whose biology is dealt here in detail.

Occurrence: Habit and Habitat

E. crispum is a free-living marine foraminiferan and occurs in the littoral zone of the sea down to about 600 meters. It is commonly found creeping about on sea weeds.

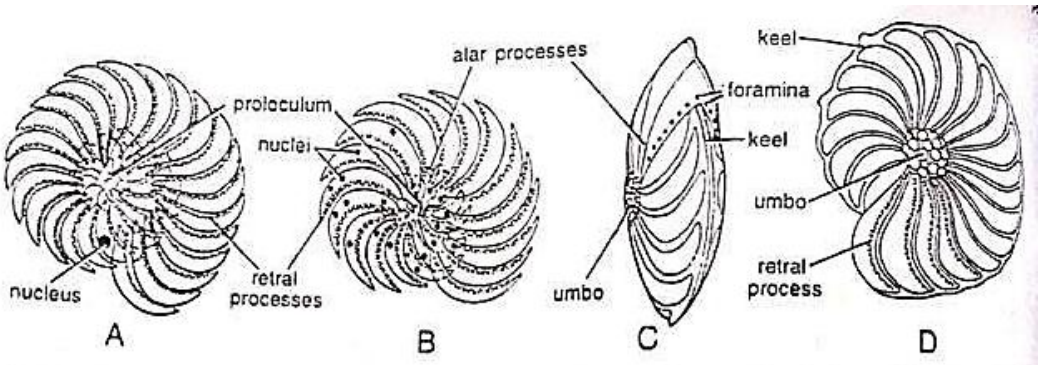

Fig. 1. *Elphidium crispum* Decalcified and stained specimens. A – Megalospheric individual. B – Microsperic individual. C – Endon view of the shell. D – Lateral view of the shell.

Structure

1. Dimorphic forms. *E. crispum* is a dimorphic species, the two forms being the microspheric and megalospheric. The microspheric form is small, multinucleate, with a smaller initial chamber and asexual mode of reproduction. The megalosphcric form is large, uninucleate, with larger initial chamber and sexual mode of reproduction.

2. Shell. Shell of *E. crispum* is sall, translucent, pale yellow in colour and spherical or oval in shape. It measures 1 mm in diameter. The shell consists mainly of calcium carbonate with small amounts of other inorganic compounds such as silica and magnesium sulphate. The shell is polythalamus or multilocular, i.e., it consists of many chambers. It is coiled in a planospiral manner, i.e., all the coils lie in the same plane or a flat spiral. All the chambers are filled with cytoplasm. The shell is perforate, that is, the walls of chambers bear minute pores through which cytoplasm becomes continuous from one chamber to another, and also extends to outside forming pseudopodia.

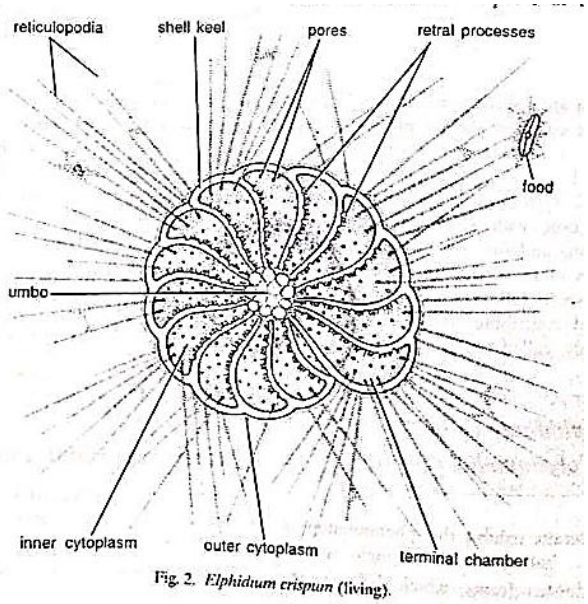

Fig. 2. *Elphidium crispum* (living).

Each chamber of shell is somewhat elongated laterally. Its anterior surface is convex while the posterior surface is concave. The concave posterior surface bears retral processes filled with cytoplasm. Minute pores occur in the spaces between retral processes which act as open doors for the emergence of the pseudopodia to outside. Peripheral part of shell is rigid and consists of a continuous rim, called keel, whereas the central part is the rounded umbo which becomes prominent due to deposition of more calcium carbonate.

Formation of shell begins with an initial single chamber, the proloculum. As the animal grows in size, successive chambers are laid down in a spiral manner, forming whorls. Each chamber is larger than the preceding one and each new whorl partially overlaps and conceals the older one. Thus, only the last whorl, which is the largest and most recently formed, is visible from outside. The overlapping portions of the chambers are referred to as alar processes.

3. Cytoplasm. All the shell chambers of living *E. crispum* are filled with a mass of inner cytoplasm. Besides, a thin layer of outer cytoplasm invests the entire shell, which makes the shell internal rather than external. Part of cytoplasm within the shell is also called endoplasm and that outside it, the ectoplasm. Endoplasm contains nucleus, (or nuclei), food particles, minute vacuoles, Golgi bodies, mitochondria, endoplasmic reticulum, ribosomes and colour granules or xanthosomes.

4. Nucleus. Inner cytoplasm or endoplasm contains a single nucleus in megalospheric individuals and many nuclei in microspheric individuals. The nucleus is vesicular and contains many nucleoli embedded in nucleoplasm.

5. Reticulopodia. Pseudopodia of *E. crispum* are typically foraminiferan because of their thread-like branching and anastomosing nature. Such pseudopodia are known as reticulopodia or myxopodia. Each consists of two regions—inner fibrillar axis and outer fluid-like cortex. It has been observed that in the network of reticulopodia cytoplasm shows streaming circulation, as is evident from the movement of granules in opposite directions along the two sides of axis. Pseudopodia may be withdrawn within the shell at lightning speed or may be extended out a short distance in water like little rockets and wave about bending, undulating, quivering and putting out side branches, which meet and fuse and so establish a reticulum. Reticulopodia help the organism in locomotion, nutrition and in the construction of shell and cyst walls.

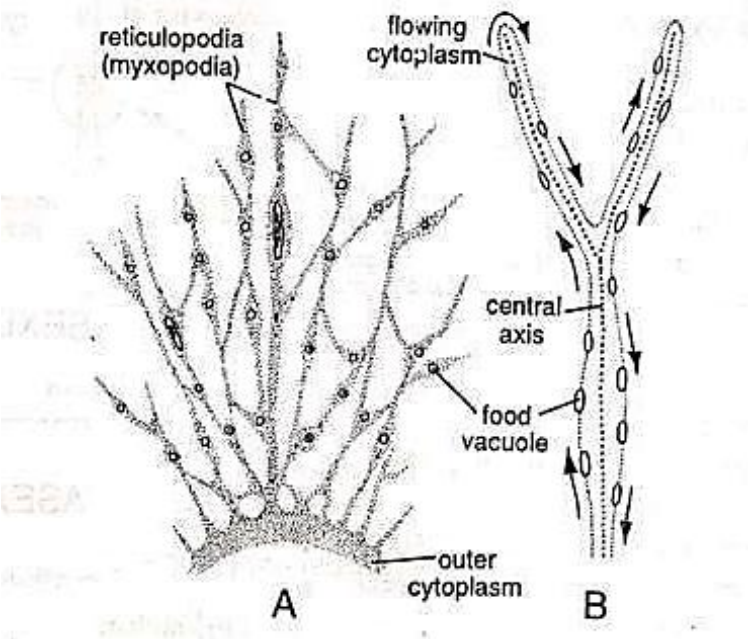

Fig. 3. *Elphidium.* Reticulopodia. A—A group of reticulopodia. B—A reticulopodium showing streaming circulation of cytoplasm.

Locomotion

E. crispum creeps slowly over the substratum on the sea bottom with the help of its reticulopodia, which are arranged in bundles around the shell. With the contraction of distally placed bundles the body is pulled or dragged forward.

Nutrition

E. crispum is typically holozoic. It feeds upon minute organisms like diatoms, other protozoans, crustacean larvae, etc. The net-like reticulopodia are thought to secrete an external mucous layer to trap the food organisms. The mucous layer contains proteolytic secretions which paralyze the prey and initiate its digestion even during capture. The captured food; enclosed in a food vacuole, is drawn into endoplasm by the withdrawal of reticulopodial filaments towards the interior of body. Digestion is normally completed outside the shell and the products of digestion pass into the endoplasm.

Reproduction and Life Cycle

The two distinct forms of *E. crispum* actually display the phenomenon of sexual dimorphism. Megalospheric forms or gamonts are the sexual forms. They reproduce by the formation of gametes (gamogony), which unite in pairs and form zygotes. Microspheric forms or agamonts are the asexual forms which reproduce by multiple fission (agamogony). In the life cycle, the two forms display a definite alternation of generations. According to Jepps, the entire cycle of sexual and asexual phases is completed in about two years.

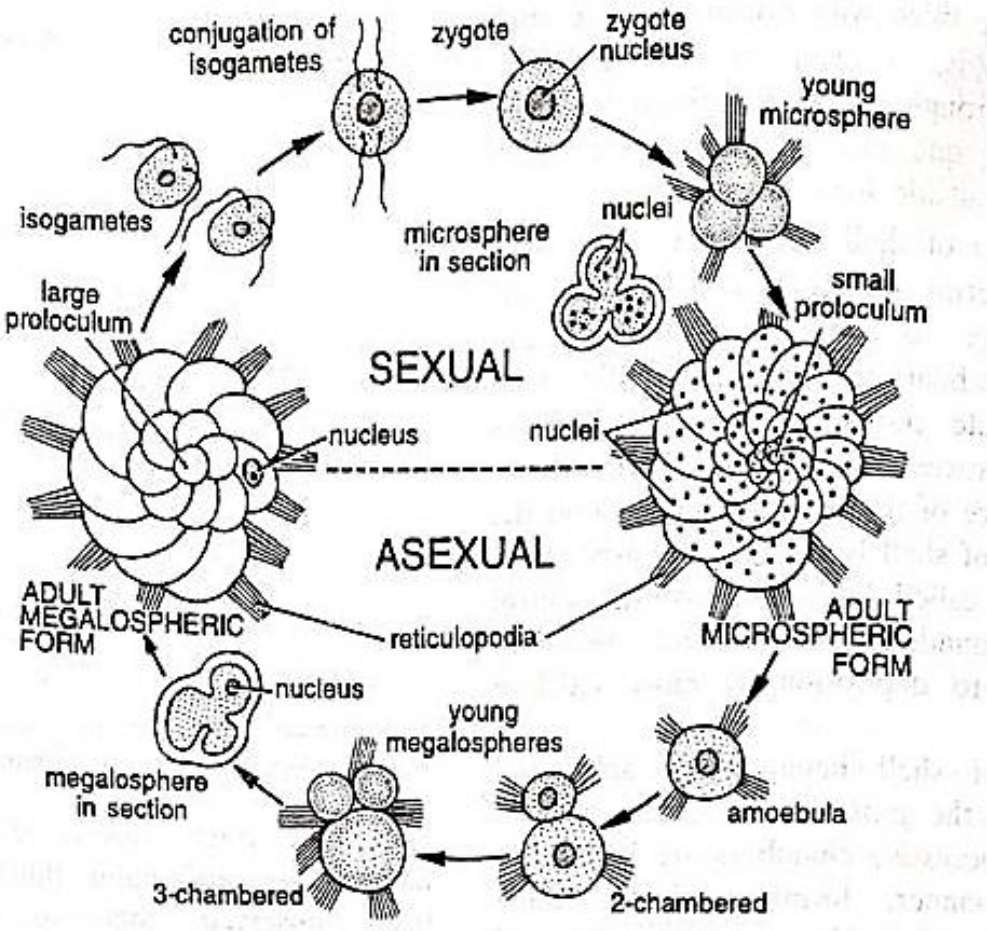

Fig. 4. *Elphidium.* Reproduction and life cycle.

(i) Sexual phase (gamogony)

1. Megalospheric form or gamont. The sexual megalospheric form or gamont is somewhat larger in size and possesses a large embryonic chamber, the proloculum. It remains uninucleate throughout its life.

2. Isogamy. Each gamont produces numerous identical biflagellate gametes or isogametes. The formation of gametes take place inside the parent shell. The single nucleus divides repeatedly by mitosis which is accompanied by the fragmentation of entire cytoplasm. Each fragmented cytoplasmic portion, along with 1 daughter nucleus organizes into a gamete. Each gamete is a spherical bit of cytoplasm and possesses two motile flagella, a nucleus and fairly large fat globule.

3. Fertilization. The gametes are released into the surrounding sea water through the shell pores. They swim about freely for some time and then elongate to become conical in shape. Later the gametes, originating from different gamonts, unite and fuse in pairs, resulting in diploid motes.

(ii) Asexual phase (agamogony)

1. Microspheric form or agamont. The zygote secretes the shell around a small initial chamber or proloculum and becomes a young agamont or microsphere. Its diploid nucleus divides first by meiosis and then by mitosis to give rise to several haploid daughter nuclei. With further growth and development, new chambers are successively added, resulting in a multinucleate and multilocular adult agamont or schizont. The nuclei are found in cytoplasm of all the chambers and they arc encircled by numerous chromatidial granules. The microspheric individuals are scarce in occurrence because of the remote chances of the fusion of gametes.

2. Schizogony. Microsphere or agamont reproduces asexually by schizogony. Entire cytoplasm containing several nuclei creeps out of the shell and takes the form of a lump around it. This lump now organizes into a large number of small uninucleate amoeba-like cells, called antoebulae or agametes.

3. Development of agametes. The agametes now become detached from the parental shell. Each one secretes a shell around a large proloculum and becomes a young gamont or megalosphere. It repeatedly secretes additional chambers and transforms into a uninucicate and multilocular adult gamont or megalospheric individual.

References:

Kotpal RL (2013). Modern Text Book of Zoology: Invertebrates (10^{th} edition). Rastogi Publications, India.