

Structure and life history of Paramecium

BSc. Part I Zoology (Subsidiary)

INTRODUCTION

Ciliates are characterized by the presence of cilia on the body, two types of nuclei, one vegetative and the other reproductive and a unique type of sexual reproduction called conjugation. *Paramecium* contains about 10 species that differ in shape, size and structure. Most of the ciliates possess advanced cellular organelles and complexity of behavior. The largest species, *P. caudatum* is discussed here in detail as a typical species. *Paramecium* is widely distributed in fresh water, sea, ponds, ditches, streams etc. and is abundant in waters containing decaying organic matter.

EXTERNAL MORPHOLOGY

P. caudatum measures 170-290 microns and is slipper-shaped. The cell is elongated, rounded at the anterior end and somewhat pointed at the posterior end. Ventral surface of body bears a prominent, oblique depression called oral groove, which leads into a deeper conical *vestibule* which in turn communicates with a *buccal cavity*.

External envelope of body is a cuticular membrane, the pellicle, which is made of a pattern of polygonal depressions and raised lines with series of cavities called *alveoli*. A single cilium emerges out from the middle of each polygon. Entire body surface is covered by cilia, which measure 10-12 microns in length and 0.27 microns in diameter.

INTERNAL ANATOMY

The cytoplasm is clearly differentiated into clear ectoplasm, which includes the basal bodies of cilia, kinetodesmata and trichocysts. Endoplasm is granular and dense semi-fluid zone that fills the entire cell body. Each trichocyst consists of an elongated shaft and a terminal pointed tip called the spike or *barb* covered by a *cap*. They are probably used as defense organelles.

Macronucleus is large, kidney-shaped, polyploid, with inconspicuous nuclear membrane. It is vegetative in function and controls the day-to-day metabolic activities. *Micronucleus* is spherical with a nuclear membrane and diploid number of chromosomes. It is lodged in a depression near the surface of macronucleus and controls the reproductive activities of the animal.

There are two contractile vacuoles in *paramecium*, one near each end of body. 6-10 long and narrow radial canals that extend far into cytoplasm and eventually connect to the endoplasmic reticulum surround each vacuole. The contractile vacuoles form an excretory system of the cell body. Food vacuoles, called *gastrioles* can be seen moving within the endoplasm.

The digestive system includes *oral groove* that leads ventrally into *vestibule*, which leads directly into a wide tubular passage, the *buccalcavity*. Buccal cavity opens into a narrow gullet or *cytopharynx* through a narrow aperture, the *cytostome*. The cytopharynx at its proximal end forms the *food vacuole*. Near the posterior end of body, a minute aperture called *cytopyge* or *cytoproct* is formed for excretion of the undigested food. The food of *Paramecium* consists chiefly of bacteria and it feeds upon small Protozoa, unicellular algae, diatoms, yeasts etc. and small bits of animal and vegetable matter.

Respiration in *Paramecium* takes place through the general surface of the body.

Contractile vacuoles are organs of osmoregulation. They contract and expand at regular intervals to get rid of excess water from cytoplasm. Water from cytoplasm is discharged into *endoplasmic reticulum*, from where it flows into the *nephridial tubules* and *feeder canals* and is stored in ampullae, which then discharge it into contractile vacuole. Once the vacuole has grown to its maximum size, it discharges excess water to the exterior through a pore in pellicle.

REPRODUCTION

Binary fission – *Paramecium* reproduces asexually by transverse binary fission, in which the *micronucleus* passes through characteristic stages of mitosis, whereas the *macronucleus* simply divides by amitosis.

Conjugation – Conjugation is a sexual reproduction unique to ciliates, in which a temporary union of two individuals of the same species takes place for exchanging their genetic material. The process is as follows: Two individuals or *preconjugants* lose their oral groove and cilia and come in contact and firmly unite together. Macronucleus disintegrates into the cytoplasm and micronucleus divides by meiotic division and then mitotic division to produce four haploid daughter micronuclei. Three daughter micronuclei degenerate and one survives, which then divides by mitosis forming two unequal gametic nuclei – one the smaller migratory gametic nucleus and the larger stationary gametic nucleus. Migratory nucleus of one individual migrates through cytoplasmic bridges to the other individual's cytoplasm and fuses with the stationary nucleus forming a zygotic nucleus or *synkaryon*. The two paramecia now termed *exconjugants* separate and the conjugation is over.

Then, in each exconjugant zygote nucleus divides mitotically three times producing 8 daughter nuclei. Four daughter nuclei in each exconjugant enlarge to become macronuclei and other 4 become micronuclei. Three micronuclei disintegrate and disappear. Remaining one micronucleus divides by binary fission, which produces 2 daughter *Paramecia*, each containing 2 macronuclei and 1 micronucleus. Further division of each daughter cell forms 2 individuals, each containing one macronucleus and one micronucleus. Thus, each conjugant produces four daughter individuals at the end of conjugation.

Conjugation rejuvenates individuals. If binary fission continues repeatedly for several generations, *Paramecium* loses its vigor. To regain vitality conjugation is resorted to and the process seems to rejuvenate and revive the lost vigor of asexual reproduction. During

conjugation the nuclear apparatus is reorganized. The periodic occurrence of conjugation ensures heritable variations in the species.

Autogamy — W.F.Diller (1936) described a process of nuclear reorganization in *P. aurelia*, resembling conjugation but taking place within a single individual. He called it autogamy or self-conjugation.

Cytogamy — R.Wichterman (1940) reported in *P. caudatum*, a sexual process without nuclear exchange and termed it cytogamy. There is no nuclear exchange between the two individuals because of the absence of cytoplasmic cross bridges. Two haploid gametic nuclei in each individual fuse in self-fertilization to produce a diploid zygote.

Endomixis — It involves a total internal nuclear reorganization within an individual in *Paramecium aurelia* and takes place in a single individual without any reduction division.