CHAPTER NO. 3
STUDY OF *PARAMECIUM*

3.1 Systematic position ,habit and habitat

3.2 Structure , nutrition , excretion and reproduction (Binary fission and conjugation).

Systematic position

- **Classification:**
- **Phylum:** Protozoa
- **Sub Phylum:** Ciliophora
- **Class:** Ciliatea
- **Order:** Hymenostomatida
- **Genus:** *Paramecium*
- **Species:** *caudatum*

Habit and Habitat

It's a free living organism having cosmopolitan (world-wide) distribution. It lives in stagnant water of freshwater, ponds, pools, ditches, lakes and slow flowing rich in decaying organic matter

Structure:

A: Shape & Size:

Paramecium cadatum is a unicellular and microscopic protozoan. It measures 170 to 290 µm up to 300-350 µm. It is visible to the naked eye. Its body has a constant elongated, slipper-like shape, so it's also called **slipper animalcule**. Anterior part of the body is blunt and broad and posterior end is thick, pointed and cone shaped, widest part is just below the middle. Body is asymmetrical showing well defined **oral** or **ventral surface** and convex **dorsal** or **aboral surface.**

B: Pellicle:

The whole body is covered by thin, firm, flexible membrane called **pellicle**. Pellicle is made up of gelatinous substance. It gives shape of the animal but is elastic to permit contraction.

C: Cilia:

Body is covered by numerous, small hair-like projections called cilia, arranged in longitudinal rows. The length of cilia is uniform throughout the body (a condition called **holotrichous)**, but there are a few longer cilia at the posterior end of body. These form **caudal tuft** of cilia (hence the name **caudatum**). Cilia have the same structure as flagella, an outer protoplasmic sheath or plasma membrane with nine double longitudinal fibrils, in a peripheral ring. Two central fibrils, which are thinner than the outer fibrils. Each cilium arrives from a basal granule. At the base the cilia has a diameter of 0.2 μm (2000 A°).

D. Cytostome:

➢ Oral groove:

On the ventro-lateral side is a large oblique, shallow depression called **oral groove** or **peristome** which gives the animal asymmetrical appearance. The oral groove lends into a short conical funnel shaped depression called **vestibule.** Vestibule leads to an oval shaped opening called **cytostome.** It is followed by a long opening called **cytopharynx;** which leads to the **oesophagous** - that leads to food vacuole.

➢ Cytopyge:

The **cytopyge** or **cytoproct** lies on the ventral surface, almost vertically behind the **cytostome.** Undigested food particles are eliminated through the **cytopyge.**

E. Cytoplasm:

The cytoplasm is differentiated into a narrow peripheral layer of clear and dense **plasmegel,** called **ectoplasm** and an inner large central mass of granular and **semifluid plasmasol** or **endoplasm.**

Ectoplasm:

It forms a firm, clear, thin and dense outer layer. It contains the **trichocysts**, cilia and fibrillar structures and is bound externally by a covering called **pellicle**.

Endoplasm:

Endoplasm is the voluminous part of the cytoplasm, contains many granules as well as other structures and inclusions such as **mitochondria, vacuoles** etc. other students includes nuclei, contractile vacuole, food vacuole etc.

F. Trichocysts:

Small spindle shape bags are embedded in the ectoplasm filled with a refractive, dense fluid having swelling substance. At the outer end there is a conical head on spike. **Trichocysts** lie perpendicular to ectoplasm.

G. Nuclei:

Macro Nucleus:

It is a ellipsoidal or kidney like shaped nucleus. Densely packed with chromatin granules (DNA). It is a vegetative nucleus, **controls vegetative functions.**

Micro Nucleus:

Small compact and spherical, found close to macro nucleus. Fine chromatin granules and threads uniformly distributed throughout the structure. **It controls reproduction.** Number varies with species to species. Nucleolus is absent in *caudatum.*

H . Food Vacuole:

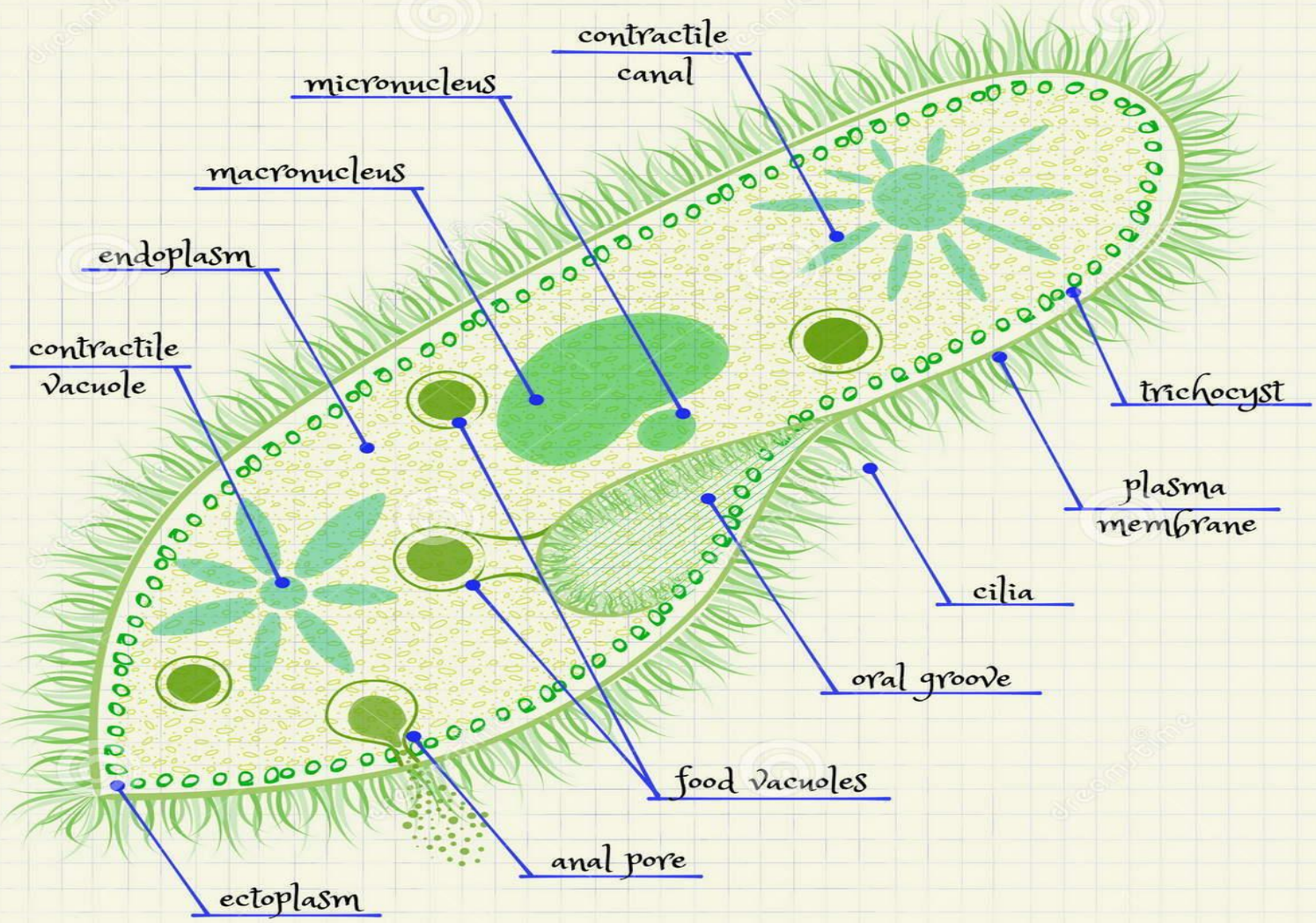
Roughly spherical, non contractile lies varying in size and lying in the endoplasm. They contain digested food particle especially bacteria and small amount of fluid.

The **digestive granules** are associated with the food vacuoles helps in digestion.

I. Contractile Vacuole:

There are two fluid filled contractile vacuoles, one each at the ends of the body close to dorsal surface. Their position is fixed between the ectoplasm and endoplasm. They are temporary organs disappearing periodically. Five to twelve radical canals are connected to each contractile vacuole. Each radial canal consists of a terminal part, a long **ampula** and a short **injector canal** which opens into the contractile vacuole. The canal communicate with large part of the body and takes up liquids and pour into the vacuole. Thus the vacuole increase in size and the liquid discharged outside during systole through the permanent opening (pore) in the pelged. The two vacuoles contract irregulargly, the posterior C.V contract more rapidly because it is close to the **cytopharynx** and more water comes to it. The main function of contracted vacuole is **osmoregulation** and probably involves **respiration and excretion.**

Paramecium caudatum



NUTRITION IN *PARAMECIUM*

- Paramecium is a tiny unicellular organism found in water.

It follows

1. **Ingestion:** **Paramecium engulfs food by the use of cilia.** Cilia is a hair like structure present on surface on body of paramecium. Food is ingested by cilia through oral groove into gullet. The food is ingested with a little surrounding water to form a food vacuole
2. **Digestion:** In Paramecium, food is digested in food vacuole by the digestive enzymes released by cytoplasm. **Digestion in Paramecium is termed as "intracellular digestion".**
3. **Absorption:** The digested food present in the food vacuole of Paramecium is absorbed directly into the cytoplasm by diffusion. After absorption of food, the food vacuole

shrinks.

4. Assimilation:

The absorbed food nutrients is stored and utilized later for synthesis of energy.

5. Egestion:

The undigested food is expelled out through anal pore.

Feeding Mechanism in *Paramecium*

- *Paramecium* feeds holozoically with the help of cilium. Food includes bacteria, unicellular plants (algae, diatoms, yeasts, etc.) and small bits of animal and vegetables. *Paramecium* swims to place where it can get its food. It does not move while feeding.
- Food is ingested by cytosome lying at the bottom of buccal cavity. At first cilia of oral groove move very fast that drives current of water with food particles toward vestibule. Ciliary tracts of vestibule direct the food particles into buccal cavity. Larger food materials are rejected whereas smaller food materials are selected and ingested through cytosome into cytopharynx. The food now gradually collects at the bottom of cytopharynx into a membranous

vesicle which is later released off as food vacuole.

- **Digestion**: Each food vacuole consists of food particles and it undergoes circulation in definite path along with cyclosis. Digestion takes place with the help of certain enzymes secreted by protoplasm into the vacuoles. The contents of vacuole first become acidic and then become alkaline. The major digestion of food occurs during the alkaline phase. In digestion proteins are converted into aminoacids, carbohydrates into soluble sugar and glycogen. Products of digestion are diffused into the surrounding cytoplasm and either stored or used for vital activity and growth.
  Finally the undigested food materials is eliminated from the body through anal spot or cytoproct on ventral surface.

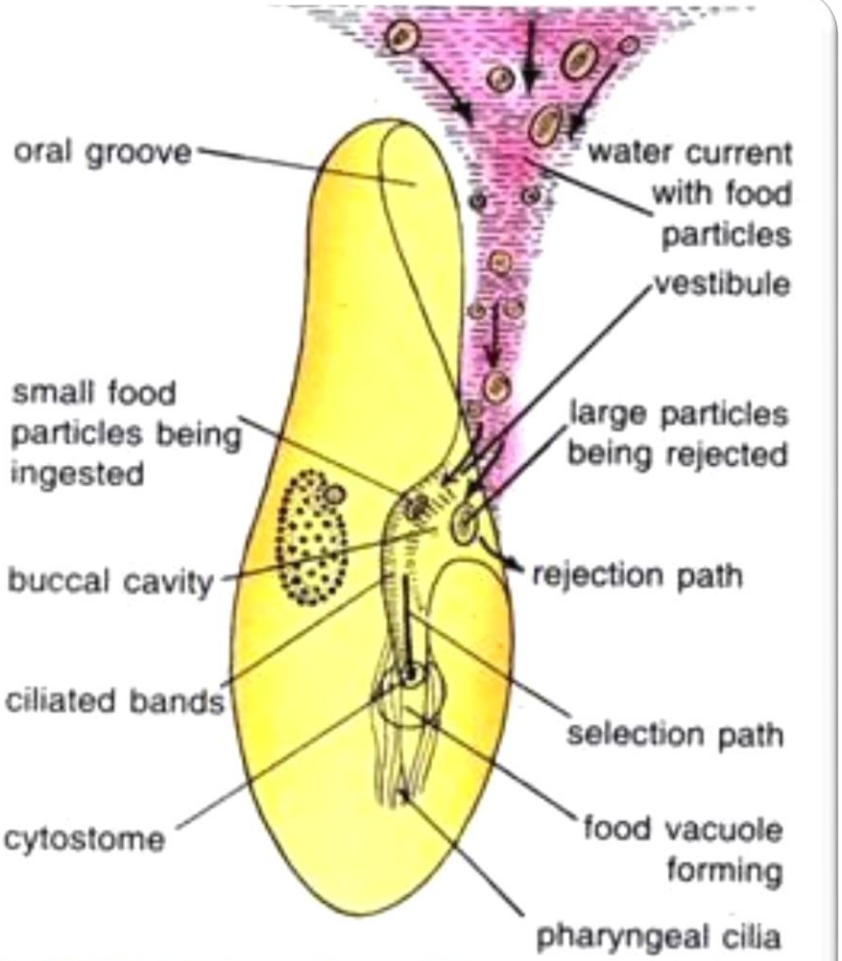


Fig. 20.16. *Paramecium*. Ciliary action creating vortex and drawing food particles into the oral groove with the water current.

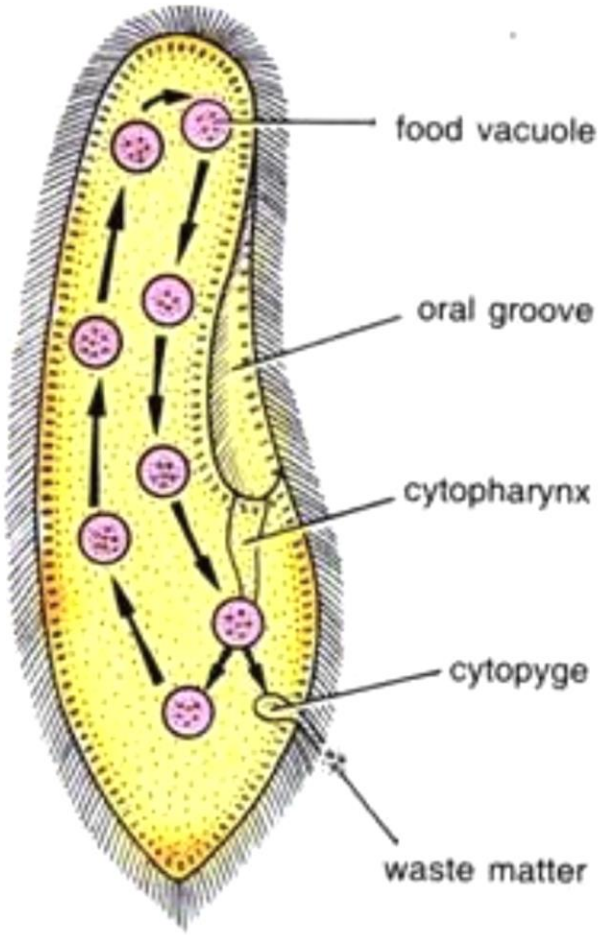


Fig. 20.17. *Paramecium*. Showing cyclosis and the course of food vacuoles in the endoplasm.

Excretion in *Paramoecium:*

- There are two prominent contractile vacuoles, one at either end of the animal. Each consists of a rounded central space surrounded by and connected with a series of six to eleven narrow radiating channels which serve as feeders to the main vacuole. Nitrogenous waste products, excess of water, and carbon dioxide formed during respiration slowly collect in the vacuoles through the feeding channels.
- The vacuoles increase in size and at the limit of dilatation they contract and burst, discharging their contents to the exterior. They are again slowly formed at their original site and the whole process is repeated, hence the name pulsating vacuoles.
- These vacuoles are, therefore, excretory and respiratory in function. Oxygen required for respiration is absorbed through the pellicle from the dissolved air in the surrounding water.

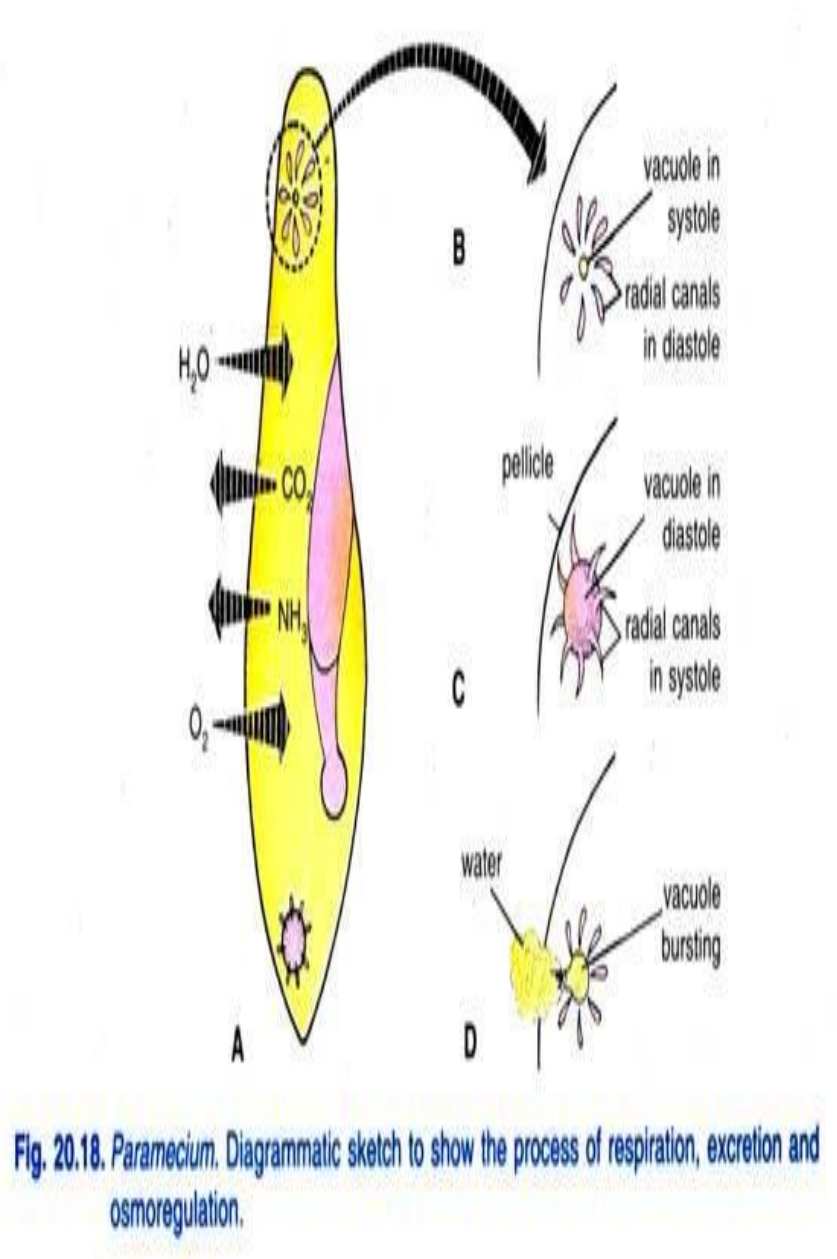


Fig. 20.18. *Paramecium.* Diagrammatic sketch to show the process of respiration, excretion and osmoregulation.

Reproduction in *Paramecium caudatam:*

Paramecium caudatum reproduces asexually by transverse binary fission and also undergoes several types of nuclear re-organisation, such as conjugation, endomixis, autogamy, cytogamy and hemixis, etc.

(i) Transverse Binary Fission:

Transverse binary fission is the commonest type of asexual reproduction in Paramecium. It is a distinctly unique asexual process in which one fully grown specimen divides into two daughter individuals without leaving a parental corpse.

The plane of division is through the centre of the cell and in a plane at right angles to the long axis of the body. Division of the cell body as a whole is always preceded by division of the nuclei; indeed it appears that reproduction is initiated by nuclear activity and division.

- Paramecium Caudatum reproduces by transverse binary fission during favourable conditions. In binary fission, the micronucleus divides by mitosis into two daughter micronuclei, which move to opposite ends of the cell. The macronucleus elongates and divides transversely by amitosis.
- Another cytopharynx is budded off and two new contractile vacuoles appear, one near anterior end and another near posterior end. In the meantime, a constriction furrow appears near the middle of the body and deepens until the cytoplasm is completely divided.
- The resulting two **"daughter"** paramecia are of equal size, each containing a set of cell organelles. Of the two daughter paramecia produced, the anterior one is called proter and the posterior one is called opisthe. They grow to full size before another division occurs.
- The process of binary fission requires about two hours to complete and may occur one to four times per day, yielding 2 to 16 individuals. About 600 generations are produced in a year.
- The rate of multiplication depends upon external conditions of food, temperature, age of the culture, and population density; also on the internal factors of heredity and physiology. Naturally, if all the descendants of one individual were to survive and reproduce, the number of paramecia produced would soon equal to the volume of the earth.
- The term clone is used to refer to all the individuals that have been produced from

(ii) Conjugation:

Ordinarily *Paramecium caudatum* multiplies by binary fission for long periods of time, but at intervals this may be interrupted by the joining of two animals along their oral surfaces for the sexual process of conjugation.

Conjugation is defined as the temporary union of two individuals which mutually exchange micro nuclear material. It is unique type of a sexual process in which two organisms separate soon after exchange of nuclear material.

Sonneborn (1947), on the basis of mating behaviour of Paramecium Caudatum, has reported that each species of Paramecium exists in a number of varieties or syngens

Further, within each syngen there are a number of mating types usually two.

The mating types remain morphologically identical but they exhibit physiological differences. In P. aurelia, there are 14 syngens and 28 mating types, while in P. caudatum, there are 16 syngens and 32 mating types. Observations have been made that usually paramecia neither conjugate with members of their own mating type nor with the other varieties, but only with the second mating type of their own variety.

Process of Conjugation

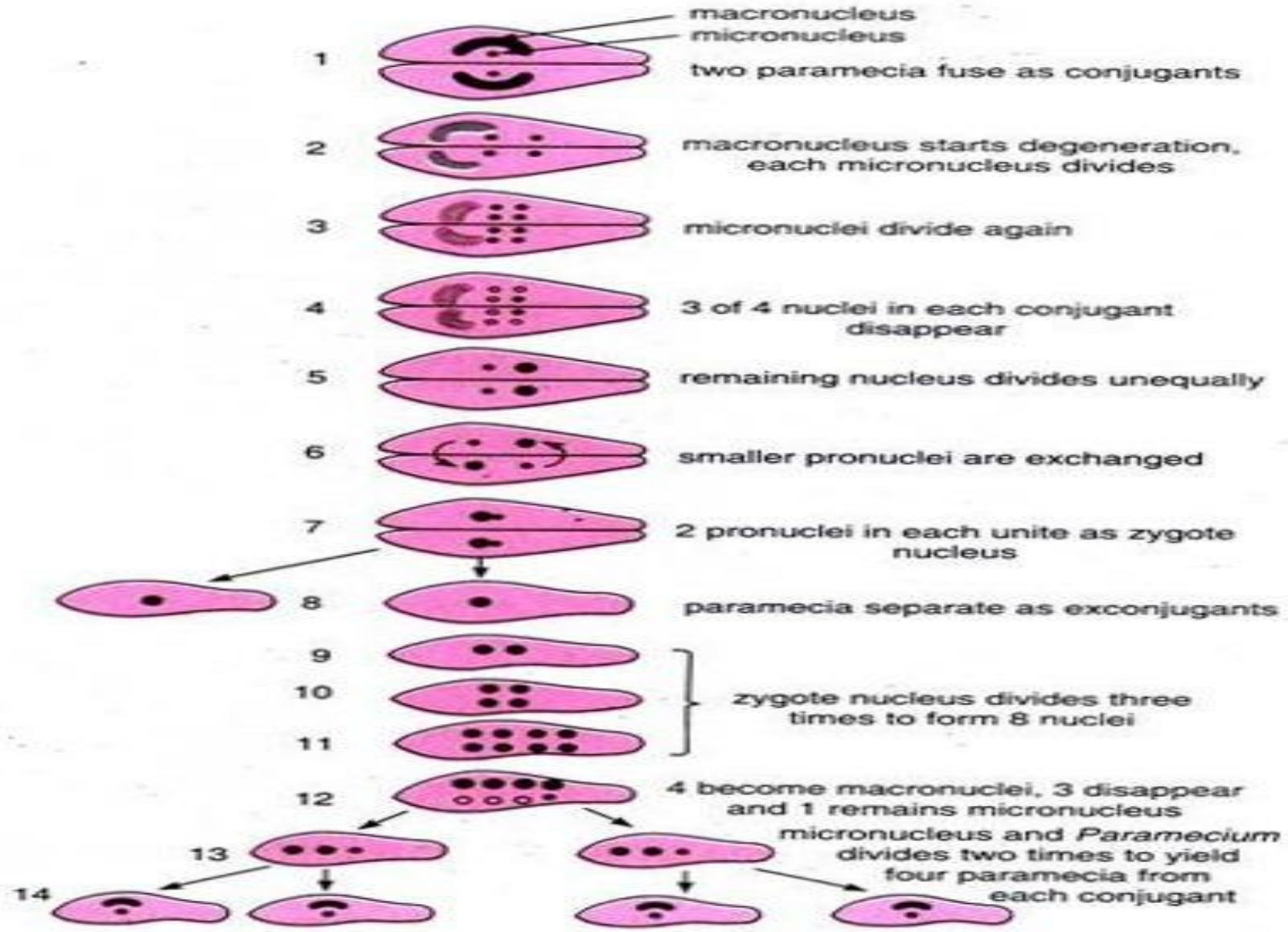


Fig. 20.21. *Paramecium caudatum*. Stages of conjugation.