

(b) Oil (paraffin, castor, olive) on water. An oil which spreads on water (e.g. paraffin) may be made to collect by adding soap to the water. After collecting into a drop, or using another oil (e.g. Castor oil), movements herein may be induced by presenting soap or alkali or chloroform. A fine soapy silken thread is laid across a floating oil drop. (T. B. Robertson, see Thompson, 191-2).

(c) Particles of camphor on pure water. (Explanation first due to v.d. Mensbrugghe, 1869, see Thompson, 212.)

4. **Agglutination.** To the water with floating camphor particles add a trace of oil.

5. **Ingestion.** Chloroform soluble and crude shellac presented to drops of chloroform under water; also a shellac-coated particle of glass filament; also a clean glass filament. (Rhumbler, 1898, see Bavliss, 1-6; Macallum, 27; Pfeffer, III, 278; Thompson, 463.)

6. **Complexity of form.** The surface of pollen grains (e.g. mallow) is coated with a resin which spreads on water, but which will not do so if e.g. acid is added. The resin extends from the pollen grains in fine threads which strongly stimulate the pseudopodia of *Gromia* (see Calkins, G.N. "The Protozoa", p. 91, illustration). Note the vacuolated appearance of the resin after spreading. Explain divergence from minimal (spherical) surface.

B. BEHAVIOURS IN PROTOPLASM.

MATERIALS: Spirogyra, Vaucheria, Chara, Elodea, Onion, Amoeba, haematocytes, leucocytes.

1. **Form.** The protoplasts of pollen grains may be set free from their containing envelopes. If first treated with strong acid (10-25%) they attain considerable consistency with alkali less. Note the form displayed. (The strength of acid and base used may vary with the kind of pollen used. Lloyd 1916).

The form taken by drops of protoplasm squeezed out through cut ends of internodal cells of Chara and the form of abstricted portions of vacuole. The form taken by extruded droplets of protoplasm of Vaucheria (Pfeffer, 3:299; Verworn, 94). The form assumed by swarm spores, e.g. of *Oedogonium* when set free from a cylindrical cell wall.

The form of vacuoles formed by action of chromates on cells of onion epidermis.

The form of vacuoles in various stages of development. Shown well in young tissues of *Elodea*, to be dissected from the terminal bud.

2. **Changes in form** through disturbance of equilibrium caused by changes in the environmental factors—heat, electric charge, solutes (alcohol, e.g.)—which among other things at least act on surface tension.

SPIROGYRA:

(a) **Heat:** Mount a few filaments of Spirogyra lengthwise on a slide in plenty of water. Examine for normality. Heat one end of slide over flame. Compare heated and unheated cells of filaments and trace all intermediate conditions. Particularly note form and position of nucleus and its surrounding cytoplasm. Make a series of drawings to show what has taken place.

Apparent changes in surface tension?

To find how far the observed changes have taken place in living protoplasm run dilute eosin over the slide (removing cover). After a few minutes wash and examine. The nuclei at heated end of slide should be distinctly stained. Compare unheated and especially intermediate cells. Since eosin does not penetrate living protoplasm what can you infer?

As a further test add a plasmolysing solution and compare the differential effect with that of eosin.

(b) **Electrical charge:** Subject Spirogyra filaments to one or more shocks from an alternating current and observe changes during several minutes thereafter. (Other material—trichomes from leaves of *Tradescantia*, onion epidermis—behaviour of nucleus especially, etc.)

(c) **Alcohol:** The "critical concentration" of ethyl alcohol was 11% by vol. corresponding surface tension being 0.666 that of water (Czapek, "On a method of direct determination of surface tension of plasma membrane in plant cells," p. 23.) Employ 3 concentrations, one above, one below and the third at ca. the "critical conc." Study exhaustively changes which take place in the various parts of protoplasm, recording as usual in drawings. Of course alcohol is used only as a single example; one might extend studies to large variety of reagents and obtained many unlooked-for results, e.g. weak alkalis, alkaloids, etc.)

Hæmatocytes. Their form, and changes occurring on external disturbances (heat alkali, saponin, alcohol, etc.)

3. Movement, ingestion, phagocytosis.

Amoeba and leucocytes may be studied.

Ref. Oertel, "General Pathology"; Tait: "Capillary phenomena observed in blood