ular body formed just outside the nucleus, which enlarges by the addition of granules similar to those found in the nucleus, until it becomes first a cap-shaped mass and finally surrounds the nucleus. *1st Period: Formation of the 'yolk-mass.'* This body then disintegrates, the constituent granules being spread evenly throughout the now highly vacuolated cell-body. The latter was shown to be composed probably of a pseudo-nuclein. *2d Period: Disintegration of the yolk-mass.* The ovum assumes its final character by the progressive vacuolization of the cell-body, and by the enlargement of the products of disintegration of the 'yolk-mass' to form the definite 'deutoplasm' spheres. *3d Period:* The original was considered to be of nuclear origin, and is probably what has been loosely homologized in some cases with the 'corps vitellin de Balbiani,' etc.

Protoplasmic Movement as a Factor of Differentiation. EDWIN G. CONKLIN.

VARIOUS factors have been suggested by different persons as the causes of differentiation, but so far no one has shown that the active movements of protoplasm constitute such a factor.

The polarity of the egg and the specializations of cleavage are two of the earliest differentiations of the developing organism. In the gasteropod *Crepidula* both of these differentiations are associated with definite and orderly movements of the protoplasm.

Before the maturation the germinal vesicle lies near the center of the egg and the yolk is uniformly distributed. With the appearance of the centrosomes and the formation of the first maturation spindle the nuclear membrane is broken opposite the poles of the spindle, nuclear sap escapes into the cell and at the same time the nucleus, spindle and surrounding cytoplasm are carried bodily toward the surface of the egg. Coincidently with this migration of the nuclear constituents there is a segregation of the cytoplasm at one pole (the animal) and of yolk at the other (the vegetal). This separation of yolk and cytoplasm goes on during the second maturation division and throughout all the stages of fertilization. The movements of the germinal vesicle and of the maturation spindles, the separation of yolk and cytoplasm and also the approach of the pronuclei during fertilization seem to be due to protoplasmic currents.

In the cleavage of the egg the evidence for such currents is much more abundant and complete. Centrosomes and *Zwischenkörpern* are preserved throughout the resting period following division, and by means of the relative positions of these bodies at different stages, as well as the relative positions of the nuclei, yolk and cytoplasm, the direction and extent of these movements can be accurately determined. During the anaphase of the first cleavage the spindle lies at right angles to the egg axis, and the centrosomes, chromatic plates and *Zwischenkörper* are in a straight line. In later stages the *Zwischenkörper* is carried down to the center of the egg, the centrosomes are carried up to the surface and move toward each other until they come to lie on each side of the first cleavage plane and immediately under the polar bodies; the nuclei are also moved upward and toward each other until they are almost in contact on opposite sides of the first cleavage wall, and the cytoplasm moves down into the center of the egg, the yolk at the same time moving up at the periphery. Such movements could be caused only by vortical currents in the daughter cells moving up at the surface and down through the center of the egg; the cell wall forms where these opposite currents meet.

Similar vortical currents occur in every cleavage up to a late stage, and they offer most important evidence not only as to the mechanics of cleavage, but also as to the mechanics of differentiation. Of the four commonly recognized features of differential cleavage—viz.: (1) inequality, (2) non-alternation of directions, (3) qualitative differentiation and (4) lack of rhythm—the first three may be correlated with these movements. Unequal cleavages are due to movements which, beginning with the early anaphase, carry the nucleus out of the center of the cell. Non-alternation is due to the absence of currents, alternation to the regular reversal of currents during each successive division. Certain qualitative differences of the two daughter cells of every cleavage are also due to these movements. The remains of the centrosphere (idiosome of Meves, mother periplast of Vejdovski) in each blastomere is carried by definite rotations of the protoplasm into one only of the two daughter cells into which the blastomere divides; there is thus produced by protoplastic movement a visible qualitative difference in the two daughter cells formed at every division.

The Characteristics of Mitosis and Amitosis. S. WATASÉ.

On Hæmatococcus. F. H. HERRICK.

OBSERVATIONS on Hæmatococcus began with Girod-Chantrans in 1797 and have been continued during the present century by Agardh, Cohn, Braun, Rostafinski, Bütschli and others. The chief points of contention lie in the supposed sexual character of this organism and in the structure and functions of the zoospores.

The following summary of results was presented: (1) Resting cells after long submergence in water lose the power of development. In one case, after being submerged for two years, the cells have greatly thickened walls, but no zoospores are formed. If these cells are now dried, even for a short time, and then returned to water development rapidly follows. Hæmatococcus has thus become adapted to the alternation of drought and moisture, so that desiccation or something equivalent to this has become necessary to bring about a normal response. (2) Great variation not only occurs in the form and size of the sporangium (developing mother cell wall) and in the number of the zoospores, but in the size of the zoospores produced in the same sporangium. In respect to size at least the terms 'macrozoospore' and 'microzoospore' have no significance. (3) The zoospores imbibe water after liberation and undergo marked changes in appearance. Before maintaining that all zoospores have a similar structure, it may be necessary to repeat and extend certain experiments, but we are convinced that no sexuality can be attributed to this form, and that no true copulation has ever been observed. (4) Monstrosities frequently occur in the motile stage, such as twins and cells with four or more 'heads' (pairs of flagella) in all cases due not to *fusion*, but to incomplete division of the mother cell. (5) Reproduction by internal cell division has been observed in the motile stage in a few cases, in one of which the zoospore-colony consisted of four small cells freely moving in the sac of the mother zoospore, which was itself distinctly propelled by its own cilia. The mother capsule soon burst setting the young free. (6) When a motile cell comes to rest its protoplasmic sac contracts and a spherical resting cell is formed which secretes its proper wall while still enclosed in the evanescent wall of the zoospore. The flagella break at the 'beak,' leaving two slender rods united with the wall of the metamorphosed zoospore. These are probably elastic cellulose tubes which serve to sustain the flagella at the points where they pierce the sac. (7) In the course of zoospore-formation in large cells endosmosis is very great and the surface tension of the wall unequal. The transparent sphere is blown out in a form often resembling that of an incandescent light bulb, with abundant room for the