[Continued from SUPPLEMENT No. 190.]

[Translated from La Nature.]

THE BEGINNINGS OF LIFE.—IV.

By PROF. EDMOND PERRIER.

BEINGS INTERMEDIATE BETWEEN ANIMALS AND PLANTS.

The flagellate infusoria are the monads of old authors. We know at the present day a great number of forms which swarm in all parts of the globe. Some are provided with

FIG. 1.—FLAGELLATE INFUSORIA.

1. *Astasia hamatodes*, Ehrb. 2. *Phacus longicauda*, Ehrb. 3. *Euglena deses*, Ehrb. CILIATE INFUSORIA. 4. *Stentor polymorphus*, Ehrb.

a single flagellum or vibratile lash, others possess two; and the majority exhibit a contractile vesicle that is seen to beat like a heart, but more slowly. It is a small transparent pocket forming a protuberance on the side of the body (Fig. 2, No. 1). This protuberance slowly swells, then its contents are expelled, and the vesicle becomes for the moment invisible; but it is not long, however, before it reappears, and the phenomenon is repeated as long as the animal lives. The length of each beat appears to be sufficiently constant to serve as a specific character. Many rhizopods, and even a certain number of zoospores, possess, like the flagellate infusoria, a contractile vesicle. This vesicle can scarcely be considered as an organ of circulation, but is rather an excretory apparatus. The form and color of the flagellate infusoria are extremely variable. The *Phacus* (Fig. 1, No. 2) is flattened and leaf-shaped; *Euglena* (Fig. 1, No. 3) is elongated rod-shaped; the *Astasiae* are

FIG. 2.—FLAGELLATE INFUSORIA.

1. *Codosiga botrytis*, Ehrb. The two individuals to the left show upon their side their swollen contractile vesicle. 2. *Salpingoeca Clarkii*, Bütschli. 3. *Dinobryon sertularia*, Ehrb. 4. *Uvella virescens*, Ehrb.

ovoid and may be considered as cells of volvox, which always live independently of each other and do not associate together in colonies like the *stephanosphaera*, the *gonia*, and the *volvoxes* properly so called.

Certain species are of a green color, and may be considered as unicellular plants, and the more so since the *astasiae* are involved for a certain time in an envelope of cellulose. Others, like *euglena sanguinea* and *astasia hamatodes* (Fig. 1, No. 1), exhibit a bright red color. Several organisms of the latter group contribute to the red color

that rain and snow sometimes exhibit, and which is attributed to blood by superstitious people. *Monas prodigiosa*, also of a red color, is quite frequently developed on amylaceous substances; and has been observed on bread and the consecrated wafers used in Roman Catholic churches. Occasion has been taken in such cases to make believe that such bread and wafers emitted blood.

Other flagellate infusoria are entirely deprived of coloring matter. If it were permitted to class those of which we have just spoken, with algae, the colorless ones would be in-

FIG. 3.—FLAGELLATE INFUSORIA.

1. *Rhipidodendron splendidum*, Stein. 2. *Cephalothamnium Cyclopus*, Stein. 3. *Anthophysa vegetans*, Stein.

cluded with fungi; but, on the other hand, nothing can prevent us from classing them among animals, and we shall see, in fact, that they are very closely connected with certain constituent elements of the sponges.

Some of these organisms are remarkable for the presence of a sort of membranous collar at the base of their flagellum, in the shape of a funnel. This is one of the characters of the genus *salpingoeca*. Different species of the latter genus secrete a membranous urn-shaped case, in which they dwell; *salpingoeca Clarkii*, for instance (Fig. 2, No. 2). A certain number of infusoria quite often associate together in colonies. Cells resembling *salpingoeca*, to the number of eight to twelve, embrace one another in a straight line, and form the genus *conodesmus* of Stein. The *anthophysae* and *cephalothamnia* (Fig. 3, No. 2) form large spherical capitula

FIG. 4.—FLAGELLATE INFUSORIA.

1. *Dendromonas virgaria*, Weise. 2. *Cladomonas fruticulosa*, Stein. 3. *Phalansterium digitatum*, Stein. 4. *Poteriodendron petiolatum*, Stein.

at the extremity of more or less ramified and flexuous stems; the *uvellae* (Fig. 2, No. 4) which are green in color, and the *codosigae* (Fig. 2, No. 1) which are colorless, are arranged in bouquets at the summit of a long peduncle. The *dinobrya* (Fig. 2, No. 3), each individual of which possesses its own case, form ramified, arborescent colonies of great elegance.

Several species form colonies that are relatively extensive and very remarkable, some from the regular arrangement of

the individuals which compose them, others from the importance of the secondary parts secreted by the infusoria to shelter them. For instance, the *anthophysae*, *codosigae*, and *poteriodendra* (Fig. 4, No. 4) are pedunculated; but here every individual has its own peduncle, and these colonies, so wonderful by reason of their perfect symmetry, are formed by a series of successive bifurcations. The peduncles of the *dendromonas* (Fig. 4, No. 1) are arranged in such a way as to bring all the individuals on the same plane, and to thus form a kind of corymb very elegant in appearance. A transparent, membranous urn, scarcely visible, and a peduncle of greater or less length, are the only parts that complicate the colonies that we have just studied; the

FIG. 5.—NOCTILUCÆ.

1. *Noctiluca miliaris*. 2 and 3. Flagellate spores of the same. 4 and 5. Different phases of the union of noctilucae. 6. Portion of noctiluca showing the groove, and the flagella at the base of the tentacle.

flagellate cell is always the most extensive element in them.

In the genus *rhipidodendron* (Fig. 3, No. 1) the animal dwells in a tube more or less curved, thick, granular, and not very transparent, and which increases constantly in length, and becomes so long eventually that its proprietor inhabits only an insignificant part of its extent. Several of these tubes are joined one with another so as to form most graceful tufts. The *cladomonas* (Fig. 4, No. 2) construct analogous tubes, but they are arranged in dichotomous ramifications. In the genus *phalansterium* (Fig. 4, No. 3) the habitations assume a still greater importance, and are fixed to the summits of great gelatinous clubs, which are arranged more or less compactly in an arborescent form. (A large number of other forms of these animals may be found figured and described in the SCIENTIFIC AMERICAN SUPPLEMENT for June 1, 1878, page 2004.)

Thus, not only are the flagellate infusoria fitted to live in common, and to become grouped in colonies, but they can also, without losing anything of their primitive character, complicate these colonies by extensive accessory parts, ap-

FIG. 6.—GREGARINIDA.

1. *Hoplorhynchus digacanthus*, A. Schneider. 2. *Cleptodrina blattarum*, Schneider. 3. Cyst of the same species emitting its spores. 4, 5, 6, 7. Different phases of the development of the *Gregarina gigantea*, Van Beneden, of the lobster.

parently living, but which are scarcely anything more than the result of a sort of exudation of the animal. We gradually pass from such simple forms as the *euglenae* or the *salpingoecae* to true cities of infusoria—cities built in common, and where each individual preserves its independence to the same degree that any citizen of a city may with respect to his fellow-citizens. And just as in a city the buildings are infinitely more extensive than the inhabitants, so in these colonies of flagellate infusoria we see the habitation forming

a mass infinitely larger than the total mass of beings to which it owes its origin.

It sometimes happens that the individuals composing these colonies become detached and go to found colonies elsewhere. To see this phenomenon take place it is only necessary to observe a rhipidodendron for some time. So every colony contains quite a large number of tubes that have been abandoned by their inhabitants; but when the infusoria are all still there, a marvelous activity reigns in the little world. The surrounding water, constantly lashed by the vibratile flagella, circulates rapidly around it, bringing with it the air necessary for respiration, and the alimentary matters which each of the infusoria seizes as they come along.

The colonies of anthophysa, codosiga, uvella, dinobryon, etc., are evidently formed of elements which correspond exactly with those which constitute a volvox, a stephanosphaera, or a magosphera. Between these two kinds of colonies, however, there is an important difference: in those of the first species, each of the individuals composing it preserves, as we have said, its complete personality; it only contracts a union, and that a mechanical one, with its neighbors, and in a physiological point of view is entirely independent of the latter. With the volvoxes and their allies or with the magosphera, it is entirely different. Here the individual appears to be an assemblage of ciliate or flagellate cells that we have described above; and the component cells are only secondary, subordinate individualities, co-operating together to maintain the higher individuality of which they form a part. Moreover, all these cells are exactly like one another, play exactly the same part and behave exactly in the same way. All contain within themselves something like the effigy of the complex individual of which they form a part; and all are fitted for reproducing it with all the peculiarities that it exhibits; and, in this group, reproduction consists essentially, in fact, in this, that each of the cells composing an individual isolates itself and afterwards becomes divided in such a way as to re-establish an organism like the one from which it was detached.

Sometimes the organism of the flagellate infusoria becomes especially complicated, without rising, however, above the value of a simple cell. In the genus ceratium (an individual of which, captured by a protomyxa, is represented in Fig. 4 of our first article), and also in the genus peridinium, the body is covered with a curiously carved carapace, the clefts of which allow small bands of vibratile cilia to appear co-existent with the flagella. The peridinia are phosphorescent; and they are sometimes developed in such large numbers that, notwithstanding their microscopic size, they render the sea luminous over a vast extent. A phosphorescence due to peridinia exclusively was observed by Ehrenberg in the Sea of Naples in the year 1869.

There is an organism, however, pretty closely related to the infusoria, but of much smaller size—the noctiluca miliaris—that most usually produces the phenomenon of phosphorescence of the sea in our latitudes. Its form is spherical; a groove of certain depth extends along one of its meridians, and from the bottom of this furrow proceeds a movable tentacle which has been compared to the flagellum of the infusoria. At the foot of this tentacle is found a sort of lip furnished with vibratile cilia, and bearing on its lower surface two flagella (Fig. 5, Nos. 1 and 6). The wall of the noctiluca's body is tough, membranaceous, and forms a vesicle, in the interior of which is found a nucleus from whence radiates a protoplasmic network always in motion. We might compare these strange beings to radiolarians, all of whose protoplasm is contained in the interior of the central vesicle.

The noctiluca have been carefully studied by Messrs. Quatrefages, Busch, Huxley, Webb, and Brightwell. Messrs. Cienkowski and Charles Robin have studied their mode of reproduction: this takes place either by simple division or by the formation of zoospores in all respects like those of the radiolarians (Fig. 5, Nos. 2 and 3). Every noctiluca furnishes (according to the time at which segmentation is arrested) from 256 to 512 zoospores. This fecundity explains how the number of individuals is sometimes great enough to change the color of the ocean. Two noctilucae often become joined to one another at the period when the zoospores are produced, and this sort of coupling appears to hasten the operation (Fig. 5, Nos. 4 and 5), but the true nature and importance of this junction is as yet very obscure.

These phenomena of reproduction show that the noctilucae are beings much higher in the scale of life than the flagellate infusoria properly so called. Should they be considered as animals? Evidently they do not exhibit characters proper to the animal kingdom much more than do the myxomycetous fungi; yet they are protista, equivalent to a single cell, but the cell has here assumed a considerable size and has singularly departed from the typical form found in higher organisms. If now, recapitulating the facts that we have just set forth, we endeavor to place in a clear light the affinities by which the protista are united either to each other or to plants and to animals properly so called, we can sketch the following picture of their evolution.

At the lowest step of the scale, immediately above the moners, come protoplasmic beings whose homogeneity is disturbed only by the presence of a nucleus and nucleolus. The protoplasm is free, without an enveloping membrane, and its contour may assume all possible forms. Such are the amœbæ, which are reproduced by a simple division into two halves, and in which division the nucleus and nucleolus take part as well as the protoplasm.

The first step in advance is made when this protoplasm becomes fitted for secreting a membranous envelope, within which it becomes divided so as to give rise to zoospores in greater or less number. If the envelope is of an albuminoid nature, the organism that produced it approaches the animal kingdom; if, on the contrary, it is of the nature of cellulose, the organism tends toward the vegetable kingdom. Albuminoid substances are always more or less flexible; cellulose is firm. It follows from this that the movements of the protoplasm in the first case will be observable externally, but in the second case they will cease to be apparent. This is why all animals are capable of moving, while the great majority of plants are immovable during their whole lifetime. The tendency toward the vegetable kingdom is always shown if starch granules are deposited in the protoplasm, or a green or red coloring matter, as we observe in many of the flagellate infusoria. If the coloring matter does not make its appearance, we are at a loss to determine, and we can just as well refer the forms that are deprived of it to the animal kingdom, as to the branch of the vegetable kingdom represented by the fungi. The myxomycetes are the extreme limit of the passage from the protista, properly so called, to the fungi. On the contrary, the euglenæ, the astasiæ, and other colored flagellate infusoria, lead us directly to the green or red algae, and, through these, to the higher and better characterized plants. As for the passage to animals, it is

established in so natural a way that it requires quite an effort of mind to refer the beings that we have just described to the vegetable kingdom. The first impulse is to make animals of them, and, in fact, the first truly animal forms of the organic world are infinitely nearer the protista than the first truly plant forms. Protoplasm, as paradoxical as the statement may seem, must have become less modified in order to produce the first animals than to produce the first plants. The former have, perhaps, preceded the latter in the order of appearance.

The gregarinida, discovered by Leon Dufour in 1826, show us, in their turn, how the transformation of moners into cellular organisms can be effected, that is, into organisms whose protoplasm contains a nucleus and is surrounded by a membrane. The adult gregarinida are composed of one or two cells, the anterior of which is at times surmounted by a caducous appendage serving perhaps as an organ of attachment (Fig. 6, No. 1); and all occur as parasites within the bodies of other animals, more especially those belonging to the sub-kingdom annulosa. They are found in small masses in the intestines of a large number of insects, in those of moles, in the body cavities of certain worms, and in the reproductive organs of lumbrici. They have been carefully studied by Lieberkühn, Edward Van Beneden, and Aimé Schneider. At a certain period of their existence they become surrounded with a firm cyst; and sometimes two gregarinæ come into contact and a cyst or capsule soon forms around them both. In either case the contents of the cyst soon divide and become transformed into a multitude of peculiar bodies which have, from their form, received the name of pseudo-naviculæ. Long tubes soon develop at the surface of the cyst (Fig. 6, No. 3), and through these the pseudo-naviculæ are set at liberty. Under the influence of moisture, the external envelope of the latter breaks and gives rise to amœbiform bodies, which at length develop themselves into young gregarinida. Van Beneden has studied the development of these amœbiform bodies in a gigantic species (gregarina gigantea) inhabiting the intestine of the lobster. The protoplasmic mass, after moving about for some time, at length has no more than two pseudopodia: one of these is immovable and rigid, and the other flexible and constantly moving in a worm-like manner. The latter soon becomes detached, and then closely resembles a small filaria. But the closest examination does not reveal the least trace of organs: it is a true moner—the pseudo-filaria of Beneden.

Soon, however, there appears in its median region a small, clear spot which increases by degrees. It seems as if a sort of departure was being made in the protoplasmic mass, as if a part, with greater consistency and more refractive, was being precipitated and condensed in the central region. This is the origin of the nucleus, the mode of formation of which would appear to be almost mechanical. The moner deprived of a nucleus has become a cell. The cell to become complete has only to surround itself with a membrane. A simple physical modification of the outermost layer of the protoplasm suffices to produce this phenomenon, and the young gregarina thus finds itself completed. The fact that the pseudo-naviculæ form a part of the cycle of evolution of the gregarinida has been disputed, since naturalists see in them only simple parasites of the encysted gregarinida; but this in no way puts in question the part of the embryonic history of the gregarinida which connects them, through a phase in which they are true moners, with the protoplasmic mass that produces the pseudo-filariæ. Thus the gradual passage of animals and plants to moners is established in the completest manner; and we see the moners transforming themselves into cellular organisms. The latter live at first in a state of simple cells, capable of successively taking on several forms; but soon they acquire a new faculty, that of becoming associated. The cells, produced one from another, dwell united into true families, the members of which, from the very first, preserve a reciprocal independence, as we see in the dinobrya, anthophysæ, codosigæ, etc. Often, as in the rhipidodendria and the phalansteria, the union of the individuals seems to take place only through the intervention of secondary parts, the mass of which is considerable, and which complicates the colony by an important element; but the members of the family may by a new step in advance contract a closer union, and then form true multicellular individuals, composed of cells entirely like one another, as in volvox and allied algae, or in magosphera. All the cells composing this new individuality are fitted to reproduce it, contain within themselves the law of its development, and transmit it to their descendants.

It is a necessary consequence of this fact that the reproduction of cells never takes place except by a simple division. The parts which proceed from this division are forcedly identical with the mother cell, and consequently possess all of its chemical or physiological properties, including those which determine its mode of evolution. This is the reason, entirely mechanical, of the law of heredity, by virtue of which every organism transmits its inherited or acquired characters to its descendants. Heredity is the ineluctable consequence of the mode of reproduction of the constituent elements of living beings.

Societies once formed—and this takes place at an early period, since we know of social moners—the division of physiological labor supervenes, just as in societies of human beings. The elements forming a society or colony are at first all like one another (as in the colonies that have been considered in this article), but soon unlike elements become associated, these coming, however, from the other, and representing the successive phases that may be assumed by certain unicellular beings having different roles to perform in the association, each living on its own account, but also accomplishing certain functions for the common good of all. Hence arises a greater variety: the organisms, instead of being comparable to an association of snops of workmen each working for himself, seem to be vast factories where the power of production is rapidly developed in considerable magnitude. This is a fundamental phenomenon that is presented in the history of the sponges.

THE BROOKLYN TREATMENT OF DIPHTHERIA.

By PAUL H. KRETZSCHMAR, M.D., Brooklyn, N. Y., Assistant to the Chair of "Practice," Long Island College Hospital.

THE list of remedial agents employed in the treatment of diphtheria is an exceptionally long one. Apomorphia, sulphate of copper, muriated tincture of iron, guaiacum, mild chloride of mercury, biniodide of mercury, black oxide of mercury in the form of vapors, ipecacuanha, chloride of potash, iodide of potassium, sulphate of quinine, salicylate of soda, salicylic acid, carbolic acid, sulpho-carbolate of sodium, flowers of sulphur, are only a part of the remedies which have been or are to-day employed in the constitutional treatment of the disease. Just as long a list of drugs could

be made up by naming those which are recommended for topical application. If we find numerous remedies in use against any disease, that fact may be considered as evidence that the therapy in such a case is not well settled. Several of the remedies mentioned have been at one time or another praised highly by enthusiastic writers as "specifics." Yet the mortality of diphtheria is indeed enormous; Albu (*Journal für Kinder-Krankheiten*, liii., p. 164) states it to be 47 per cent.; according to other writers it varies between 20 per cent. and 50 per cent.

To speak briefly of the merits of "alcohol" in the treatment of diphtheria, and to report my experience in thirty cases treated by alcohol, is the object of this paper.

The treatment of uræmic convulsions, and especially that of puerperal eclampsia by large doses of veratrum viride, has gained considerable reputation as the "Brooklyn treatment." The same name should be applied to the alcoholic treatment of diphtheria, because its first advocate was a physician of this city. As early as 1863 has Dr. E. N. Chapman, in the *Boston Medical and Surgical Journal*, published his opinion on this subject. He has defended his assertions since that time on several occasions, and has lately published a valuable little work on the subject.

The reappearance of diphtheria during the past winter in an epidemic form, and its undiminished mortality under the so-called "recognized" forms of treatment, should draw the attention of the profession to the existing antagonism of alcohol and diphtheria.

Dr. Chapman, in his first article in the *Boston Medical and Surgical Journal*, reported nineteen recoveries in twenty consecutive cases; he gave further evidence of the value of the alcoholic treatment of diphtheria at a meeting of the Kings County Medical Society early in 1874, and in October, 1877, he read a paper before the same society, stating that during the period of more than three years he had treated eighty-five cases of diphtheria by large doses of alcohol with the most gratifying results. Of the eighty-five cases reported, eighty-four made a splendid recovery and one died. In the little work, "The Antagonism of Diphtheria and Alcohol," the doctor publishes his observations up to the 15th of May, 1878, and he reports forty more cases, with thirty-nine recoveries and one death. One hundred and twenty-five cases of diphtheria have been treated with alcohol—*and of those but two died*. If compared with the usual mortality of the disease, the statistics given are so remarkable as almost to stagger belief, more especially as the doctor has not even lost a case of croup during the period of his observation.

A natural feeling of doubt may come over almost everybody about the correctness of the diagnosis; but Dr. Chapman's ability and his excellent reputation should be sufficient evidence that the reported cases were "genuine" and not "homœopathic" cases of diphtheria.

Of late several practitioners of this city have employed the alcoholic treatment, and it has yielded results emphatically confirmatory of Dr. Chapman's. Having tried the "Brooklyn treatment" in thirty cases, I can only confirm what Dr. Chapman says about its great efficiency and value.

Shortly after the doctor read his paper before the Kings County Medical Society in 1877, I treated for the first time a case of diphtheria with large doses of alcohol. The patient made a good recovery. I have since treated thirty cases of diphtheria by this method, many of them of the most severe variety, and a number of them complicated by scarlet fever, and I only lost four. Twenty-six recoveries and four deaths is an excellent success; if added to the cases reported by Dr. Chapman, our statistics will show an aggregate of one hundred and fifty-five cases treated with large doses of alcohol. Of these one hundred and forty-nine recovered and six died—a mortality of about 4 per cent. If clinical experience can settle therapeutical questions, the alcoholic treatment of diphtheria must be recognized as one of the most powerful means to diminish the mortality of the disease. Whatever the true pathology of diphtheria may be—whether the local affection is only a symptom of a specific condition of blood poisoning, or whether the disease should be regarded as a contagious infectious one which commences as a local difficulty, and which may either continue and remain such, or may lead secondarily to a constitutional affection, a large clinical experience shows that there is no form of treatment more effectual than the administration of large doses of alcohol. In cases of diphtheritic poisoning alcohol does not act as a stimulant; it induces none of its ordinary effects; intoxication has never been observed, while enormous doses have been administered to young children. The remedy should not be employed as in a variety of other diseases, to relieve or prevent great prostration, but simply for its *specific* action as an antidote to the diphtheritic poison. Not only as an antidote, but also as a preventive of diphtheria, has alcohol proven to be of great value; if administered early and in sufficient doses, its prophylactic properties can easily be demonstrated. And even to prevent or cut short any of the sequelæ of diphtheria, there is no remedy as reliable as alcohol.

In most of Dr. Chapman's cases quinine had been administered in addition to the alcohol; in twelve cases of mine, all of which recovered, alcohol alone was employed. The effect seemed to be almost as decided and quick with out as with quinine. The children often refused the medicine on account of the taste of quinine; lately I have always used quinine by intunction and given the alcohol separately. I have in cases of diphtheria, but oftener in cases of acute catarrhal pneumonia, produced cinchonism by the frequent use of an ointment made of

Quinæ sulph. 3 ss.
Chloroformi 3 ss.
Bals. Peru. 3 ss.
Adipis 3 ℥j.
M.

For the administration of the alcohol the following formula has generally been employed:

Spts. vini Gallic., or Spts. frumenti 3 ijs.
Glycerini opt.
Syr. simplic aa 3 ss.
Aquæ menth. pip. q.s. ad 3 iv.
M.

To children under two years 3 j. every hour, from two to three years 3 jss., from three to five years 3 ij., from five to eight years from 3 ijs. to 3 ss., every hour.

In a few very severe cases champagne has been used. Great importance has always been attached to hygiene; cleanliness and fresh air have always been obtained first of all. Of course, whenever a direct cause for the development and propagation of the diphtheritic poison could be found great care has been taken to remove it. It was hardly ever left to the inspector from the Board of Health to examine the plumbing; the escape of sewer gas could be detected in about one-half of the cases reported.