

and all the vital phenomena are performed by one and the same homogeneous and formless matter. So low in the scale of living were (and are) these *Monera* that they were not equivalent to a simple cell even, their form value being that of a cytod; for the little lump of protoplasm did not as yet possess a cell-kernel. The first of these *Monera* originated in the beginning of the Laurentian period by, probably, spontaneous generation, or archigony, out of so-called "inorganic combinations,"—simple combinations of carbon, oxygen, hydrogen, and nitrogen. A direct proof of the earlier existence of this most ancient ancestral stage, based upon the fundamental law of ontogeny, or embryology, is furnished by the circumstance that as many investigators assert, in the beginning of the development of the egg, the cell-kernel, or nucleus, disappears, and the egg-cell thus relapses to the lower stage of the cytod,—the *Monera* stage.

SECOND STAGE:—AMOEBA.—The second ancestral stage of Man, as of all the higher animals and plants, is formed by a simple cell,—that is, a little piece of protoplasm enclosing a kernel. There still exists large numbers of similar "single-celled organisms." Among them the common, simple *Amoeba* cannot have been essentially different from these progenitors. The form value of every *Amoeba* is essentially the same as that still possessed by the egg of Man, and by the egg of all other animals. The egg-cell of Man, which, like that of most other animals, is surrounded by a membrane, resembles an enclosed *Amoeba*. The first single-celled animals of the kind were evolved from the *Monera* by the inner kernel and the external protoplasm being differentiated; they lived in the earlier Primordial period. An irrefutable proof that such single-celled primæval animals really existed as the direct ancestors of Man, is furnished according to the fundamental law of embryology by the fact that the human egg is nothing more than a simple cell.

THIRD STAGE:—SYNAMBÆ.—From the "single-cell state" arose the simplest multicellular state, namely, a heap or a small community of simple, equi-formal, and equivalent cells. At the present day, in the ontogenetic development of every animal egg-cell, there first arises a globular heap of equi-formal naked cells, by the repeated self-division of the primary unitized cell. This accumulation of cells occurs in the same simple form in all the different tribes of animals, indicative of the fact that the most ancient, many-celled, primary form of the animal kingdom was in fact a single heap of *Amoeba*-like primæval cells, one similar to the other. This most ancient community of *Amoeba*,—this most simple accumulation of animal cells,—which has been and is recapitulated in the individual development of all subsequent forms, is called the *Synambæ*. These *Synambæ* originated out of the single-celled Primæval animals of the second stage by repeated self-division and by the permanent union of the products of this division.

FOURTH STAGE:—CILIATED LARVA (*Planœada*).—Out of the *Synambæ*, in the early Laurentian period, there was evolved a fourth primary form of the animal kingdom, called the ciliated larva. This arose out of the *Synambæ* by the outer cells on the surface of the cellular community beginning to extend vibrating fringes, or hair-like processes, called cilia, and becoming ciliated cells, thus differing from the internal and unchanged cells. The *Synambæ* consisted of completely equi-formal and naked cells, and crept about slowly, at the bottom of the Laurentian primæval ocean. The *Planœada*, as the forms of the fourth stages are termed, on the other hand, consisted of two kinds of different cells,—inner non-ciliated ones like the *Amoeba*, and external ciliated cells. By the vibrating movements of the cilia, or fringes of hair, the entire multicellular body acquired a more rapid and stronger motion, and passed over from the creeping to the swimming mode of locomotion. A certain proof of the existence of ancestors of man in the early Primordial period possessing the form value of these ciliated larvæ is furnished by the *Amphioxus*, the lowest of the Vertebrate animals, which is on the one hand related by blood to Man, but on the other hand has retained down to the present day the ciliated-larva stage during its embryologic development.

FIFTH STAGE:—PRIMÆVAL STOMACH ANIMALS (*Gastrœada*).—Out of the fringed-larva state was next developed an exceedingly important and interesting animal form, called the *Gastrœada*,—that is, larva with a stomach or intestine. This *Gastrœada* externally resembles the form of the fourth stage, but differs essentially from it in the fact that it encloses a cavity which opens to the outside by a mouth. The cavity is the "primary intestine," or "primary stomach," the *progestæ*, the first beginning of the alimentary canal; its opening is the "primary mouth" (prostoma). These *Gastrœada* possessed a perfectly simple globular or oval body, which enclosed a simple cavity of like form, the primitive stomach or intestines; at one of the poles of the longitudinal axis the primary intestine opened by a mouth which served for the reception of nutrition. The body wall—which was also the intestinal wall—consisted of two layers of cells, the unfringed intestinal layer, and the fringed skin-layer; by the motion of cilia or fringes of the latter they swam about freely in the Laurentian ocean. This exceedingly important larval form, the *Gastrœada*, makes its appearance in the embryologic evolutions of all tribes of animals,—in Sponges, Medusæ, Corals, Worms, Ascidians, Radiated Animals, Molluscs, and the lowest of the Vertebrates. A certain proof that the *Gastrœada* are included in the ancestors of man is furnished by the *Amphioxus*, which, in spite of its blood relationship to man, still passes through the stage of the *gastrœada*.

SIXTH STAGE:—GLIDING WORMS (*Turbellaria*).—The human ancestors of the sixth stage, which originated out of the *Gastrœada* of the fifth stage, were low worms, which, of all the forms of worms known to us, were most closely allied to the Gliding Worms, or *Turbellaria*, or at least

upon the whole possessed their form value. Like the *Turbellaria* of the present day, the whole surface of their body was covered with cilia, or hair-like fringes, and they possessed a simple body of an oval shape, entirely without appendages. The acelomatous worm did not as yet possess a true body-cavity (coelom) nor blood. They originated in the early primordial period out of the *Gastrœada*, by the formation of a middle germ-layer, or muscular layer, and also by the further differentiation of the internal parts into various organs; more especially the first formation of a nervous system, the simplest organs of sense, and the simplest organs for secretion and generation. Both comparative anatomy and the ontogeny of the lower acelomatous worms enable us to recognize in these worms the nearest blood relations of those extinct animal forms which were the original primary forms of the four higher animal tribes. Hence these latter, the Molluscs, Star-fishes, Articulated animals, and Vertebrate animals, do not stand in any close blood relationship to each other, but have originated independently in four different places out of the tribe of Worms. The Vertebrate kingdom, of which Man is a member, having been evolved from one branch of these worms, they constitute, therefore, a sixth link in the chain of human ancestry. Now, of all the animals known to us, the *Turbellaria*, which possesses neither a body-cavity nor blood, are most closely allied to these primæval acelomatous Primary Worms.

SEVENTH STAGE:—SOFT WORMS (*Scolecida*).—Developing out of the *Turbellaria* of the sixth stage by forming a true body-cavity and blood in their arteries, we find the next intermediate form to be Soft Worms, or *Scolecida*. Of the still living worms of this class, probably the Acorn-worms (*Balanoglossus*) are the nearest akin to these extinct forms.

EIGHTH STAGE:—SACK WORMS (*Himatæga*).—Under the name of Sack Worms, or *Himatæga*, are evolved those celomatous worms out of which the most ancient skull-less Vertebrata were directly evolved. Among existing forms the Ascidians are the nearest relatives of these exceedingly remarkable worms, which connect the widely-differing classes of Invertebrate and Vertebrate animals. The embryologic evolution of the Ascidians agree in their earlier stages of development in a most remarkable manner with that of the lowest Vertebrate, the Lancelot or *Amphioxus*. Although an Invertebrate animal, the freely swimming larva of the Tunicate Ascidians develop the undeniable beginning of a *spinal marrow* and of a *spinal rod*,—the special characteristics of the Vertebrate kingdom,—and this moreover in entirely the same way as does the *Amphioxus*, the lowest true Vertebrate. The spinal marrow, as the beginning of the central nervous system, and the spinal rod, as the first basis of the vertebrate column, are such important organs, so exclusively characteristic of Vertebrate animals, that we may from them with certainty infer the true blood relationship of Vertebrate with Tunicate animals. It is not meant by this, that Vertebrate animals are derived from Tunicate animals, but that both groups have arisen out of a common root, and that the Tunicates, of all the Invertebrata, are the nearest blood relations of the Vertebrata. It is quite evident that genuine Vertebrate animals developed progressively during the primordial period (and the skull-less animals first) out of a group of worms, from which the degenerate Tunicate animals arose in another and a retrograde direction.

[Concluded in next number.]

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