BIOLOGY

Degeneration

"A Classic of Science"

Not All Evolution is Upward Toward More Complex Forms Some Animals Find Equilibrium While Others Retrogress

DEGENERATION: A CHAPTER IN DARWINISM. By E. Ray Lankester. Delivered as one of the evening lectures at the Sheffield Meeting of the British Association for the Advancement of Science, 22d August 1879. *Published in THE ADVANCEMENT OF SCIENCE, Occasional Essays & Addresses. London and New York: Macmillan and Co.,* 1890. *This is an exact reprint of extracts from the original publication.*

IT IS CLEARLY enough possible for a set of forces such as we sum up under the head "natural selection" to so act on the structure of an organism as to produce one of three results, namely, these: to keep it *in statu quo;* to increase the complexity of its structure; or lastly, to diminish the complexity of its structure. We have as possibilities either BALANCE, or ELABORATION, or DEGENERATION.

Owing, as it seems, to the predisposing influence of the systems of classification in ascending series proceeding steadily upwards from the "lower" or simplest forms to the "higher" or more complex forms,—systems which were prevalent before the doctrine of transformation had taken firm root in the minds of naturalists, there has been up to the present day an endeavour to explain every existing form of life on the hypothesis that it has been maintained for long ages in a state of Balance; or else on the hypothesis that it has been Elaborated, and is an advance, an improvement, upon its ancestors. Only one naturalist,—Dr. Dohrn, of Naples —has put forward the hypothesis of Degeneration as capable of wide application to the explanation of existing forms of life; and his arguments in favour of a general application of this hypothesis have not, I think, met with the consideration which they merit.

The statement that the hypothesis of Degeneration has not been recognised by naturalists generally as an explanation of animal forms, requires to be corrected by the exception of certain kinds of animals, namely, those that are parasitic or quasi-parasitic. With regard to parasites, naturalists have long recognised what is called retrogressive metamorphosis; and parasitic animals are as a rule admitted to be instances of Degeneration. It is the more remarkable whilst the possibility of a degeneration —a loss of organisation making the descendant far *simpler* or *lower* in structure than its ancestor—has been admitted for a few exceptional animals, that the same hypothesis should not have been applied to the explanation of other simple forms of animals. The hypothesis of Degeneration will, I believe, be found to render most valuable service in pointing out the true relationships of animals which are a puzzle and a mystery when we use only and exclusively the hypothesis of Balance, or the hypothesis of Elaboration. It will, as a true scientific hypothesis, help us to discover causes. . . .

Degeneration Defined

Degeneration may be defined as a gradual change of the structure in which the organism becomes adapted to less varied and less complex conditions of life; whilst Elaboration is a gradual change of structure in which the organism becomes adapted to more and more varied and complex conditions of existence. In Elaboration there is a new expression of form, corresponding to new perfection of work in the animal machine. In Degeneration there is suppression of form, corresponding to the cessation of work. Elaboration of some one organ *may* be a necessary accompaniment of Degeneration in all the others; in fact, this is very generally the case; and it is only when the total result of the Elaboration of some organs, and the Degeneration of others, is such as to leave the whole animal in a lower condition, that is, fitted to less complex action and reaction in regard to its surroundings, than was the ancestral form with which we are comparing it (either actually or in imagination) that we speak of that animal as an instance of Degeneration. . . .

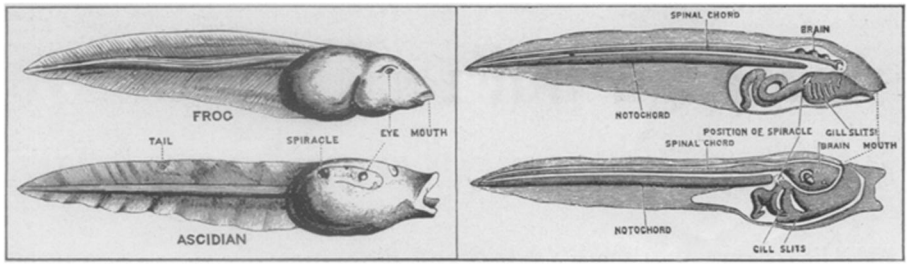
The Nauplius

Amongst these Nauplii—all belonging to the great group Crustacea, which includes crabs and shrimps—is one which gives rise to an animal decidedly degenerate, but not precisely parasitic in its habits. This Nauplius is the young of the ship's Barnacle, a curious stalked body, enclosed in a shell of many pieces. The egg of the Barnacle gives rise to an actively swimming Nauplius, the history of which is very astonishing. After swimming about for a time the Barnacle's Nauplius fixes its head against a piece of wood, and takes to a perfectly fixed, immobile state of life. . . . Its organs of touch and of sight atrophy, its legs lose their locomotor function, and are simply used for bringing floating particles to the orifice of the stomach; so that an eminent naturalist has compared one of these animals to a man standing on his head and kicking his food into his mouth.

Were it not for the recapitulative phases in the development of the Barnacle, we may doubt whether naturalists would *ever* have guessed that it was a degenerate Crustacean. It was, in fact, for a long time regarded as quite remote from them, and placed among the snails and oysters; its true nature was only admitted when the young form was discovered. . . .

The Ascidian

The instances of degeneration which we have so far examined are due to parasitism, except in the example of the Barnacle, where we have an instance of degeneration due to sessile and immobile habit of life. We may now proceed to look at some sessile or immobile animals which are not usually regarded as degenerate, but which, I think, there is every reason to believe are the degenerate descendants of very much higher and more elaborate ancestors. These are certain marine animals, the Ascidians, or sea-squirts. These animals are



FROG AND ASCIDIAN TADPOLES

are similar both on the surface and internally. But one becomes an active, bright-eyed, noisy vertebrate, while the other attaches itself barnacle-like to a rock, sheds its rudimentary spinal column, and vegetates for the rest of its days.

found encrusting rocks, stones, and weeds on the sea-bottom. Sometimes they are solitary, but many of them produce buds, like plants, and so form compound masses or sheets of individuals all connected and continuous with one another, like the buds on a creeping plant.

We will examine one of the simple forms—a tough mass like a leather bottle with two openings; water is continually passing in at the one and out at the other of these apertures. If we remove the leathery outer case, we find that there is a soft creature within which has the following parts: Leading from the mouth a great throat, followed by an intestine. The throat is perforated by innumerable slits, through which the water passes into a chamber—the cloaca: in passing, the water aërates the blood which circulates in the framework of the slits. The intestine takes a sharp bend, which causes it to open also into the cloaca. Between the orifice of the mouth and of the cloaca there is a nerve-ganglion.

My object in the next place is to show that the structure and life-history of these Ascidians may be best explained on the hypothesis that they are instances of degeneration; that they are the modified descendants of animals of higher, that is, more elaborate structure, and in fact are degenerate Vertebrata, standing in the same relation to fishes, frogs, and men, as do the barnacles to shrimps, crabs, and lobsters.

The young of some, but by no means of all these Ascidians, have a form totally different from that of their parents. The egg of Phallusia gives rise to a tadpole, a drawing of which placed side by side with the somewhat larger tadpole of the common frog is seen in the adjoining figure. The young Ascidian has the same general shape as the young frog, but not only this; the resemblance extends into details, the internal organs agreeing closely in two cases. Further still, as shown by the beautiful researches of the Russian naturalist. Kowalewsky, the resemblance reaches absolute identity when we examine the way in which the various organs arise from the primitive egg-cell. Tail, body, spiracle, eye, and mouth agree in the two tadpoles, the only important difference being in the position of the two mouths and in the fact that the Ascidian has one eye while the frog has two.

Now let us look at the internal organs. There are four structures, which are all four possessed at some time of their lives by all those animals which we call the Vertebrata, the great branch of the pedigree to which fishes, reptiles, birds, beasts, and men belong. And the combination of these marks or structural peculiarities is an overwhelming piece of evidence in favour of the supposition that the creatures which possess this combination are derived from one common ancestor. . . . These four great structural features are—first, the primitive backbone or notochord; second, the throat perforated by gill-slits; third, the tubular nerve-centre or spinal cord and brain placed along the back; and, lastly, and perhaps most distinctive and clinching as an evidence of affinity, the myelonic or cerebral eye.

Now let us convince ourselves that these four features exist not only in the frog's tadpole, as they do in all fishes, reptiles, birds, and beasts, but that they also exist in the Ascidian tadpole, and, it may be added coexist in no other animals at all.

The corresponding parts are named in the figures in such a way as to render their agreement tolerably clear. . .

It is clear then that the Ascidians must be admitted to be Vertebrates, and must be classified in that great sub-kingdom or branch of the animal pedigree. The Ascidian tadpole is very unlike its parent the Ascidian, and has to go through a process of *degeneration* in order to arrive at the adult structure . . . It will be observed, that in somewhat the same manner as the young barnacle, the young Ascidian fixes itself to a stone by its head; then the tail with its notochord and nerve-chord atrophies. The body grows and gradually changes its shape, whilst the cloacal chamber forms. The brain remains quite small and undeveloped, and the remarkable myelonic eye (the eye in the brain) disappears. The number of gill-slits increases as the animal grows in size and its outer skin becomes tough and leather-like.

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AGRICULTURE

U. S. Wheat Crop To Be Shortest in Generation

WINTER WHEAT in the United States promises the shortest crop since 1904, the May issue of Wheat Studies of the Food Research Institute estimates. The official forecast as of May 1 indicated a crop of only 337 million bushels, 125 million below the standing estimate of last year's crop. Acreage abandonment was unprecedentedly high, over 32 per cent., leaving the smallest area for harvest since 1912.

Reports of farmers' intention to plant spring wheat indicated that the acreage sown this spring in North America may be four or five per cent. smaller than the area planted in 1932. Since the publication of the Institute's report, unfavorable weather has held back spring wheat planting, along with practically all other crops, so that some shortage in spring wheat may be expected also, though whether it will be as great as that in winter wheat cannot be predicted at present.

One major wheat harvest of the world, that in India, has already been reaped, the report states. It is officially estimated at 340 million bushels, a trifle larger than the 1932 crop. It is not expected that the Indian crop will have much influence on world wheat prices during the May-July period. (*Turn Page*)