12. On the Development of the Individual and of the Species as Forms of Instinctive Action. By St. George Mivart, V.P.Z.S., Ph.D., M.D., F.R.S.

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The object of this paper is to endeavour to show that the clearest comprehension of Ontogeny and Phylogeny is probably to be obtained by regarding them as special forms of Instinctive Action. In order to make this conception intelligible, it is necessary to begin by considering "Instinct" itself.

Instinct has been very generally considered to be an altogether peculiar phenomenon, very distinct from all the other powers possessed by animals. Attempts have, however, been made to explain it by "reflex action" on the one hand, and by "conscious deliberate intelligence" on the other. It has by some persons been regarded as "compound reflex action" in which sensation intervenes. It has by other persons been considered as made up of the relics and remains of intelligent acts, which acts were once performed with deliberate purpose and intention, but which have become so extremely habitual as, at length, to be performed without the intervention of any consciously intelligent purpose on the part of the creatures which perform them.

To appreciate fully the bearing of Instinct on Ontogeny and Phylogeny, we should also see what are its relations to the other vital processes—such as reflex action and the repair and reproduction of lost parts after injury. Before entering upon this question, however (the question of the relations existing between Instinct and the various other vital processes), it will be well to start with a declaration as to what is meant by the term Instinct in the present paper.

The general notion of "Instinct" is that of a special, internal "impulse urging animals to the performance of certain actions which are useful to them or to their kind, but the use of which they do not themselves perceive, and their performance of which is a necessary consequence of their being placed in certain circumstances"[1]. Such actions can, however, only be considered as being generally useful—useful in the great majority of instances, as Instinct every now and then impels animals to perform an act prejudicial to the individual performing it in some particular case.

That we may securely proceed from the more known to the less known, it will be best to begin with a consideration of Instinct[2] as it exists in Man; since we can know no creatures so well as we can, by the help of language and reflection, know ourselves and our own species.

[1] Todd's Cyclopædia, vol. iii. p. 3.

[2] "Instinct" *as such* (like "life," "mind," &c.) is, of course, a pure abstraction, and exists thus only in our minds, though it has a real existence enough, in certain concrete actions which animals perform.

As every object of study is made clearer by contrasting it with other objects distinct in kind from it, so our "instinctive actions" may be more clearly apprehended by contrasting them with such of our actions as are said not be "instinctive." But we habitually contrast "Instinct" with "Reason." What, then, are the characters which distinguish actions which are attributed to "Reason"? Now "reasonable," "consciously intelligent" conduct, is understood by all men to mean conduct in which there is a more or less wise adaptation of means to ends—a deliberate adaptation, not one due to accident only. No one would call an act done blindly a reasonable intelligent action on the part of him who did it, however fortunate might be its result. Our highest mental activity, our type of reason, consists of conscious, deliberate, intellectual perceptions—explicit judgments—and our reasonable actions are actions performed in accordance therewith.

But besides these actions due to our self-conscious intellect, there are a variety of other actions—such *e. g.* as our respiratory actions—which we ordinarily perform without advertence, though we can, if we will, perform them with self-conscious deliberation. Again, we may, when our mind is entirely directed upon some external object, or when we are almost in a state of somnolent unconsciousness, have but a vague feeling of our existence—a feeling resulting from the unobserved synthesis of our sensations of all orders and degrees. This *un*intellectual sense of self may be conveniently distinguished from intellectual "*Consciousness*" as "*Consentience.*" [1]

Nothing is more common with us than to experience modifications of our organs of sense to which our intellect in no way adverts. Such modifications constantly influence our actions (as in walking and running) without our ever adverting to them, either at the time of their occurrence or afterwards. We may also, as everybody knows, suddenly recollect sights or sounds which were quite unnoticed at the time we experienced them; yet our very recollection of them proves that they must, nevertheless, have affected our sensorium. Such unnoticed modifications of our sense-organs may, at least provisionally, be called "unfelt sensations."

According to our preliminary definition and according to general usage, actions, whether adverted to or not, cannot be called "instinctive" unless they are generally useful ones directed to the accomplishment of *un*foreseen ends. But it is a familiar fact that we often perform such actions. As examples of the kind may be enumerated:—spontaneous, instantaneous actions directed to the warding off of a blow or to the due maintaining of the body's balance. Who also has not experienced how much better such actions are performed (as *e. g.* the action of running up stairs) with the mere aid of consentience, than when our intellect is brought to bear upon our motions?

The little boy as yet unable, or hardly able to speak, has no expectation of future encounters when he begins unconsciously to grasp at weapons; and long before the little girl can represent to

[1] A term I believe first introduced by the late Mr. G. H. Lewes.

herself future tributes to her charms, she seeks to decorate her tiny body with the arts of infant coquetry. Still less does she look forward to the pains and pleasures of maternity, when she begins to caress and chastise, to soothe and cherish her first doll, and fondly presses it to that region whence her future offspring will draw its nourishment.

Again, when—the lapse of a few years having made her a young woman and the boy a youth—they first feel the influence of love, however ignorant they may be of the physiology of their race, they will none the less, circumstances permitting, be surely impelled towards the performance of very definite actions. In the more refined individuals of the highest races of mankind, the material element is most certainly far from being the one great end distinctly looked forward to by each pair of lovers. Yet every incident of affectionate intercourse infallibly leads on towards the one end, useful to the race, which nature has in view. Such actions fully merit to be called "instinctive."

That animals even of the higher classes do perform actions which are truly instinctive is generally admitted by naturalists. Mr. Wallace, indeed, believes that Birds learn to build their nests by observing the structure of those in which they themselves are reared. I have not found this view to be shared by other naturalists of my acquaintance; and, in spite of the deference and respect due to so eminent an observer and so lucid a reasoner as my friend Mr. Wallace, it seems to me a view which is untenable. Some of the nests which require an especial skill in their construction are those which are suspended and entirely enclosed save at one small aperture. How the young within such a nest can, by observation, learn to form it, is to me inconceivable.

It is, however, the instincts of Insects which are the most wonderful, and these are so numerous and so notorious that only one or two instances at most need here be referred to, such as those of the Carpenter Bee, the Wasp *Sphex*, and the larval Stag-Beetle, the male of which, it is said, digs a hole, for its transformation, twice as big as his own body (to allow for the development of his enormous mandibles), while the female only digs one of her own size.

Even more wonderful than the instincts of insects, are the actions of those Rhizopods which, as Dr. Carpenter affirms[1], build up tests or casings of the most regular geometrical symmetry of form, and of the most artificial construction. "From the very same sandy bottom, one series picks up the coarser quartz grains, cements them together with phosphate of iron secreted from its own substance, and thus constructs a flask-shaped test having a short neck and a single large orifice. Another picks up the finest grains and puts them together with the same cement into perfectly spherical tests of the most extraordinary finish, perforated with numerous small pores at regular intervals. Another selects the minutest sand-grains and the terminal portions of sponge-spicules, and works these up together —apparently with no cement at all, by the mere laying of the

[1] 'Mental Physiology,' p. 41.

spicules—into perfect white spheres, each having a single fissured orifice. Another (which makes a many-chambered test like the shell of an Orthoceratite, the conical mouth of each chamber projecting into the cavity of the next), while forming the walls of its chambers of ordinary sand-grains rather loosely held together, shapes the conical mouths of its successive chambers by firmly cementing together grains of ferruginous quartz, which it must have picked out from the general mass." On considering such remarkable differences in action, between creatures of structures so simple and so similar, the question naturally arises, "May not the differences be due to diversities of molecular structure?" That structural differences which our senses cannot detect, exist not only between all the kinds, but also between all the individuals, is what no one can reasonably deny; but as such differences cannot be known by observation, whereas the differences of habit can be so known, an attempt to explain the latter by the power would be to explain *obscurum per obscurius*. Moreover, it is very difficult to see how such molecular difference alone, can govern the shape and ornamentation of the flask which a particle of protoplasm constructs to shelter its own amorphous substance. Moreover Mr. Carter has recorded [1] observations with regard to actions of other Rhizopods which at the least have much appearance of being instinctive. There are also actions performed by animals not so very much higher in the scale—certain *Cœlentera* and *Echinoderma* [2], which must I think be allowed to be instinctive by all who hold that Instinct is generally beneficial vital action in which sensation intervenes. That sensation, in some form, does intervene in these animals, is, in my opinion, so far shown by the possession of a distinct nervous system, that we may assume it in the absence of any good reason to the contrary being brought forward.

When a nervous system, however, does not exist, we cannot venture to assert the presence of any true sensation. The, at least seemingly, instinctive actions in the lowest animals may then serve to introduce to our consideration certain actions in ourselves and in other animals which are not generally reckoned as "instinctive."

Before, however, proceeding to their consideration, I would say a few words on the subject of "lapsed intelligence." I am strongly persuaded that "lapsed intelligence" will not explain "Instinct" generally, but I should be the last to deny that certain instinctive actions may be so explained, and I fully admit that intelligent action in ourselves does tend to become instinctive. It is also fortunate for us that it does so tend, as thereby we are saved great mental friction, and our intelligence is, as it were, set free to appropriate and render instinctive a continually wider and more important range of deliberate, purposive actions.

That such "lapsed intelligence" will not, however, explain *all* instinctive actions, seems to me clear from a consideration both of the lowest, or most simple, instinctive actions on the part of ourselves

[1] Ann. of Nat. Hist. 3rd series, 1863.

[2] See 'Animal Intelligence,' by G. J. Romanes, pp. 22, 23.

and other animals, and also of our own highest and most complex instinctive actions.

I will now revert to the consideration of certain actions, in ourselves and other animals, which actions are not generally reckoned as "instinctive." The characters presented by the actions of the lowest animals may serve as an introduction to them.

In the first place let us glance at those actions which are termed "reflex." Herein it is commonly supposed that the living mechanism occasions a prompt responsive muscular action upon the occurrence of some unfelt nerve-stimulation. The best-known examples are the appropriate actions, in response to stimuli, performed by a decapitated Frog, and those which the lower limbs of a Man may execute when the nerves of his feet are stimulated after his spinal cord has been so injured that he has lost all power of sensation in his inferior extremities. It has been objected by the late Mr. G. H. Lewes and others that we cannot be sure but that the spinal cord itself "feels." But there is often an ambiguity in the use of the term "to feel." By it we ordinarily mean a "modification of consciousness," but experiences such as those before adverted to, and which I have provisionally called "unfelt sensations," show clearly that effects may be produced by surrounding agents on our sense-organs without the intervention of consciousness, similar to those produced on them when they *do* arouse consciousness. Without then entering into any discussion as to whether "sentiency" may or may not be attributed to the spinal cord, it seems evident that some definite term is required to denote those modifications of our being which have here been provisionally termed "unfelt sensations."

It is obviously very difficult, probably impossible, to draw any hard and fast line between reflex action, unfelt sentiency, and such unconscious, instinctive impulses as have been above referred to in speaking of Instinct in man.

There is also another class of organic vital actions which seem to have a certain affinity both to reflex action (from their perfect unconsciousness) and to Instinct, from their being directed towards a useful but unforeseen end. The class of actions here referred to are those which relate to the repair of injuries and the reproduction of lost parts.

In a process of healing after a wound, a true secretion is poured forth of intercellular substance in which cells are abundantly formed, and, by a process of transformation, vessels, tendons, nerves, bone, and membrane all arise, as they originally first arose in the embryo, from undifferentiated cellular substance.

In a case of broken bone, the two broken ends soften and a substance is secreted which becomes at first gelatinous, often afterwards cartilaginous, and finally, osseous.

But not only distinct tissues, but very complex teleological structures, such as admirably formed joints, may be reproduced. Thus we read [1] that "a very interesting example is recorded by Mr. Syme, in which he had the opportunity of dissecting the new joint,

[1] See Mr. Timothy Holmes's 'System of Surgery,' 3rd edition, vol. iii. p. 746.

nine years after the operation (excision of the elbow) which had been performed on account of injury—the man having in the interval acted as guard on a railway, swinging himself from one carriage to another while the train was in motion, with the injured arm, quite as easily and securely as with the other. The ulna was found united to the humerus by ligament; the end of the radius was polished off, and played on the humerus and on the ulna, a material something like cartilage being interposed. The ends of the bones of the forearm were locked in by two processes projecting downwards from the humerus, and strong lateral, and still stronger anterior and posterior ligaments, also bound them to the latter bone." It would be easy to bring forward a great number of more or less similar cases.

The amount of reproduction of lost parts of which many of the lower animals are capable every naturalist knows. It is also a notorious and very noteworthy fact that in both man and the lower animals, the processes of repair take place the more readily the younger the age of the injured individual may be. But these unconscious but practically teleological processes of repair are often preceded by actions which *every one* would call instinctive. The actions here referred to are such as the throwing off (by a Lobster, Crab, or Spider) of an injured limb in order that by its separation at a suitable spot its reproduction may be brought about. But this spontaneous removal of the limb is only the first act, and a necessary act, of the process of its reproduction. It is (as has been observed by Hartmann [1]) analogous to the reproduction, by a larva, of its injured cocoon, or by a Spider of its torn net. They are all reparative actions accompanied by feelings of different degrees.

A consideration of the process of remedial reproduction in the individual, naturally leads us on to the consideration *of the reproduction of the individual itself.*

It would be a quite superfluous task here to make more than a general reference to the wonderful series of changes which each embryo of a *Hydra tuba*, an *Echinus*, a *Sepia*, a Butterfly, a Batrachian, and a Man goes through during its individual process of development, or ontogeny.

This process, in its perfect unconsciousness, is like reflex action, but it is far more wonderful, since in the earliest stages even nerve-tissue is absent and has itself to be formed. In the accuracy of its direction towards a useful end, it is the very counterpart of the most developed Instinct; nor, if the impulses by which adult individuals are led to seek and to perform those processes which give rise to the embryo are to be called instinctive, is it easy to see how the term "instinctive" can be refused to that impulse by which each developing embryo is led to go through those processes which give rise to the adult.

Can these analogies be carried further still, and can we, from the consideration of Instinct in the widest sense of that term, throw any

[1] I would refer my hearers to E. von Hartmann's work on 'The Unconscious,' which they will find very suggestive, and to which I gladly acknowledge many obligations, as regards my treatment of this subject.

glimmerings of light upon that most recondite and still most mysterious process, *the genesis of new species*?

We may be encouraged to hope that such a result is possible from the words of one of those twin Biologists who on the same night put forth their independently arrived-at views as to what we are all agreed to regard as at least an important factor in the Origin of Species. No less a person than Mr. Wallace has written the following significant words [1]:—

"No thoughtful person can contemplate without amazement the phenomena presented by the development of animals. We see the most diverse forms—a Mollusk, a Frog, and a Mammal—arising from apparently identical primitive cells, and progressing for a time by very similar initial changes, but thereafter each pursuing its highly complex and often circuitous course of development, with unerring certainty, by means of laws and forces of which we are totally ignorant. It is surely a not improbable supposition that the unknown power which determines and regulates this marvellous process may also determine the initiation of these more important changes of structure, and those developments of new parts and organs which characterize the successive stages of the evolutions of animal forms."

These words advocate and confirm what I have elsewhere [2] antecedently urged.

Many influences doubtless may come into play in the origin of new species; but let us look a little narrowly at certain influences which *must* come into play therein, and the action of which no man can deny.

One of these influences (which no one has more richly illustrated than has the late Mr. Darwin) is that of Heredity; but, what *is* heredity?

In the first place it is obviously a property, not of new individuals —not of offspring—but of parental forms. As every one knows, it is the innate tendency which each organism possesses to reproduce its like. If any living creature, X, was self-impregnating and the outcome of a long line of self-impregnating predecessors, all existing in the midst of one uniform and continuously unvarying environment, then X would produce offspring completely like itself. This fundamental biological law of reproduction may be compared with the physical first law of motion [3],—*according to which any body in motion will continue to move on uniformly at the same rate and in the same direction until some other force or motion is impressed upon it.*

The fact that new individual organisms arise from both a paternal and a maternal influence, and from a line of ancestors every one of which had a similar bifold origin, modifies this first law of heredity only so far as to produce a more or less complex compound of hereditary reproductive tendencies in every individual; the effect of which must be analogous to that mechanical law of the composition of

[1] In the 'Nineteenth Century,' Jan. 1880, p. 96.

[2] 'Genesis of Species.' Macmillan, 1871.

[3] My attention was called to this analogy by my friend Dr. Gasquet.

forces resulting in the production of a new creature resembling its immediate and more remote progenitors, in varying degrees, according to (1) the amount of force springing from each ancestral strain, and (2) the compatibility or incompatibility[1] of the prevailing tendencies—resulting in an intensification, perpetuation, modification, or neutralization of ancestral characters, as the case may be.

All such action is but "heredity" acting in one or other mode; but there is another, and fundamentally different, action which has to be considered, and that is the action of the environment upon nascent organisms—an action exercised either directly upon them, or indirectly upon them through its direct action upon their parents. That such actions produce unmistakable effects is notorious. It will be, I think, sufficient here to advert to such cases as the well-known brood-mare covered by a quagga, and the peculiar effects of a well-bred bitch being lined by a mongrel. These show how an action exercised upon the female parent (but with no direct action on the immediate offspring) may act indirectly upon her subsequent progeny.

As a rule, modifications accidentally or artificially induced in parents are not transmitted to their offspring; as is well shown by the need of the repetition of circumcision, and of pressure of Indian children's heads and Chinese girls' feet in each generation. Yet there is good evidence that such changes are occasionally inherited. The epileptic offspring of injured Guinea-pigs is a case often referred to. Häckel speaks of a Bull which had lost its tail by accident and which begot entirely tailless calves. With respect to Cats[2] I am indebted to Mr. John Birkett for the knowledge of an instance in which a female with an injured tail produced some stump-tailed kittens in two litters.

There is evidence that certain variations are more apt to be inherited than others. Amongst those very apt to be inherited are skin affections, affections of the nervous system and of the generative organs, *e. g.* hypospadias and absence of the uterus. The last case is one especially interesting, because it can only be propagated indirectly.

Changes in the environment notoriously produce changes in certain cases even in adults. The modifications which may result from the action of unusual agencies on the embryo have been well shown by M. C. Dareste[3]. As has been already remarked, processes of repair take place the more readily the younger the age of the subject. Similarly it is probable that the action of the environment generally acts more promptly and intensely on the embryo than in the older young. That the same organism will sometimes assume

[1] Mr. Darwin tells us that two topknotted Canaries produce bald offspring, due probably to some conflicting actions analogous to the interference of light.

[2] See 'The Cat' (John Murray, 1881), p. 7.

[3] See 'Archives de Zool. expér.' vol. ii. p. 414, vol. v. p. 174, vol. vi. p. 31. also Ann. des Sci. Nat. 4 séries, Zoologie, vol. iii. p. 119, vol. xv. p. 1, vol. xvii. p. 243; and his work 'Recherches sur la production artificielle des Monstruosités ou essais de Tératogénie expérimentale.'

very different forms has been shown by Professor Lankester in the very interesting case of *Bacterium rufescens*[1].

It is also obvious that the very same influences (*e. g.* amounts of light, heat, moisture, &c.) will produce different effects in different species, as also that the nature of some species is more stubborn and less prone to variation than that of others. Such for example is the case with the Ass, the Guinea-fowl, and the Goose as compared with the Dog, the Horse, the Domestic Fowl, and the Pigeon. Thus both the amount and the kind of variability differ in different races, and such constitutional capacities, or incapacities, tend to be inherited by their derivative forms, and so every kind of animal must have its own inherent powers of modifiability, or resistance, so that no organism or race of organisms *can* vary in an absolutely indefinite manner; and if so, then unlimited variability must be a thing absolutely impossible.

The foregoing considerations tend to show that every variation is a function[2] of "heredity" and "external influence"—*i. e.* is the result of the reaction of the special nature of each organism upon the stimuli of its environment.

In addition to the action of heredity and the action of the environment, there is also a peculiar kind of action due to an internal force which has brought about so many interesting cases of serial and lateral homology which cannot be due to descent[3], but which demonstrate the existence of an intra-organic activity, the laws of which have yet to be investigated. Comparative anatomy, pathology, and teratology combine to point out the action of this internal force.

As to its action as exemplified in the homloogies of the Crustacea Mr. Brooks[4] makes the following remarks:—

"Special homology may be defined in two ways, morphologically and phylogenetically.

"From the morphological point of view an homology is a similarity in essential plan of structure, which may be obscured by differences due to diversity of function.

"From the phylogenetic point of view it is a resemblance which is due to community of origin or heredity from a common ancestor. . . .

"Now are the phenomena of serial and lateral homology like those of special homology in this second or phylogenetic sense, as well as in a morphological sense?

"On the assumption that the remote ancestor of the Crustacea was a community of independent organisms, all of which had inherited their organization from the same parent, we might answer that serial homology is like special homology when viewed from a phylogenetic standpoint; and if we assume that this series was at

[1] See 'Quarterly Journal of Microsc. Sci.' new series (1873), vol. xiii. p. 408, and vol. xvi. (1876), p. 27.

[2] In the mathematical sense of the word.

[3] Such *e. g.* as some of those noticed by me in a paper on the Fins of Elasmobranchs, Trans. Zool. Soc. vol. x. p. 439.

[4] W. K. Brooks in Phil. Trans. 1882; 'A Study of Morphology,' p. 57; and Serial Homology and Bilateral Symmetry in Crustacea,' p. 125.

first double, and that the progress of centralization suppressed one side of each metamere as the community became gradually fused into a bilateral organism, we may make the same statement regarding symmetry.

"A process of evolution of this sort is not impossible . . . . The Salpa-chain is a bilateral community, and in *Doliolum* we have a similar community which exhibits considerable polymorphism. If this process were carried a little further, we might ultimately have a bilaterally symmetrical organism in which corresponding parts in the series or on opposite sides should be strictly homologous by descent; but we are not therefore justified in assuming that all instances of serial and lateral homology have originated in this way, and even if we were, a more careful analysis will show that the assumption does not remove all the difficulties.

If we grant, for the sake of argument, that the Crustacea are not the descendants of *Nauplius*, but of a remote ancestor which consisted of a community of independent metameres, we shall still be forced to recognize a bond of relationship between the limbs of a Decapod, which is very much more recent than that which they owe to common descent from the parent of the group of Zooids which formed the ancestral community.

"The first, second, and third thoracic limbs of the adult *Lucifer* agree with each other, or are homologous, in certain features which are not present in a Schizopod. The exopodite is absent and the endopodite is long and slender in all of them, and it carries short hairs along its entire length, while in the Schizopod-larva the exopodite is present and the long hairs are restricted to the tip of the stout endopodite. We must therefore recognize a bond of union or homology between these three appendages which has determined that they shall be like each other in the adult *Lucifer*; and the assumption that this similarity is due to heredity from the parent of the imaginary metameres which joined together to form the primitive Crustacean, is out of the question, for we know that no further back than the Schizopods these appendages had quite a different structure.

"The study of serial or lateral homology in other groups of animals forces us to the same conclusion, and compels us to recognize a persistent bond of union between them which cannot be due to what we usually understand by heredity.

"On the assumption that the Vertebrates are the descendants of a community of metameres, the genetic relationship between a Man's arm and a Bird's wing must be almost infinitely closer than that between a Man's arm and his leg, and this again much more recent than that between his right and his left arm. The arm and wing inherit their homology from the anterior limb of the common ancestor of Man and the Birds; but Man's arm and leg have no common ancestor more recent than the limb of the parent of the imaginary metameres which gave origin, by their union, to the ancestor of the Vertebrates, and the common ancestor of the right and left arms must have been still more remote.

"When we compare Man's arm and leg we find that they have

homologous features which are not only more recent than the time when man's ancestors diverged from the ancestors of the birds, but more recent than the separation of the anthropoid and simian stems. They resemble each other in the texture of the skin and in the shape of the nails, and these resemblances are strictly homological, that is they are not due to external conditions, but in spite of them; and we meet with countless similar resemblances all through the animal kingdom. They are not accounted for by the 'metamere' theory, even if this is fully accepted, for in many cases they are not old, but are of recent acquisition.

"In the case of the Crustacea the assumption that the remote ancestor of the group had a many-jointed body does not account for them; and as the supposed necessity for an explanation of serial homology is the only reason for believing that this remote ancestor had a great number of body-segments, it is clearly illogical to reject the embryological evidence that this ancestor was a three-jointed *Nauplius* in order to hold an hypothesis which fails to account for the facts which are supposed to render it necessary."

It seems then to be undeniable that the characters and the variation of species [1] are due to the combined action of internal and external agencies acting in a direct, positive, and constructive manner.

It is obvious, however, that no character very prejudicial to a species could ever be established, owing to the perpetual action of all the destructive forces of nature, which destructive forces, considered as one whole, have been personified under the name "Natural Selection."

Its action of course is, and must be, destructive and negative. The evolution of a new species is as necessarily a process which is constructive and positive, and, as all must admit, is one due to those variations upon which natural selection acts. Variation, which thus lies at the origin of every new species, is (as we have seen) the reaction of the nature of the varying animal upon all the multitudinous agencies which environ it. Thus "the nature of the animal" must be taken as the cause, "the environment" being the stimulus which sets that cause in action, and "Natural Selection" the agency which restrains it within the bounds of physiological propriety.

We may compare the production of a new species to the production of a statue. We have (1) the marble material responding to the matter of the organism; (2) the intelligent active force of the sculptor, directing his arm, responding to the psychic nature of the organism, which reacts according to law as surely as in the case of reflex action, in healing, or in any other vital action; (3) the various conceptions of the artist, which stimulate him to model, responding to the environing agencies which evoke variation; and (4) the blows of the smiting chisel corresponding to the action of Natural Selection. No one would call the mere blows of the chisel—

[1] The existence of internal force must be allowed. We cannot conceive of a Universe consisting of atoms acted on indeed by external forces but having no internal power of response to such actions. Even in such conceptions as those of "physiological units" and "gemmules" we have (as the late Mr. G. H. Lewes remarked) given as an explanation that very power the existence of which in larger organisms had itself to be explained!

apart from both the active force of the artist and the ideal conceptions which direct that force—*the* cause of the production of the statue. They are *a* cause, they help to produce it, and are absolutely necessary for its production. They are a *material* cause, but not the *primary* cause. This distinction runs through all spheres of activity.

The *formal* discoverer of a new fossil is the naturalist who first sees it with an instructed eye, appreciates, and describes it; not the labourer who accidentally uncovers but ignores it, and who cannot be accounted to be, any more than the spade he handles, other than a mere *material* cause of its discovery. So we must regard the destructive agencies of Nature as a material cause of the origin of new species; their formal cause being the reaction of the nature of their parent organisms upon the sum of the multitudinous influences of their environment.

This kind of action of "the organism"—this formal cause—has been compared by Mr. Alfred Wallace, and by me, with the action of the organism in its embryonic development; and this, I have further urged, is to be likened to the processes of repair and reproduction of parts of the individual after injury, and this, again, to reflex action, and, finally, this last to Instinct as manifested in ourselves and in other animals also.

These relations of similarity appear to me to exist between Instinct and all the various other vital actions just enumerated. Instead, then, of explaining Instinct by reflex action[1] (as a reflex action accompanied by sensation), I would explain reflex action, processes of repair, and processes of individual and specific evolution, by Instinct—the wonderful action and nature of which we know as it exists in our own personal activity. These seem to me to be all diverse manifestations of one kind of activity of which Instinctive Action is the best type, because by it we can to a certain extent understand the others, whereas none of the others enable us to understand *it*. Instinct contains reflex action, but reflex action does not contain Instinct[2]. But instinctive action has a wider range still. The evolution of language, of literature, of art, of science, of politics, are also embraced by it, in so far as they take place without the intervention of conscious and deliberate intention; for no one can pretend that human progress in these various directions was at first evolved by any such deliberate and intentional action. Let us glance at some simple form of language to test the truth of this assertion, supposing a case in which a man and a brute are simultaneously stimulated to expression by the same influences, that we may more

[1] To attempt to explain Instinct by reflex action is an attempt to explain it by omitting its most eminent characteristic—its practically telic nature—its direction to a future, unforeseen, but generally useful end. It is like the attempt to explain the building of a house by bricks, mortar, bricklayers, and hodmen, omitting all reference to any influence governing their motions and directing them towards a predetermined end which is not theirs.

[2] Professor Carpenter informs me that in a paper of his on the Voluntary and Instinctive Actions of Living Beings (to be found in No. 132 of the old 'Edinburgh Medical and Surgical Journal'), read in 1837, he pointed out the essential similarity between Instinct and Reflex Action.

clearly see in what distinctively human language really consists. Let us then suppose a man and a brute to be standing under an oak-tree which begins to fall. The falling tree will produce similar effects upon the senses of both man and brute; both will instinctively fly from the danger, and both may cry out from alarm, and both, by their cries or gestures, may give rise to similar feelings of alarm in other men or brutes. Such language, whether vocal or of gesture, is *emotional* language only; but the man may do what the brute cannot do: he may emit the vocal sounds, "That oak is falling," and these words are the expression and embodiment of three universal abstract ideas:—

1. The word "oak" is a conventional sign for the idea "oak," and is a universal, abstract term applicable to every actual or possible oak. It denotes no single subsisting thing, but a whole group of things.

2. The word "is" denotes the most important of all abstract ideas—the idea of existence, or being. It is an idea (expressed in every human tongue) which we must possess in order to perform *any* intellectual act. It is an idea which, though not itself at first adverted to, makes all other ideas intelligible to us, as light, though itself unseen, renders everything else visible to us.

3. The word "falling" is a term denoting an abstract quality, and is evidently of very wide application, namely, to everything which may fall. Yet the idea itself is one single idea.

Thus all human language (apart from mere emotional manifestations) necessarily implies and gives expression to a number of abstract ideas. It is impossible for a savage to speak the simplest sentence without having formed such ideas for himself.

Is it then for a moment possible to suppose that any man deliberately invented language? Vocal and gesture signs are essentially conventional, and require comprehension on the part of those addressed as well as on the part of those who use them. Analogous considerations apply to the first beginnings of literature, art, science, and politics, which could not therefore have been consciously and deliberately invented.

The evolutions of these lofty forms of human activity are those cases of highest and most complex instinctive human actions before referred to[1], which can no more be due to "lapsed intelligence" than they can be accounted for by mere compound reflex action. To do more, however, than thus briefly to refer to these matters would be to wander beyond the proper scope of this paper. Its aim is but to call attention to the close correlation which exists between the various orders of vital activity which have been now referred to, and to throw out the suggestion that it is rather in "Instinct" than in any other of these various forms of activity, that the best and most apposite type of the whole group is to be found. Such I believe to be the case, whether it may or may not be expedient to devise some different generic term to denote the whole group of such correlated activities.

[1] See *ante*, p. 466, the first line.