THE AMERICAN CATHOLIC

QUARTERLY REVIEW

VOL. XVII.—JULY, 1892.—No. 67.

MATTER AND FORM IN BIOLOGY.

I.

THE human mind seeks for causes. To the student it is an absolute necessity, if his work deserves to be called study. Of this the vagaries of modern philosophy afford ample proof. It is true, that nearly all non-Catholics will sneer at an exemplar cause; will affect indifference to the final cause; that some will presume to question any First Cause; that most have not the slightest idea what material and formal causes may be; but all men who have not fallen to think only of phenomena have an interest in the efficient cause. The child asks what makes the grass grow, and just now men of science are asking what may be the immediate cause of the shape of organisms, either considered as units or as the sum of many parts, to each of which the same question applies. Why is the leaf of the maple five-pointed? What makes the serrated border of that of the elm? Why do we have five fingers and toes, and by what agencies are the ends of our hands and feet thus split up? Some would reply, that these are the effects of mechanical causes, not yet fully explained, by which growth is checked in certain parts and in others increased. Some, the so-called vitalists, would refer it to a vital force, which, acting from without on the organism, as do mechanical and chemical agents, has the property of bringing it into its proper shape. According to Scholastic philosophy, the form determines the structure, not, however, as an external force, but according to its nature as the life-giving agent to the matter of which the organism is composed. The very cells are not inert particles to be squeezed together or drawn out by forces ouside of them. Each lives and grows, not, however, as an independent individual, but as a part of the whole. Undoubtedly, the shape of each is dependent on the action of its neighbors. They may be pushed and pulled without injury, provided that the pushing and pulling are conducive to the arrangement that is characteristic of the parts they go to make in the organism. The form directs the development, but it makes use of the ordinary physical forces, chemical and mechanical. It is not impossible that the last clause may not always have been kept enough in sight, and the whole ascribed to the form. Such an answer is no longer (if it ever were) satisfactory. We want to know more. Those who admit the directing principle, still ask how it acts. Do purely mechanical forces take part in the process, and if so, to what extent?

Precisely what is meant by the mechanical system or theory, just now so much in fashion, is not quite so clear as could be wished. The underlying idea seems to be a protest against anything that is not mechanical, any vital principle, and, probably, any act of creation. Carried to its extent, it makes even reason and will the results of physical processes. It is not our province to expose the absurdity of such a system. We confine our discussion to the growth of organisms. Even in this narrower field the same want of clearness reigns. Some authors see only the work of mechanical forces. Others dwell on the wonderful adaptation of means to ends, showing, for instance, how admirable is the mechanism of the structures for support and motion, and in how close accord with the laws of physics. The height of their ambition appears to be to express this in mathematical formulæ. They see no evidence of design. If they do not say that the cause is mechanical, they put it aside altogether, concentrating their attention on the result. The mechanical system proper belongs to the former; the latter, though classed among its followers, can hardly be said to have a system at all. The real conflict is between the Scholastic system and Monism. Vitalism may be put aside. There is no evidence of any separate vital force. If there were one, it could not take the place of the form, and would be wholly superfluous.

It is our purpose to pass in review a number of biological phenomena, choosing by preference those of the human body, to see what light is to be gained from a study of the physical side of the question. We shall touch on many mysterious problems in passing, and suggest questions which we cannot answer.

Let us begin with the human thigh-bone. The shaft slanting upward and outward from the knee is joined above by a short neck which runs upward and inward. This, capped by a globe-shaped head, forms a ball-and-socket joint with the pelvis at the hip. In the adult, the angle formed by the neck and the shaft is, on the average, one of about 125°. At birth, the two parts of the bone are more nearly in line. The angle is about 160°. What is the cause of the change which subsequently occurs?

It is generally taught that the weight of the body in the erect position transmitted to the heads of the thigh-bones, tends to force the necks down, thus lessening the angle. Very strong evidence in favor of this has been brought forward by Professor Humphry.[1] He examined the bones of a child who lived some years with so enormous a head (a case of hydrocephalus) that it never could have walked. It is doubtful if it could ever have sat up. In this case the neck of the thigh-bone preserved its original infantile angle with the shaft, for the simple reason that it never was subjected to the weight which should have bent it down. The process is remarkably well stated by Humphry: "During development, pressure and growing force combine, in what may be called a harmonious antagonism to effect the desired size and form." To some extent, different parts of the developing body act on each other as external forces. When the bones of the vault of the immature skull meet along their edges each checks the growth of the other. Thus, very long heads are due to the premature union of the parietal bones in the middle line so that the growing force expends itself in a forward and backward direction. Returning to the hydrocephalic child, we find that the bones of the head are abnormally large. The reason is, that the fluid in the head kept them apart, preventing them from mutually checking each other's growth.

Thus we have two illustrations of the effect of the purely mechanical resistance of parts of the body on the development of other parts. But as we watch these and similar processes, we soon see that living matter reacts very differently from lifeless matter to certain mechanical influences. In the first place when the weight of the body has sufficiently bent the neck of the thigh-bone the process stops, except in unfortunate cases when the bones are wanting in earthy salts. The habitual bearing of weight will make the healthy bone stronger and more rugged than a life of idleness. It is a well-known fact that mechanical action from without which would wear away an inorganic substance will strengthen the growth of an organic one, provided, of course, that it be not excessive. Not only does muscle grow stronger by work, that is by overcoming resistance, but the points of its attachment to bone grow also. The raised line of its insertion, scarcely to be felt on a weak bone becomes a rough ridge on a

---

[1] *Journal of Anatomy and Physiology*, vol. xxiii.

strong one. This is brought about by mechanical forces, but it is not a purely mechanical process. Whatever is received, is received according to the nature of the receiver. It is by the vital principle[1] of the organism that forces which would otherwise be destructive become salutary.

Although we propose not to stray far from the development of the individual (ontogeny), we must refer to the fact that mechanical explanations are given of the changes occurring in the alleged ancestry of any species (phylogeny). Professor Macalister writes as follows in his "Text-Book of Human Anatomy:" "Mechanical environing conditions are the chief factors which determine and modify the growth of bones. Along the lines of pressure, bones become thickened and dense; along lines of tension, they become elongated and projected. With unilateral pressure, they become curved; with oblique and terminal pressure, twisted. These characters are hereditarily impressed upon bones, and we can even trace the outcome of ancestral experience in the directions in which the primary spicules are formed." Professor Cope[2] has attempted to explain the shape of bones by purely mechanical causes. He labors to show that both in the joints and in the length of the bones we see the results of gradual changes clinched by heredity. Whether acquired features are inherited is still a disputed point, but Professor Cope settles the matter thus: "if they are not inherited there is no evolution." This is true enough if evolution is necessarily brought about by the accumulation of minute changes. There is a system of evolution which does not require this impossibility. But let this pass. It is rather surprising to find that this author accounts for the lengthening of bones by two precisely opposite causes. He would have the long arms of apes arise by stretching from the weight of the hanging body, and again he accounts for the lengthening of certain bones in the hind limb of bounding mammals by the effect of repeated impact. If we admit this latter explanation, it is only another and an admirable example of the influence of the form, and of the difference between living and non-living matter. If pounding makes the bone grow, it can only be because the growing force is within, and its action is increased or modified by external conditions. In the same way the nature of the motion of one bone on another is said to determine the kind of joint between them. How can it do so if there be not in the parts, at the very least, a faculty of receiving adaptation, which is one of the characteristics of a living organism?

The internal structure of bone is not less interesting than the external. If we divide a long bone lengthwise we find that the

[1] We use the term "vital principle" as synonymous with "the form."

[2] *The Journal of Morphology*, vol. iii., 1889.

shaft is a hollow cylinder. Much greater strength is thus obtained than if the same amount of bone were moulded into a solid column. Towards the ends, the thick walls become thin. The cavity they inclose is filled with a network of bony plates and rods known as spongy-bone. If thin slices be made of this bone in the proper directions, it is found not to be a meaningless tangle but to present a well-planned architectural arrangement. This has been studied in much detail in man and animals. A much-quoted instance is that of Professor Culmann designing a crane, the stress lines of which corresponded very closely with those of the neck of the human thigh-bone. How has this distinctly purposeful structure been produced? To call it the work of chance is really too absurd. Let us suppose that a change has occurred in the surroundings of a certain animal which would make it for his advantage to have a longer neck for his thigh-bone. The longer neck, of course, requires a new disposition of the plates of bone within it representing the stress-lines. The reasonable way to account for the occurrence of such a change is that by a law of growth, in other words by the action of the form, these plates appear in their proper places, the change of outward shape and inward structure going on *pari passû.* It is not credible that the desirable change should have been brought about solely by the mating of animals somewhat more favorably built than the others, and the gradual accentuation of the advantageous peculiarities. Further it is incredible that by this process alone the longer necks of the femurs should always have the correct internal stress-lines. What a long series of generations would be required to perpetuate this piece of good fortune in the matter of only a single point in the animal economy! The race must in the meantime have dwindled almost to extinction, for the bones of those animals that did not have the luck to get correct stress-lines must have broken down from weakness, or have grown over heavy from an excess of incorrectly disposed bone.

Let us return from the origin of the peculiarities of the species to that of those of the individual. Assuming that the causes above mentioned may have modified the species, they cannot work in the embryo. Rotary motion cannot cause a ball-and-socket joint, nor angular motion a hinge joint, for the joints appear in the tiny limbs before the muscles that move them are fairly developed. As Macalister points out, the early-formed spicules of bone take the proper position. To account for this, heredity, that somewhat overworked *deus ex machinâ,* is invoked. That it has its share in the process we do not doubt, but it is that of a modifying agent. It cannot be a prime mover.

Here is another instance. Very abstruse calculations have been made on the calibre of the arteries; on the laws regulating the place for the giving off of branches; of the sum of the calibres of the branches compared with the calibre of the parent trunk; of the thickness of the walls; of the elasticity of the coats, etc.; showing in some respects most wonderful adaptations to the laws of hydrostatics. But when we watch the development of the early capillaries, we see nothing that points to any mechanical action suggesting, or corresponding to, that of fluid in motion. Certain star-shaped cells in the tissues enlarge; their slender prolongations join with those of their neighbors; the cell contents break down, leaving a cavity and forming the blood; the cavity enlarges, extending into the prolongations which become hollow tubes, and thus an early system of bloodvessels is formed. They grow larger and form systems according to a predetermined plan, but not always the systems of the mature animal. Though in the main the difference is due to the peculiar needs of the developing body, certain changes occur from unknown causes. Certain vessels are obliterated, and others persist without any advantage that we know of. Occasionally, a vessel that should be lost survives, or *vice versâ*, and we find what we call an anomaly of the arteries, which is usually easy to understand by one who knows the ground-plan. Very probably some quasi-accidental mechanical process has deflected a part of the current from its usual course, thus causing the decline of one vessel and the rise of another. Still, two facts stand forth clearly: 1st, that the plan of the bloodvessels is not the result of hydrostatic laws; 2d, that it is for future rather than for present needs. None the less at times purely mechanical forces may intervene. When a mammal first breathes the arterial blood which till then was shot from the pulmonary artery through a tube, the *ductus arteriosus*, into the aorta, rushes instead to the lungs. The useless, or rather the now dangerous, communication with the aorta is soon closed. The mechanism is thus explained by a recent German observer:[1] The first act of respiration changes the position of the pulmonary artery. The raising of the breast bone and the fall of the diaphragm change both the direction and the calibre of the duct. Folds appear inside it. Later its cavity assumes an hour-glass shape, and soon it becomes impervious. Schanz produced similar longitudinal folds in the duct by blowing up the lungs of an immature embryo. Assuming that this explanation is correct, we have here a distinctly mechanical process; but it would be stark madness to suppose that it was simply by chance that the parts were so disposed that this desirable action should occur thus opportunely. This must be the work of a principle presiding over growth.

[1] Schanz, *Archiv für Gesampt. Physiologie*, bd. xliv., 1888.

A very curious instance of the mechanical action of certain internal structures in determining the disposition of others, and also of the tolerance of the more passive parts to the action of the first, is furnished by the recurrent laryngeal nerves which supply nearly all the muscles of the larynx. The great pneumogastric nerve emerges from the base of the skull, and runs down through the neck and chest to the stomach. Shortly after leaving the skull it gives off the superior laryngeal nerve, which runs downward to the larynx, where it is distributed chiefly to the mucous membrane, but the main trunk passes by the larynx down into the chest without giving any other branch to the larynx. The right pneumogastric nerve passes in front of the subclavian artery behind the collar bone; the left one in front of the arch of the aorta, which lies deeper in the chest. At these points the inferior laryngeal nerves are given off. They curl backward under these vessels, and then run upward along the windpipe to the larynx, thus deserving the name "recurrent." Two things in this arrangement seem very peculiar: 1st, that the nerve to the larynx should be given off so late from the parent trunk that to reach its destination it must describe a long and apparently useless retrograde circuit; 2d, that if it is to make a loop at all, the left one should not turn under the left subclavian artery symmetrically with the right, instead of under the still more remote arch of the aorta. These two peculiarities have a common cause. At an early stage of embryonic life the heart lies under the head, from which it gradually recedes. Five arterial arches on either side are developed in front of it; that is, still nearer the head. These, which are generally regarded as corresponding to the arteries of the gills in fishes and amphibians, are called the branchial arches. The pneumogastric nerve runs before this system of arches, and as it passes the last one sends beneath it the inferior nerve to the larynx. As these arches descend lower and lower into the chest, the point at which the nerve gets free from the parent trunk is dragged down with them, and thus it happens that in the adult it has to retrace its course for several inches (in the giraffe it must be for several feet) to reach its sphere of activity. The want of symmetry is due to the fact that the arch of the aorta, not the left subclavian, is developed from the arch corresponding to the one which forms the subclavian on the right. A very apt confirmation of the truth of this theory is given by cases in which the right subclavian artery arises irregularly. In these cases the last two branchial arches on the right either disappeared early or were never developed. Thus there was no structure to pull the right laryngeal nerve down into the chest, and accordingly it leaves the pneumogastric, perhaps as two or three different bundles of fibres, as the main trunk passes the larynx and runs there directly. One could hardly imagine a more perfect demonstration of the theory that the origin of the nerve is drawn down into the chest by the artery. Yet the process is not a purely mechanical one. If in later life a man suffers from a dilatation (an aneurism) of the arch of the aorta or of the right subclavian, a common symptom is the paralysis of the muscles of the half of the larynx on the side of the disease. This is due to the injury to the nerve fibres as they curl under the artery; but the pressure to which they are subjected would seem to be far less, and the resistance of the nerve far greater, than when its hardly formed fibres were drawn so far out of place. In after life, when two structures are thus strained, one or both must suffer. In the embryo they pursue their remarkable course together, the artery does not destroy the nerve, nor does the nerve cut through the artery. The mechanical school might be tempted to reply that as this arrangement is by no means common to man but widespread throughout vertebrates, heredity has given it so firm a hold that it may be called natural; but the refutation is at hand in those cases in which the nerve does not form a loop, there being no vessel to pull it.

If we call into our service the microscope to give us a nearer view of what takes place among the elements of the developing body, we see signs of the mechanical effect of one tissue on another, and still more of a directing principle. The lung of the unhatched chick has long been a favorite object. First a single outgrowth from the gullet appears and pushes out into the surrounding tissue. Soon it divides into two tubes, one for each lung. These again divide and subdivide forming more and smaller lobules continually advancing, and destined to form the cellular lining of the bronchial tubes and air cells. But the surrounding tissue which is to form the connective tissues and bloodvessels of the lung is not idle. We see the newly-formed capillaries pressing against the epithelial cells. Two opposing forces seem to be meeting. Each triumphs at alternate points. There the epithelial cells rush forward against the vessels, and on either side the vessels rush in against the cells. Thus a wavy line is produced which grows more and more complicated as the air-cells are formed. Franz Boll[1] rejected the view that any one tissue should be considered the moulding one. He declared the process to be a conflict, and the result a compromise. From his description we see that all the elements of the tissues are alive; but what he does not tell us is that it is no blind struggle but an harmonious action presided over by a guiding and vivifying principle, the form. Were it otherwise, how slight an irregularity in the early processes would

[1] *Das Princip. des Wachstums.* Berlin, 1876.

distort the growth of the organ! How frequent, or rather how general, must be the occurrence of such irregularities were there no restraining influence! The plan of the lung would be hopelessly confused. That species should have any typical plan of lung would be obviously impossible. Evidences of this super-mechanical principle are rife, not only in normal development but under entirely different circumstances.

The artificial production in animals of monstrosities and deformities is something higher than scientific play. Dr. Wilhelm Roux undertook a series of experiments to ascertain to what extent the fertilized ovum, or even parts of it, could develop of itself; to what extent it depended on external influences. He found when a fertilized frog's egg showed on the surface a division into two halves, if one of these was injured in the proper way with a hot needle, that it remained undeveloped, and that the other half of the egg became, as the case might be, the right or left half of a tadpole. "This," writes Roux, "is certainly surprising; but what is wonderful is that at a later period the half which is entirely wanting is perfectly developed from the other. This can occur in the same way as in the regeneration of lost parts. The cells on the surface of the side of the body towards the defect increase and form such shapes that all that is wanting of the typical animal is replaced."[1] This is indeed analogous to the restoration of lost parts in animals low in the scale, and to the less perfect repair of injured parts in higher ones. It is only more striking. The more we study the process the more clearly we see that it can be accounted for by no purely mechanical system. It is fatal to the theory that each part of the body must be developed from a certain part of the blastoderm. It is fatal to any purely mechanical theory. It shows the agency of something higher.

What is this principle of growth? According to the scholastic philosophy it is the form. According to many scientists of the day it does not exist. Their efforts to get on without it are pitiable. Others admit frankly their ignorance. Thus Roux: "We do not yet know what forces are present in the fertilized ovum, nor how they are grouped, so that they are able to start the development of the individual. We do not know what combination of forces carry on this development. In short, we do not know *why* a typically formed highly complicated organism comes from a simple egg, nor why the organism thus formed is able, in spite of constant change of matter, to maintain itself for a long time comparatively unchanged."[2] As we have already implied, many have

---

[1] *Die Entwickelungsmechanik der Organismen.* Eine Festrede, 1889. Also Virchow's *Archiv.*, Bd. cxiv., 1888.

[2] Festrede, p. 5.

raised heredity into a kind of idol, attributing to it powers beyond its sphere. There is something almost pathetic in the way that a positivist anatomist appeals to it to explain the origin of the arrangement of the convolutions of the brain and at the same time admits the weakness of the explanation. "To sum up, as the morphogenic explanation of the folding of the surface of the brain, we are reduced to the commonplace formula that the hemispheres, passing through the various stages of their development, obey this *quid ignotum* called heredity which stamps each of our organs with its specific seal. The reader will admit with us that this is no explanation, and the formula in question can hardly satisfy a positive mind seeking not words but clear and precise answers."[1]

Very probably he would retort on us that the scholastic doctrine of the form is not a whit more satisfactory. Generations have laughed at the last act of the *Malade Imaginaire* when the hero replies in his examination to the question why opium causes sleep: "*quia est in eo virtus dormitiva.*" The sarcasm of the enthusiastic applause of the chorus: "*bene, bene, bene, bene, respondere*" was perhaps as much directed at the philosophy as at the medicine of the day. Professor His[2] parodies it in this connection. Such replies as ours to the question why protoplasm can develop into certain organisms amount to saying: "*quia est in eo virtus formativa.*" The comparison seems to us perfectly just. In neither answer is there the slightest explanation of the mode of action of the *virtus*, be it *dormitiva* or *formativa*. The difficulty is in the limitation of our powers. With many persons it is made greater by the error of confounding the imagination with the understanding. We recognize the truth of many things which we cannot represent to our imagination. For instance, it is certain that we see. It is easy to prove that matter pure and simple cannot see. Therefore there is something besides matter that is essential to sight. The fact that we do not in the least know *how* we see does not weaken the force of the argument. In the same way it can be proved that the doctrine of a form (or soul) by which animals and plants grow into their proper shape is reasonable, though we remain in ignorance of its *modus operandi*. The question is not in the least a new one in metaphysics, but the growth of the study of biology has brought it before a new audience and calls for its discussion from the physical standpoint. In the days of St. Thomas there were no means of studying the physical phenomena. Perhaps they were passed by too easily; but it is hard to judge justly in such cases. They were not ignored, for the scholastic system recognized fully the share of matter in the process; but they were treated

[1] L. Testut, *Traite d'Anatomie Humaine.* Tome ii., p. 476, 1891.

[2] *Unsere Körperform*, 1874.

from the metaphysical standpoint. At that time it could hardly have been otherwise. It is likely enough that advancing science will show us one mechanical process after another, and drive further and further back the super-material action, but it is safe to say that it can never be dislodged. It will be seen to act as a director of processes, even if all the processes themselves should prove capable of strictly mechanical statement. Professor His's theory of "imparted motion" may have a great future before it, but it will never free itself from the need of a directing principle. Indeed, this leader of embryologists in a recent paper of great value [1] declares his belief that all efforts to find in matter alone the solution of the problems of generation and growth must fail. He concludes as follows: "The interaction, according to law, of numberless individual processes makes every degree of development the result of preceding and the conditions for future degrees; but on our mind it makes the impression of that internal order for which even to-day the old definition of Leibnitz, pre-established harmony, is the most fitting." One is tempted to wonder whether aught but prejudice could lead such a man to see in this theory any superiority to that of matter and form.

II.

Let us turn to some of the difficulties, real or apparent, connected with this teaching. In the first place if there be a form, it is clear that it must act teleologically; that is for an end. As has been shown, the parts grow for a future usefulness. We do not see because at first useless organs in lower animals have luckily become eyes; but eyes develop in order that we may see. This, we know, is not the fashionable theory, but the impossibility of any fortuitous system has been so often shown that it is not worth while to repeat the refutations resting on the doctrine of chances. Still we are inclined to believe that teleologists have sometimes gone too far, and not they only, but others who see in shape only an adaptation to surrounding influences. Thus in old times we heard much of the perfection of organs and organisms which more accurate observation does not appear to have borne out. Wolff,[2] writing of the internal structure of bone declared that not only could the function be deduced from the shape, and the shape from the function, but that bones were made on the only possible plan. This is pure assumption. The vertebræ of an alligator are both without and within very different from those of a mammal. One, in short, is on the reptilian, the other on the mammalian plan. It

[1] *Zur Geschichte des Gehirns*, etc., Bund xiv., Abhandlungen der mathemat.—physichen Classe des Sächsischen Gesellschaft der Wissenschaften.

[2] Virchow's *Archiv.*, Bd. l., 1870.

is not proved, nor in our opinion is it likely, that the static and dynamic needs of the spine of the alligator could not be met by vertebræ founded on the mammalian type.

There is a projection called the third trochanter near the upper end of the thigh-bone, which is found well marked in hoofed animals with an odd number of toes, but which is wanting, or at most rudimentary in those with even toes. Thus it is met with in the horse and the rhinoceros, but not in the deer and the ox. Yet it is very hard to believe that the needs of the horse and rhinoceros are so similar, and so different from those of the deer and the ox, that it should be a necessity to the former, and useless to the latter. There are those who on such grounds unjustifiably attack the general principle of teleology. We on the contrary hold to it firmly. We merely say that it seems to us rash to apply it too strictly to details of structure, ignoring that there may be circumstances, heredity for instance, which modify the action of the form.

This brings us to certain phenomena which are claimed by the most extreme and least critical Darwinians as fatal to any non-evolutionary hypothesis. We refer to rudimentary organs, and to anomalies in which some feature that is normal in certain animals appears occasionally in man. Some of the rudimentary organs seem to admit of easy explanation; but some of the anomalies are most perplexing. This third trochanter in a case in point. It is found not rarely in the human thigh-bone. It is not due to the strain of muscles nor to particular occupations. It is found in delicate bones. It is found occasionally in savage races, among the individuals of which there was presumably no great difference in mode of life. Moreover it may be found in young persons, which proves that it is not the result of any long-continued habit or position. We have attempted to show in a preceding number of this REVIEW[1] and elsewhere, that many of the anomalies cannot be explained as reversions. Some of these animal peculiarities cannot be made to fit into any conceivable scheme of human descent. Still there must be a cause. What is it?

Modern Catholic writers seem to us to leave much to be desired in their treatment of this subject. Father Pesch[2] speaks of anomalies as mostly of a pathological character.

We do not think that this view is justified; but even if it were they none the less call for explanation. Father Harper[3] in a note

---

[1] Vol. xi., July, 1886.

[2] *Die grossen Welträthsel.* T. Pesch, S. J. Bd. ii., s. 237. It is to be regretted that this truly admirable work has not been translated into English, and is not more generally known. It is the subject of a very interesting paper, "The Battle of Theism," by the Rev. William Barry in the *Dublin Review*, of October, 1884.

[3] *The Metaphysics of the School*, vol. ii., p. 645.

accounts for rudimentary organs as follows: "But these physical facts offer no real difficulty, if we accept the doctrine of Aristotle and of the Angelic Doctor. They are the result on the matter of antecedent provisional Forms which have carried on the organization to its appointed term; and their arrest is due to the action of that higher Form which finally determined the specific nature." We shall not presume to discuss the vexed question of successive forms in the human embryo, nor shall we consider how far ontogeny is a true abstract of phylogeny; suffice it to say that if we admit both, the mystery of the occasional appearance in man of a peculiarity of a member of some distant side branch of the alleged genealogical tree still remains untouched. Professor Mivart in his excellent "Truth" says little or nothing of anomalies occurring in individual members of a species.

From anomalies to monstrosities there is but a step. We do not mean that they are of the same nature, but that it is often hard in practice to draw a sharp line between them. The subject is a vast one, which we shall not attempt to deal with. We shall refer merely to a few remarkable facts not easy to account for. If the tail of a lizard be properly cut or broken off, sometimes two, sometimes even three new ones will come in its place. If the forelimb of a triton be amputated the new one is said to have occasionally an additional finger. It would seem as if under certain abnormal conditions the form may act with excessive but ill-regulated energy. Such examples are most common among lower animals, but very extraordinary cases of reduplication of parts are sometimes found in man. Sometimes the hands and feet show not only extra fingers and toes but are clearly made by the fusion of two hands or feet on a single arm or leg. There is a very rare specimen in the museum of the Harvard Medical School illustrating this condition. It is a dissected left arm bearing seven fingers arranged as follows: First there are the four fingers of a normal left hand, but the thumb is wanting and at that side, there is a portion of a right hand bearing the little, ring and middle fingers. The hands are so placed in their fusion that the palms are on the same side, and that the line of union is between the forefinger of the left hand and the middle finger of the right. The forearm has two bones as is natural, but a glance shows that they are two ulnæ; that is, there is a doubling of the bone of the same side as the little fingers, while the radius, the bone of the thumb side, is wanting. In short, from the elbow down this man had a limb composed of the inner parts of two fused together. The origin of such deformities is extremely obscure. This is not the place to discuss the matter in detail. Suffice it to say that we incline to the hypothesis of an action analogous to that by which a multiplicity of lizards' tails is brought about. Should that be the case the question arises whether the matter or the form is at fault. According to the scholastic system the form does not err. Defects depend on the matter inasmuch as the form requires a proper disposition of the matter for its full and free action. In accord with this we may notice in the cases of the lizards and the tritons (perhaps also in this human arm) that the action of the form does not become erratic, so to speak, till the matter has suffered injury. Still why or how this should induce a reduplication is most obscure. If these questions are hard to answer according to the scholastic system we know of no other 'that makes them easier. It is quite as impossible that matter alone, without a directing form, should develop into the inner halves of two forearms fused together as into the normal limb. Other and, perhaps, still more puzzling cases might be mentioned. Nothing is further from our thought than to imply that the system of matter and form makes clear even the simplest of the problems we have before us. The point we wish to emphasize is that, though not clear to our imagination, this system is satisfactory to reason. There is no conflict between it and the observations of physical science. It shows that life is the result of an immanent force. External forces (counting as such the physical properties even of internal parts of the organism) can and do modify, but cannot originate. That the mode of action of the form is beyond us is not a defect of the system but the consequence of our limited powers. After all what process of physical forces even in non-living bodies can we claim to truly know and understand?

THOMAS DWIGHT.