

**Anatomy.** — "*On the Problem of Anthropogenesis.*" By Prof. L. BOLK.

(Communicated at the meeting of December 19, 1925).

Since the conviction began to make its way, that our form has gradually developed from another more primitive one, the study of this form has ever been of a more or less biased nature. The investigation into specifically human characteristics for their own sake, or an inquiry into the essentially morphological character of the human physical properties, was made subordinate to a study of these characteristics with a preconceived purpose. Considered as elements of comparative anatomy their value was tested for the construction of a pedigree for Man. The measure, by which that value was determined, was the greater or lesser correspondence to the degree of development of the characteristic under consideration in forms, that had been assumed beforehand as being more primitive. Comparative anatomy was studied with a certain tendency: genealogy and the problem of the descent predominated over the study of the form. Far be it from me indeed to deny the immense profit science has derived from the views obtained along this path.

But the one-sided application of this method implies a danger, viz. that the study of the form as a phenomenon and of its specific qualities in their interrelations, is somewhat neglected. But, you ask me, can it be worth while trying to understand the form of the human body apart from any hypothesis whatever of the descent of man? For there is no denying the fact that also the form of our body has been developed from a series of constantly changing forms, our primitive forms, and that, to confine ourselves to the Primates the series of forms in the phylogenic of the now living Primates must at some point in the part meet the line of descent of Man. I do not deny this at all, but two sides of the question should be kept distinct, viz. that of the structure of the primitive human form — this is the anatomical side of the problem; and secondly, that of the etiological factor by which Man obtained his present shape — this is the physiological side of the problem. It seems to me that one should begin by answering the second question, and must try to find an answer by studying the human form itself.

At variance with the methods employed, I purpose to discuss in the present paper the historical genesis of our actual form, entirely apart from any theory of descent. I was prompted to do so by the ever-growing conviction that the solution of this problem cannot be arrived at by applying the current methods. Just as it would be impossible for me to obtain a true insight into the degree of relationship, which undeniably exists between myself and every one here present, by comparing only our individual bodily characteristics, so would it be impossible to conclude

anything about the relationship between present-day Man and the other Primates now living by comparing our specific characteristics with those of the anthropoids or lower monkeys in existence at present. And the greater or lesser resemblance in form is no reliable index, because it is not of necessity a consequence of relationship, but may be effected by the same etiological factor, that has operated repeatedly. To exemplify this in a simple way, I will assume the possibility that in some of you, for instance, the lateral incisor of the upper jaw be lacking; this does not imply a closer relationship between the individuals concerned, but is the result of a cause having acted independently upon their individual development. Now that, which holds for individuals of one species, is also applicable to species belonging to a genus, and to genera belonging to the same family. Nobody indeed would consider the absence of a tail, or a thumb, in Primates as an indication of relationship; well then, why should we attach such great importance to the presence or the absence of a cusp on the crown of a molar? If Man possessed a dentition in which one might almost vainly look for variations, as in the case of some species of Primates, such a characteristic might be a trustworthy guide. But whoever has had the occasion to view the extraordinary variety in the cusps of human molars must be convinced that in this case the teeth are a most unreliable guide for any conclusions as to the degree of relationship. What criterion have we, moreover, upon which to base an assumption of relationship upon homogeneity of form? Absolutely none!

Furthermore, as it is impossible to deduce the individual properties of my own skeleton from those of the skeleton of one or more of my immediate ancestors, so is it impossible to deduce the specific properties of the human skeleton in general from skeletal remains of extinct types found by mere chance. For, just as every individual is a new creation, a creature *sui generis*, a result of heredity and individual genesis, so is every species a new creation in which what is inherited, is modified through the evolutionary factor, which I believe to be essential to life itself. Evolution is not a result but a principle; it is a function of life, it is for the organized world as a whole what growth is for the individual, but, just as in the individual development, it is subject to external influences.

Comparative anatomy can catalogue the structural differences between now living Primates and Man and the structural variations in paleontological objects; they can be arranged systematically like the words in a dictionary, and each new discovery means a lengthening of the list. But the richer the store of words becomes, the greater will be the possibility of constructing sentences with the aid of these words. Each new discovery increases the number of possibilities. And, although it may sound paradoxical, it is my firm conviction that the more numerous the discoveries of extinct forms, the more shall we be convinced of the impossibility of solving the problem of the genesis of the human form in this way. This does not in the least detract from the great significance of the

paleontological material in general for tracing the principal line in the historical development of certain groups, especially when these are characterized by a pronounced specificity. I merely wish to point emphatically to the inadequacy of this method for application to a form so little differentiated as that of Man.

Let us, therefore, abandon the deductive method used to lift the veil from the genesis of our form, and let us see if the application of an inductive method can serve our purpose better. To this end our form should not be the goal but the starting-point of our inquiry. Beginning with Man himself, we should, independent of any consideration of relationship, commence by answering the question: What is the essential of Man as organism, and what is the essential of Man as form? As you will see the character of my question is twofold, physiological and anatomical. We have to consider Man as a being and Man as a phenomenon. This does not imply a real contradistinction, but a methodological principle. For our bodily form is the result of our development, and this is a function of the organism. It will appear from my further argumentation that the same causality forms the basis to the essential of man as organism and as form.

Before proceeding to answer the above questions, let it be pointed out that the problem of Anthropogenesis, as I conceive it, is more comprehensive than it has hitherto been conceived to be, on account of the physiological element implied in it. Hitherto the anatomical side of the question was always put in the foreground, the appreciation of the somatic differences between adult forms of the Primates was the clue to a conception. I, on the contrary, will try to approach the solution of the problem along the physiological way, tracing the essentials of our form from the specific characteristics of our genesis and the character of this genesis as an expression of the specifically human as organism.

To trace how my present conception of the Anthropogenesis has developed in the course of time, I must go back to a short communication made more than 25 years ago, dealing with the observation of several anomalies in an adult man, which had all something in common. I found in this individual a number of anatomical peculiarities which occur transitorily in the normal development of the human fetus, but which had persisted in this individual. I described this case as a *curiosum*, without attaching to it a significance of a more general nature. It was merely a description. But now I wish to point to something that is psychologically remarkable; in my sub-consciousness the idea: „persistence of fetal characteristics” must have been implanted by this observation, and involuntarily it must have influenced my conception of specifically somatic features of Man. For in later researches the idea crops up repeatedly in one form or other. Thus, for instance, in a conclusion after an inquiry into the phylogenetic development of the human dentition, in which I demonstrated that our first permanent molar is originally a milk

tooth that has become permanent and is thus an infantile, i.e. temporary, organ which has changed into a permanent organ. Afterwards this idea took on a more distinct form in a comparative investigation into the position of the Foramen magnum in Man and in monkeys. Quite in accordance with the usual scheme, in which the monkey-skull is considered as the primitive one from which the human skull is derived, the current view was that the Foramen magnum in Man has shifted anteriorly in conformity to the erect posture. I came to the contrary conclusion : that the central position of the Foramen magnum in Man is the primitive one with all Primate-fetus, but that in the other Primates it shifts to the posterior pole of the skull, whereas in Man it persists in this position. Here the idea : persistence of a fetal condition was applied for the first time not as an individual variation but as etiological factor of a normal, specifically human feature. What was sub-conscious before, had now become an element of a conscious association. However it was only an isolated case as yet, there was no question of generalization of this causality. But no idea brands itself more strongly upon the human mind than the one that has been conceived as an objection to an existing conception. What in our mental mechanism was first a conclusion, becomes a touchstone for the possibility as to whether other phenomena may not be accounted for in the same way. Should this appear to be the case, the supposition arises whether perhaps all properties can be explained from this new point of view ; further investigations raise this supposition to probability, criticism leads to certainty, and along this path a causal principle develops in our mind from a conclusion.

And in this way, in the course of years, the idea : persistence of fetal characteristics, from being a simple characterization of an observed condition has become to me the basis for a comprehension of the human somatic form. For our essential somatic properties, i.e. those which distinguish the human body from that of the other Primates, have all one feature in common, viz. they are fetal conditions that have become permanent. What is a transitional stage in the ontogenesis of other Primates has become a terminal stage in Man. His smooth skin, the form of his skull, the central position of the Foramen magnum, the shape of his ear, his unpigmented skin, the presence of labia majora, the structure of hand and foot, etc., all these can be also observed as temporary conditions of the fetus of every Primate, but get lost in the further individual development, being succeeded by other conditions. This is why the fetus of monkeys has in general a much more human aspect, not, as would follow from an application of the biogenetic law, because monkeys are descended from more man-like ancestors, but because man has preserved the fetal type up to his adult state. The morphogenesis of the other Primates goes further than that of Man. This difference between men and monkeys I will indicate by characterizing the development of Man as conservative and that of the other Primates as propulsive.

The recognition of this fact could not fail to alter entirely my conception of the relation between the human somatic properties and those of the other Primates, but at the same time, and that means much more, it was sure to bring about a change in my views regarding the causality of Anthropogenesis.

For, as regards the first point, I was now able to answer the fundamental question propounded at the outset of this paper: What, then, is the essential in the anatomical characteristic of the human form? The answer is: The fetal character of his form. And this opens up a point of view upon that form and its genesis quite apart from any consideration of relationship or pedigree-construction, as it appears that we need not of necessity deduce the specific properties of our body from those of other Primates. For where present-day Man may be bodily considered as a Primate-fetus that has become sexually mature, our ancestors already possessed all our specific properties, though only as temporary developments, by way of transitional stage. This is the principle of what I term the *Fetalization-theory* of Anthropogeny.

As stated before, this understanding of our form brought about an essential change in my conception of its genesis, and that in two respects.

When all the characteristics of Man have something in common, it is not conceivable that they should have originated independently of each other, each from a cause of its own. Like effects must result from a common cause. The body as a whole was transformed because its development stopped at a younger stage, a process that was brought about gradually of course. The cause must therefore have operated uninterruptedly for a period of time that cannot be determined approximately. But from this it follows again that this fetalization cannot have resulted from external influences acting upon the organism. It was not the effect of an adaptation to modified external conditions, it was not brought about under the influence of a struggle for life, it was not the result of natural, or sexual selection, for these evolutionary factors exert their influence not on the body as a whole but in a more limited way, on circumscribed parts of the organism. Thus the etiological factor of the process must have been an internal, a functional one. In short, an anthropogenesis as consequence of a single, organic principle of development. Anyone conversant with the tenor of the current theories on this point will readily understand the difference between the point of view I have gradually come to adopt and the principle of these theories. An elaboration of my theory would have to commence by dividing the human properties into two groups, viz. primary and consecutive properties. As an instance of the former, I might mention Man's glabrate skin; of the latter, the strong differentiation of the muscles of his face.

The human form, thus, as the effect of a single, functional cause. What can have been the nature of this cause?

When fetal qualities or conditions become permanent, this must be due

to an influence that prevents these qualities from reaching the proper degree of development; they remain in a transitional stadium, more or less removed from their original terminal stage. Consequently a restraining influence must come into play. Thus we can look upon the human form as the effect of a general restraining of development.

When this had once become clear to me, the question naturally arose as to whether this functional principle applied only to the development of the human form, because the morphogenesis, as I have already pointed out, is only one of the functions of the organism. What about the other functions?

On further consideration of this problem it gradually became clear to me that the restraining principle put its stamp not only on the morphogenesis, i.e. not on the developmental progress alone, but on the entire individual life-progress of Man. When we compare Man in this respect with the other Mammals, and particularly with the Primates, we perceive at once that there is no Mammal that grows so slowly as Man, and not one in which the full development is attained at such a long interval after birth. And, though on this point no time-data are at our disposal, it is nevertheless sure, that the organisms nearest to Man, the Anthropoids, are also far behind him as regards the duration of their prime period. This slow development, this protracted maturity, is eventually succeeded by a phase of decay which again proceeds more tardily than in the case of any other Mammal. I cannot go into a detailed argumentation and must confine myself to general remarks, as I must get to the point I am aiming at and my final conclusions as quickly as possible along the main lines of my theory. But what has just been said furnishes us with a startingpoint from which to answer the second question: What is the essential in Man as an organism? The obvious answer is: The slow progress of his life's course. Again I cannot produce special evidence for my assertion that this slow tempo is the result of a retardation that has gradually come about in the course of ages. This I will term the *Retardation-hypothesis* of Anthropogenesis. This retardation is demonstrable on historical grounds. Rather more than a year ago I demonstrated in a communication read before this assembly that, for instance, prehistoric Man, *Homo neanderthalensis*, developed at a more rapid rate than *Homo recens*. Another proof of this retardation is the fact that not all living races of the genus *Homo* have an equally retarded course of life. Furthermore this retardation accounts for a number of remarkable facts, and in part also for contradictions in the functional development of the human organism. But of all this I must not speak, though to my extreme regret, for you can well imagine how keen a delight I should take in reviewing Man in his form and in his nature in the light of these principles.

So it is evident that, with respect to his form and his organism, Man is distinguishable by a very particular characteristic, viz. the essential in his form is the result of a fetalization, that of his life's course is the result of

retardation. These two facts are closely related, for, after all the fetalization is the necessary consequence of the retardation of the morphogenesis. Anatomically this effect is brought about in two ways, namely, it may be that a fetal characteristic persists, because, as is demonstrable in other Primate-fetus, its disappearance is delayed to a later phase of development, until at last it remains constant. As an example of this I may refer to the *labia majora* of the woman. Also in the lower Primates we find rudiments of these pudenda, but very early they disappear here; in Anthropoids they also disappear, but not entirely until after birth; in Man finally they persist. Here, then, we see the disappearance of a fetal characteristic, first retarded, then lacking. The second way in which, anatomically, the form is fetalized through retardation is of more frequent occurrence. As an example I shall take the hirsuteness. In the fetus of the lower Primates the hairy coat is present at a comparatively early stage. In that of the gibbon the development is already retarded, the neo-natus has hair only on skull and dorsum, the belly is bare or but slightly covered with hair, the hairy coat appearing after birth. With anthropoids there is hair only on the skull of the fetus, just as is the case with Man, for the rest they are glabrate, and acquire the hairy coat only in the course of the first half-year of life. The breast of Gorilla remains glabrate throughout life. In Man, finally, the skull only is covered with hair, and for the rest the fetal skin remains glabrate. Here, then, the retardation has reached its maximal intensity, i.e. a standstill, and has ended in elimination of a characteristic.

I need hardly emphasize that the above exposition of the process of Anthropogeny is still incomplete. I have set forth how Man originated through a modification — a retardation — of the common life's course which entailed a fetalisation of the form of his body. But we have now to consider the final question: What was its immediate preceding cause. I purposely say its immediate preceding cause, for the possibility of this cause, whatever it is, being spontaneous is a priori precluded. This cause also must have been the effect of a preceding one, and the anthropogenesis itself must ultimately be considered as a symptom of the evolutionary principle of life. Indeed, I have already suggested that, in my opinion, evolution is an inherent function of life as such, of organism itself; to inquire into its cause is equivalent to seeking for the nature of life itself.

My answer to the question I have propounded shall be brief: The gradual retardation of the life's course of the ancestors of Man with all the consequent effects, both as regards his morphological features and his functional properties, must have had for its immediate cause a modification of the action of the endocrin system of the organism. This system built up of a number of organs distributed over the body, regulates the metabolism.

During the first phase of our life it governs the morphogeny, later the

maintenance of the form. Again I must pass over in silence how our body with its multiplicity of properties develops through the action of the hormones, secreted by these organs. This would furnish material for a separate discussion. Suffice to say that in controlling the intensity of the metabolism these hormones can inhibit or promote the growth. In Anthropogenesis an inhibitive action appears to have gradually increased in significance, the rate of development became slower, the progress of development more retarded, and this influence revealed itself as much with regard to the development of the organism in toto as with regard to the genesis of separate morphological properties.

Though all this brings out the great significance of the endocrin system for the genesis of our form, it does not by any means open up a new biological vista. For already numerous experiments have shown us that in lower forms a retardation or acceleration of development can be effected by the addition of hormones to the food. In this connection I may remind you of the discourse held by our fellow-member VERSLUYS a few months ago at a meeting of our Academy. But now I utilize this fact, as biological basis for the historical, normal development of a form so eminently differentiated as that of Man from his primitive parents, and use it as a starting point for the solution of the highly important problem of Anthropogenesis. In passing I wish to point out that fetalization is, therefore, related to the phenomenon known in biology as Neoteny.

Time is lacking for me to bring forward any special argumentation. Moreover, this would lead me into the field of embryology and comparative anatomy, which would divert your attention from the present subject. But the above-mentioned principle of my theory of Anthropogenesis viz. that Man's development is acted upon by a retardation that originates in the endocrin system, I feel impelled to substantiate by some evidence. This I shall take from the domain of pathology. Congenital malformations of our body are not rare. Now it is very remarkable that all these congenital anomalies observed in Man are the consequence of a retardation of development. The pathologic in all these cases, therefore, is to be considered as the consequence of a locally too intensive action of the normal regulator of the rate of development, which prevents a regular and full accomplishment of a morphological property or characteristic. I do not know of any instance of the opposite kind. Of the very long list of congenital anomalies in Man I could not name one that might be interpreted as a consequence of an accelerated development, i.e. through the absence or lessening of the inhibitory factor. But ..... and this is undeniably extremely interesting ..... such instances are to be found in the post-natal phase of our existence.

Briefly, let me express it thus: our endocrin system secretes inhibitive hormones (which, strictly speaking, is a *contradictio in adjecto*). The properties suppressed in the anthropogenesis under the influence of the historic inhibition are still present in a latent condition, and must remain

suppressed all through life. So we preserve in us some properties of our ancestors, but checked. What happens in case one or more organs of our endocrin system are diseased and in consequence the normal production of hormones disturbed? Then the inhibition ceases or weakens, and properties which had been lost in the course of ages will appear again, or functions which were retarded will develop in an abnormally rapid tempo. Do you desire instances? Man has lost his hairy skin, i.e. the growth of hair was first retarded, then suppressed. When the endocrin system is diseased, the inhibition may cease and the hairy coat reappears. One group of the human race has lost the pigment in the skin. Now with affections of the endocrin system it may reappear, the production of hormones which suppress the development of these properties is disturbed. During Anthropogenesis the jaws of Man have become relatively smaller in compass as well as in size, because fetal conditions became more and more permanent; if the endocrin system becomes diseased, the inhibition ceases and the jaws — and not infrequently the supra-orbital ridges also which are governed by similar conditions — begin to enlarge again, and become stronger. Contrary to what occurs in the other Primates the sutures of the human skull do not close after the brain has attained its definite size. They persist, their obliteration is inhibited and is established sometimes only in old age. The endocrin system becomes diseased, one of the symptoms being the possible premature closing of one or more sutures and consequent cranial malformation. This goes to show how a number of what we may call "monkey-like" properties may be present in us in a latent condition, waiting only for the disappearance of the factor that suppresses them to appear again. Let these few examples suffice to show that pathology also can furnish evidence which confirms the biological principle of anthropogenesis brought forward here. But let me add one more instance of a more functional nature. Together with the retardation of the process of Man's development the commencement of the functioning of the genital glands is delayed to a later age, i.e. its commencement is checked for some time. The endocrin system becomes diseased, and as an effect premature sexual maturity may occur, the inhibition being absent. But enough of this so productive subject, for I must draw to a conclusion, but wish first to present to you, though briefly, two new points of view.

The first is the biological relation of the human races inter se and to the other Primates. The human form, then, has arisen from a fetalization-process. But the developmental progress has not been the same with all mankind, nor has fetalization equally affected all races. For instance, the typical physiognomy of the Mongolian race, with their flat nose-bridge and the so-called Mongol-fold of the eye, is a fetalization effect that does not occur in the white race. Yet this, as I believe, has been retarded and fetalized most, it has covered the longest distance on the path of anthropogenesis, it is the most human. But it is possible for all other races to reach

the zenith of development now occupied by the white race. The only thing required is continued progressive action in these races of the biological principle of anthropogenesis. In his fetal development the negro passes through a stage that has already become the final stage for the white man. Well then, when retardation continues in the negro too, what is still a transitional stage may for this race also become a final one.

As to the relation of Man to the other Primates, each Primate passes in his fetal life through a stage that has become the final stage for Man. Thus, in every Primate, if the retardation principle but begins to operate, lies the possibility of resemblance to the human race. To my regret the time fails me to show you in what respects this is already the case with the anthropoids.

Do you perceive how the theory propounded here alters fundamentally our view of the relation of Man to the other Primates ?

The second point of view that I still wish to discuss concerns the question of the relation of our endocrin system to the rest of our organism.

The said system is very complicated, the complex of the endocrin organs regulates the metabolism by the production of hormones. How that regulation is effected we do not know, for the terms stimulation or excitement, and inhibition or suppression are only indications of the character of the effect of the action. But with regard to its *function* I would draw a parallel between this system and the central nervous system, and *with regard to its relation to the whole organism*, a parallel between this system and the genital glands. The central nervous system also consists of a number of organs. But we have to confess to great ignorance of the associations and the co-ordinations existing between these organs. We see the effect, however, and this is always a result, but one which we have not learned to analyse. It is the same with the endocrin system. Here also a result of the functioning of a great number of organs, but the part played by each of them we do not know. Just as in the central nervous system there is not a single effect to which all the organs do not contribute, or have not contributed, directly or indirectly, so is it also in the endocrin system, the function of which is to be considered as an instance of ideal co-operation. This raises the biological significance of our endocrin system above that of a system properly so-called, it is of itself an organism, an imperium in imperio, it regulates and governs. The effect of this action is first the genesis of the form and then its maintenance. In view of this important role I would designate the whole complex of organs performing this part by the term *Endocrinon*.

Now I can draw my parallel between this and the other above-named constituent of the organism : the genital glands, or the so-called germa. For the germa is to the species as the endocrinon is to the individual. Just as the germa determined the origin of the species and ensures its maintenance, so the endocrinon serves to maintain the individual, after having governed his genesis.

Gentlemen, I have had to make severe demand upon your attention, the more since my exposition had of necessity to be compressed within a narrow compass, which may have rendered it somewhat difficult to follow. But it was no easy matter to set forth clearly, in a limited space of time and in logical context, the result of many years' speculation and investigation of such a comprehensive subject as Anthropogenesis. I might have taken some subdivision of this subject and have discussed it at more length, bringing evidence to support my assertions, but I preferred to give you an outline of my train of thought as it has gradually taken form in the course of years. I shall consider myself amply rewarded for my trouble if I have succeeded in awakening a vague conviction that the solution of the problem of Anthropogenesis must be looked for in quite a different direction from the one hitherto followed, and that the problem of the racial relations of Man is not the same as that of the development of our form.

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