VERHANDELINGEN DER KONINKLIJKE NEDERLANDSE
AKADEMIE VAN WETENSCHAPPEN, AFD. NATUURKUNDE
TWEEDE REEKS – DEEL LVII, No. 1

INTRODUCTION TO THE PHILOSOPHIC BACKGROUNDS AND PROSPECTS OF THE SUPRASPECIFIC COMPARATIVE ANATOMY OF CONSERVATIVE CHARACTERS IN THE ADULT STAGES OF CONSERVATIVE ELEMENTS OF VERTEBRATA WITH AN ENUMERATION OF MANY EXAMPLES

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AMSTERDAM – 1966

AANGEBODEN SEPTEMBER 1965
GEPUBLICEERD MEI 1966

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I

PREFACE

For many years in succession the author opened his university lectures on the morphology of the Vertebrata and larded the introductory lectures to each of the various chapters with comments on the theoretical part, the theoretical background and the theoretical prospects of the various subsciences of modern morphology. As to these subsciences, we think of analytic anatomy, systematic anatomy, topographic anatomy, the comparative anatomy of structural elements, functional anatomy, oecologic morphology, structural morphology ("Bauplanmorphologie") and ontogeny.

This publication contains that part of the subject matter of my lectures which applies to the theoretical aspects of comparative anatomy of structural elements of the Vertebrata (in the development of this discipline up to modern times, but based on the original delimitation). In many places, however, the text has been extended and amplified.

The idea of lecture-notes has been maintained, which renders a textbook-like character to this treatise. By this is meant that the author's insights form the basis of this treatise without a justification being given on the ground of literature and without critically going into different views. As far as appears necessary, the sources of literature have been given in a list of literature, in which reference-words refer to these subjects.

The enumeration of examples, which, however, have not further been developed, has also been maintained with the numerous subjects mentioned of theoretical importance. Several times the same example has been mentioned at many places. This is mostly connected with the theoretical value of different aspects of such an example, but now and then it also serves to illustrate divergent theoretical insights. Discussions of these examples, as well as references, have been omitted. They can easily be found back by consulting a somewhat more detailed textbook on comparative anatomy; for the students at the University at Leiden the majority of them had been borrowed from the Dutch Textbook on the Comparative Anatomy of Vertebrates ("Leerboek der vergelijkende ontleedkunde van de Vertebraten"), the last edition of which (1947) was under the editorship of J. E. W. IHLE.

The choice of this branch of morphology as the contents of this treatise and the restriction to this branch were made for various reasons.

In the first place, in comparative anatomy nowadays, many data resulting from a wide and general comparison are collected, without there being sufficiently accurate and critical supervision to see to it that the comparated data really are of equal character (whether compared morphological structural elements, or compared functional components, or compared adaptations). Heterogeneous results are combined, so that the data may be valuable and reliable, it is true but they do not fit in with a "construction" of a certain style, which indeed every subscience means to be.

In the second place the author was of opinion that he should discuss the kernel of comparative anatomy as it has been understood for years, *viz.* as the "comparison of elementary structural elements". Holding on to this the task was, to show and to develop their theoretical backgrounds.

In the third place, by doing so the author has been able to draw the attention again to the very special theoretical backgrounds of the so-called "factual character" of this comparative anatomy. Here again it proves to be true that theoretical reflection is necessary and valuable when there is a growing doubt as to the theoretical backgrounds of a discipline, the development and the aspect of which are in a critical situation (likewise there is a need of theoretical reflection in the case of new rising subsciences).

In the fourth place we have restricted the subject matter of this treatise to the problems concerning the Vertebrata, firstly because this domain is usually treated by itself and secondly because in this domain there is the most agreement about what may be called an elementary structural element.

In the fifth place the theoretical backgrounds and prospects of other domains of comparative anatomy will not be discussed in this treatise. This applies to a comparative anatomy of elementary structural elements of Evertebrata-groups; it also applies to a number of subsciences of morphology which have become modern again, such as functional anatomy with oecological morphology, and structural morphology, which in their turn have their influence on ontogeny. An important part of these subsciences is highly developing.

II

INTRODUCTORY REMARKS; THE TERMS

In this introduction to the philosophic backgrounds and the philosophic prospects of the supraspecific comparative anatomy those only in the sense commonly used in a rather long post-darwinian period will be treated. This means that the "supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements" will be treated. These "conservative elements" are the "constituting ground elements in the architectural constitution" of the body. These "conservative elements" show a number of characters, part of which are specific, part of which are conservative characters, peculiar to a more or less large systematic group. We may learn the nature of these elements and that of the characters of these elements by a comparative study of a group of allied and related species, genera, etc., and by such a study of the descendants of an allied group.

In this branch of morphology we deal with adult stages, but also with senile stages, with youth stages, with developmental stages, sometimes even with very young larval and embryonic stages.

The comparative anatomy in this sense (of conservative characters of conservative elements) is highly developed as regards the Vertebrata, less highly developed as regards the Evertebrata with the exception of a few scattered systematic groups (Mollusca, etc.) as in many systematic groups of Evertebrata we are uncertain as to the common architectural ground plan and the limits and boundaries of the conservative elements.

III

THE DEFINITION OF THE NOTION ANATOMY AND OF ALLIED SUBSCIENCES; THEIR NATURE, CHARACTER AND LIMITATION

III, 1. Introduction

In the expression "supraspecific comparative anatomy of conservative characters of conservative elements" the word "anatomy" has a restrictive meaning. The same is the case with related notions, such as morphology, eidonomy, etc.

Each definition has a practical aspect, a historical aspect and a purely logical aspect. In relation to the purely logical aspect, we may distinguish three types of definitions:

(1) the name-definition ("Nominaldefinition");
(2) the positive or contents definition ("Inbegriffdefinition");
(3) the negative or limiting definition ("Begrenzungsdefinition"), to which are joined especially:
(4) the definitions on the basis of a system of sciences, which system entails a positive as well as a negative definition.

Also in these cases difficulties may present themselves in the delimitation and in drawing the right lines. These difficulties may be caused by incapability of the faculty of thinking, but they may also be caused by the existence of transitory domains. At every bifurcation and limitation we have to do with problems of separation and connection.

III, 2. A general notion of anatomy, morphology and eidonomy, according to its history

The name-definition ("Nominaldefinition") of anatomy speaks of analysis and means dissecting or the science which becomes possible by this dissection and by the art of dissection or the technique of dissection and the skill to separate the various parts of an organized body with a knife, a pair of scissors, etc. In certain developmental stages of scientific thinking the name-definition ("Nominaldefinition") may indicate a difference between "art" ("Kunde") on the one hand and on the other hand terms ending in "logy" ("Logik"), indicating branches of science. Formerly those disciplines to which no really scientific character (episteme, scientia) was assigned, were designated by "art". However, the domains of knowledge that were distinguished as "art" were given a higher standard than the lowest degree of knowledge. In those days, the lowest degree of knowledge was attached to:

(1) pure experience of the senses;
(2) the knowledge of the individually-material and therefore continually changeable thing;
(3) pure knowledge of facts.

Nowadays "art" ("Kunde") and "logy" or science are no longer distinguished in this way. The terms are used in the same meaning.

If now we look at what the name-definition ("Nominaldefinition") of anatomy implies apart from the terms "art" ("Kunde") and "logy" or science, we must come to the conclusion that on the one hand the term "dissection" is too narrow and leaves too little space, while on the other hand its meaning is too wide and allows too much space;

(a) too little: there is also anatomical investigation by means of X-rays, otoscope, laryngoscope, etc.;
(b) too much: there is also functional investigation of the internal parts by opening the abdominal cavity, etc.

Later on we shall see that with the term anatomy we should not think of mechanical or optical distinctions, but of analysis by our thinking, so not of a technical, but of a methodical distinction.

The name-definition ("Nominaldefinition") of morphology speaks of a science of the "form", but not all that can be said in science about "form" is classed under morphology, for in other subsciences, too, characteristics of the form are treated in a special scientific way (as is done in systematics, cytology, histology, in the doctrines on variability, heredity, speciation, in phylogeny, autoecology, pathology, etc.). For Goethe the term morphology had a different import; for him morphology was a synthetical counterpart to analytical anatomy; nowadays morphology is of equal significance and import as anatomy.

The name-definition ("Nominaldefinition") of eidonomy says: the rules of outward appearance, in other words: eidonomy is the art or the science of the form, etc. of an animal's exterior, of the outwardly visible parts of the body. As such can be distinguished: (a) the body as a whole, (b) the divisions of the body or the parts of the body, (c) the regions of the body, (d) the subdivisions of the divisions of the body and finally (e) appendages (these appendages may be appendages of the body as a whole, appendages of the separate divisions of the body and appendages of subdivisions of the separate divisions of the body), as well as parts of all conceivable appendages, etc. *(Note 1)*.

For a more exact definition of anatomy, morphology and eidonomy it is necessary to give not only the name-definition ("Nominaldefinition"), but also the positive or contents definition ("Inbegriffdefinition") and the negative or limiting definition ("Begrenzungsdefinition"), as well as the definition on the ground of a system of subsciences of biology. These definitions indicate positively and negatively what must be understood by anatomy, morphology, eidonomy, etc. And as the point is here: the data about the form, etc. that are classed under the subsciences of biology, it will be necessary to say what is a natural science and, more in general, what is a science. So it will be necessary to say positively and negatively what must be understood by a science, what by a natural science and by a branch of science, what by biology and what by that subscience of biology which is concerned with the problems and the scientific data about the form, etc.

III, 3. The notion and the definition of science in general

It is especially the positive or contents definition ("Inbegriffdefinition") we are interested in here.

As for a positive definition of science in general, we want to pay special attention to the specific elements in anatomy, morphology, eidonomy, etc.

If we take science in the meaning of the "factual possession of objective knowledge", it must be established that also in modern times opinions greatly differ in this respect. The differences of opinion among the authors are such questions as: does science comprise generalities only, or also particularities (*e.g.* form-aberration); does science only summarize, or also specify (*e.g.* the specific adaptations to the erect walk); does science comprise only general views, or merely laws (*e.g.* growth laws); does sciense comprise certainties only, or also probabilities; does science bring knowledge of causation only, or also other knowledge (*e.g.* in the domain of ordination, of fitting together); does science merely give knowledge which can be formulated mathematically, or also other knowledge, etc.

We will give a wide definition of science here. In our definition we especially subscribe to the definition given by E. Becher (1914), to whom the notion of science especially applies to natural science(s).

A definition of science may then be: science is the complete whole of the multitude of human knowledge, logically and objectively planned in a "growing" system, constituting a coherent whole, showing a unity, containing (a) the truth or truths (with its true notions, true judgments, both judgments of "being" and judgments of "value" and true conclusions), (b) the probabilities, (c) the questions and problems, with (d) the researches and motivations (argumentation) belonging to these questions and problems and connecting them, all these refer to one and the same object, respectively to one and the same multitude of objectively connected and mutually coherent objects, laid down in words and formulas which exclude all misunderstanding.

In illustration of this definition some remarks and elucidations may follow here.

The "complete whole" included in this definition, has not been realized, but has only been made a demand.

The term: the "logically and objectively planned, 'growing' system" means to express that the planning in the first place makes knowing and knowledge into a science. By logical planning is meant that the planning follows the principles of logic and by objective planning is meant that the planning conforms to objects of the science in question (to the "Beschaffenheiten der Gegenstände der Wissenschaft") and not to the alphabet or to the size, nor to a different science. The latter, however, is permissible, if some author should want to reduce the science concerned to that other science, or derive from that other science, as can be the case with physiology from physics.

The term "growing", accompanying the word "system", means to indicate that science carries the notion of adding and reducing, hence of a "process". Science is a growing, not finished whole and as such it is sometimes but in contrast to a "doctrine", in which knowledge is thought to have reached a finished, fixed whole.

"Knowledge" in the definition of science means to express in the first place that knowledge is more than experience with regard to facts. Knowledge is the result of thinking about the facts, so the result of our thinking about the contents of our knowledge. "Knowledge" is more than "just knowing". "Knowledge" and "sure knowledge" have subjective and objective validity.

Next to the logical side of our knowing, our knowledge and science, is the psychological side; in it the question is asked how knowing, knowledge and science are formed and built in our minds. With regard to this, we only remark that our perceptions can be worked out into something of a general or more comprising nature. In certain cases we can feel this in our mind by intuition. In other cases we can "see" ("schauen") this in our mind, while we cannot yet define it in words in an objective form, or fix it in a formula. In yet other cases, we can define it in words in an objective form or fix it in a formula. In the cases that we do not come to a clear statement and circumscription of a general notion in the "seeing" ("schauen"), the definition within a notion appears to be difficult, too. *(Note 2)*.

The connections of facts in knowing are called "judgments". Judgments place two or more contents of our thinking in relation to each other. Judgments may occur in all sorts of forms, *e.g.* in that of a formula, a notion, etc. It may also be a logical result ("consecutio"), a conclusion from two premisses.

With the conclusion from two judgments serving as premisses, a third judgment follows. The two premisses have one notion in common which does not occur any more in the conclusion. The second notion occurring in both premisses, becomes the subject in the conclusion (the narrower notion), respectively it becomes the predicate (the wider notion). *(Note 3).*

Judgments may be distinguished in various kinds. We only deal with the following four kinds of judgments here:

(1) Judgments of "being" or "existence". These are determinations of measure, weight, form, etc.
(2) Judgments of "value". These are determinations of the value of something for something. *(Note 4).*
(3) The analytic judgment. This is one of the principal forms of the judgment as a notion. The analytic judgment mentions something in the predicate that is already implied in the notion. The analytic judgments therefore, do not help our knowing along. An analytic judgment separates one general notion from another general notion of equal rank, within a general notion of greater purport. *(Note 5).*
(4) The synthetic judgment. This is a second principal form of the judgment as a notion. In the predicate the synthetic judgment exceeds what is already implied in the notion. Hence a synthetic judgment connects two or more judgments and thus leads to a higher degree of knowledge. *(Note 6).*

The terms "truth", "truths", "true notions", "true judgments", etc. are used in those branches of science, in which sensory perception and experience play a part, if there is "agreement of the notion with the known thing", so of human knowledge with the facts of experience. Here we have to do with the "degree of truth", which is measured by means of "criteria", as well as with the "certainty" of our knowledge.

By "probabilities" as elements of science are meant in this connection: hypotheses, the theories based on them, the proofs of analogy, the statistical indications, etc.

A "hypothesis" or "supposition" is a judgment whereby a fact or a process is assumed to exist, so by way of supposition. Such a hypothesis, such an assumption, such a supposition is reached by a very far-reaching induction. A hypothesis is wrong, when this judgment is not tenable, because the fact or the process appears not to exist. Such a hypothesis is *e.g.* the descent of the Vertebrata from the Annelida. *(Note 7).*

A "theory" is a summarizing consideration giving an explanation of numerous, related phenomena, on the basis of a principle which is invented and which should be the right and the only explaining principle. A theory is built up through a very far-reaching induction. Hence the hypothetically assumed principle is the entrance to the theory. A theory is wrong, when some phenomenon contradicts the invented principle. Such a theory is *e.g.* the selection-theory; this theory would be wrong, if the selection, which can be proved with certainty in nature, would appear not to be the right or the only explaining principle. *(Note 8).*

The words "questions" and "problems" indicate the gaps in our knowledge, which have not yet or not yet completely been solved scientifically.

The researches and motivations (argumentation) pertaining to this scientific knowledge, cannot be dispensed with in a science, because otherwise we would only possess a collection of results or formulas or an enumeration of divisions.

A science may refer to one and the same object or to one and the same class of objects. As a system of human knowledge – and this applies particularly to the natural systems – it implies, together with what belongs to it, a summarizing knowledge as the result of our thinking about the experience with this single "object". This single "object" may present itself in a number of principal forms, if the class of objects consists of the following forms, as is described in the following list of characters of the "object":

(1) as a certain natural object or certain related natural objects (the sun, a certain species of bird, the Vertebrata);
(2) as a certain part of such a natural object or of certain natural objects as meant above (the fibres of connective tissue, the brain, a community of living plants and animals);
(3) as a consideration of certain general properties of different natural objects, or of all particular properties of a limited group of natural objects;
(4) as a certain choice from the properties of a certain natural object or certain related natural objects, which choice is determined (a) by the application of a certain apriorism, (b) the choice of a certain empirism, (c) application of a certain method and (d) the application of a certain idea of knowledge ((a) the machine-properties of an organism; – (b) form, function, heredity, adaptation, etc.; – (c) analytical sciences; – (d) typological comparative anatomy)).

However, a science may also refer to one and the same multitude of related "objects", materially belonging together. A clear example of this is the combination of karyology and cytology, to which histology may also be added. Another example is the combination of sciences referring to the build and the function of related organs in one single organ-system, but also of related organs belonging to different organ-systems, such as parts of the skeleton with the muscles attached to them, tendons, etc. – In general we can observe that this tendency in science to join larger domains, to connect in a more extensive range, is widely spread, beside the tendency to search for a more and more specializing distinction.

For a positive definition of science in general, it does not seem necessary to add to these data a negative or limiting definition ("Begrenzungsdefinition") of science in general.

III, 4. The notion and the definitions of natural science

III, 4. i. *The name-definition ("Nominaldefinition") of natural science*

Anatomy, morphology, eidonomy, etc. should not only be defined as such, but also as a science in general and as a natural science and finally also as one of the subsciences of biology.

The name-definition of anatomy, etc. as one of the natural sciences means to define natural science on the basis of the name, by explaining the meaning of the word. The latter is not or hardly achieved in the case of the term "natural" science, because the word "nature" is used in so many different meanings, that an explanation of the word "nature" in all its meanings is of no advantage to us.

III, 4. ii. *The positive or contents definition ("Inbegriffdefinition") of natural science*

Here, too – as in the case of science in general – we want to think of and pay attention to specific elements in anatomy, morphology, eidonomy, etc. when coming across positive elements in definitions of "natural science".

To such positive or contents definitions, which adequately reflect the essence of the notion defined, in this case natural science, we reckon the following positive or contents definitions ("Inbegriffdefinition") of "natural science". Natural science is, in the first place, the science of the material world; in the second place it is characterized by its empirical nature; in the third place, according to some authors, it is characterized by the experimental method. The first part of the definition means, that the knowledge of the experiences of the material world belongs to the object of natural science. The second part of the definition expresses that this material world is an empirical reality; for it says that natural science is a science of experience and not a speculative contemplation on nature. The third part of the definition expresses the opinion of certain authors, who moreover are of opinion that natural science is positively determined by the method, *viz.* the experimental method. The meaning of the notion "experimental" varies widely. In French experimental means nothing but empirical, derived from empiricism by observation. In German the meaning of the notion experimental is limited to the meaning of "that which is associated with a manipulation", moreover usually limited to the meaning of "that by which the investigator places the object in a situation thought out and wanted by him, hoping thus to obtain an answer to a certain question".

III, 4. iii. *The negative or limiting definition ("Begrenzungsdefinition") of natural science*

An important contribution to a definition of natural sciences may be supplied by the negative or limiting definition ("Begrenzungsdefinition"), which says what natural science is not, what does not belong to it. It separates natural science from neighbouring sciences, not belonging to natural science. – A negative or limiting definition ("Begrenzungsdefinition") is also obtained by locating the science concerned in a "system of sciences".

III, 4. iv. *The definition of natural science on the basis of a system of sciences*

In such a system of sciences within an overall science or in such a system of subsciences within a more comprising science, each science, respectively subscience is positively defined according to its own contents and negatively according to what is classed under other sciences, or subsciences. The latter is done *i.a.* by placing the sciences or subsciences side by side, which entails that the domain of each is separated from that of others.

There are a number of such systems of sciences which are based on important mutual contrasts.

We will mention four of such contrasts. They are:

(1) sciences "a posteriori" as against sciences "a priori".
(2) natural sciences as against spiritual sciences ("Geisteswissenschaften").
(3) nomothetic sciences as against ideographic sciences.
(4) natural sciences as against cultural sciences.

(sub 1) The natural sciences belong to the sciences "a posteriori" ("Realwissenschaften"). With sciences "a posteriori" the object in the outside world is given according to reality, the source of knowledge lies in experience and the preferred method is induction. The natural sciences have the character of sciences of experience in common with many other sciences. It should not be forgotten that, according to many authors thinking, also thinking in the sciences of experience, should finally go back to an aprioristic form. – With the sciences "a priori" ("Idealwissenschaften") to which *i.a.* belong philosophy and mathematics, the object lies in thinking itself, the source of knowledge lies in thinking and the method is mainly deduction.

(sub 2) To the natural sciences, as contrasted with the spiritual sciences ("Geisteswissenschaften") belong all sciences dealing with nature in the way of the natural sciences. – Among the spiritual sciences ("Geisteswissenschaften"), as contrasted with natural sciences, there are a number of sciences, which can be distinguished into sciences of the subjective mind (psychology) and sciences of the objectivated mind (these are the cultural sciences, to which belong theology, philosophy, history of art, aesthetics, history, social geography, sociology, economics, political science, law, etc.). Psychology and cultural sciences in the sense mentioned are all called, as we saw, spiritual sciences ("Geisteswissenschaften"). – Animal psychology,

therefore, which deals with the subjective psyche of the animals, is not a natural science according to the adherents of this system. The fact that biologists study animal psychology in the sense mentioned, would – according to them – therefore merely be based on practical grounds, as *e.g.* that this study requires such knowledge of the animal, that psychologists of the human psyche do not concern themselves with it, etc.

(sub 3) The natural sciences would be nomothetic, *i.e.* "laying down laws", whereas the ideographic sciences, *i.e.* sciences describing the ideas, would be constituted by the spiritual sciences ("Geisteswissenschaften"). – However, natural science, at least biology, is not exclusively nomothetic. A part of it has ideographic aspects, too, like phylogeny and biohistory. Moreover biology also has its norms and values, such as: important and unimportant for the maintenance of life; normal and ill. Norms and values, therefore, are not exclusively the domain of the spiritual sciences. – According to those who follow this system, the spiritual sciences would be ideographic. With this "idea-describing" character of the spiritual sciences, the essential point would be the understanding of what is not fit for repetition; therefore they would be idiographic and individualizing. But the spiritual sciences have not only an ideographic character; there is also objectivity as well as discovery of laws.

(sub 4) To the natural sciences as opposed to cultural sciences belong those sciences, which are concerned with nature not influenced or altered by man. Many communities of living plants and animals, however, many species and races of plants and animals, and also man in many physical properties, have been altered by man, apart from cultivated plants and domestic animals. The question then is, whether and how a bifurcation can be made between the aspects which are the domain of biology as a natural science and those which are the domain of the cultural sciences. Cultural sciences would be in contrast with natural sciences. The question then is, what should be understood by culture and by culture-products, or which aspects of certain products should be classed under cultural sciences and which aspects under natural sciences.

III, 5. The notion and the definitions of biology

III, 5. i. *Introduction*

Anatomy, morphology and eidonomy are not only characterized by belonging to science in general, and not only by belonging to natural sciences, but also by belonging to biology. We now have to examine what it means that anatomy, etc. belong to biology.

In the definition of biology as a biological natural science we have to do – as in similar cases – with a practical aspect, a historical aspect and a purely logical aspect. The latter aspect shows three types of definitions:

(1) the name-definition ("Nominaldefinition");
(2) the positive or contents definition ("Inbegriffdefinition");
(3) the negative or limiting definition ("Begrenzungsdefinition"); to the latter group of definitions (positive and negative) belong in particular:
(4) the definitions on the ground of a system of sciences within one comprising main science.

We may repeat here what has been said before: that difficulties in making a limitation and in drawing the right lines may be caused by an incapability of our thinking, but also by the existence of transitory domains. For at each bifurcation and limitation we have to do with problems of separation and with problems of connection.

Pursuing the historical course (see III, 1 and III, 2), the original meaning of the notion of biology is taken as starting-point, the historical development of this meaning is traced from TREVIRANUS (1802) up to the present and a certain definition of the term biology is found. Thus it is found that nowadays the term biology is used in three principal meanings, *viz.:*

(1) as the whole of botany plus zoology, may be rather as the whole of botany plus zoology plus protistology plus biologically oriented anthropology. In the latter description the view is taken that protistology cannot be clearly divided into protophytology and protozoology. For various reasons knowledge of the human nature or character is treated separately from zoology. In biology the biologically oriented physical or somatical anthropology and partly also the ethologic anthropology would then be treated as a separate subscience. Several authors diverge in their views whether two, three or four clearly separated disciplines should be spoken of, or two, three or four sub-divisions. Anatomy, morphology and eidonomy of the Vertebrata belong to this extensive notion of biology.

(2) biology as that which can be examined on living organisms only, and not on dead specimens. To biology in this sense belong œcology, psychology, ethology, a part of ontogeny. This meaning of "biology" is known in entomology. So anatomy, morphology and eidonomy do not belong to biology in this sense.

(3) biology as that which holds good for all organisms, as is the case with general physiology, with general genetics, with general cytology, etc. This meaning of "biology" is used in Anglo-Saxon literature with its "general biology". So anatomy, morphology and eidonomy do not belong to biology in this sense.

III, 5. ii. *The name-definition ("Nominaldefinition") of biology*

The name-definition of biology may run: "the doctrine of life" or: "the science of life". By "doctrine" is often understood a well-rounded and closed whole of knowledge, by "science" the still growing whole of knowledge. Nearly all modern authors agree that the question: what is "life", does not belong to the field of biology as a natural science. According to nearly all modern authors it is a question of a philosophic biology, of a "Philosophie des Organischen", because according to nearly all modern authors biology as a natural science does not have the "essential" as its object. "Life" is not an objective, but a subjective notion, because we derive it from our own human feeling. Therefore we cannot define "life" objectively in a positive sense, but we can only measure other phenomena by it, such as *e.g.* winterrest, diapause, flame, etc. – So biology as a natural science only has the empirical reality as its object and therefore this empirical reality only gives us the "phenomena of life". According to the name-definition, biology in a natural-scientific sense would be: the science of certain phenomena of life (it is on purpose that we do not say: of "the" phenomena of life; we shall see the reason below).

III, 5. iii. *The positive or contents definition ("Inbegriffdefinition") of biology*

According to a positive or contents definition ("Inbegriffdefinition") of biology, the point is an enumeration of positively acknowledged phenomena of life, the digestion of which has been included in natural-scientific biology. Apart from the phenomena meant, the question sometimes also concerns certain principles underlying these phenomena and sometimes also the application of certain methods.

The positive enumeration of the acknowledged phenomena of life differs considerably with various authors. According to certain authors (DESCARTES; HAACKE, 1887) these phenomena follow from the comparableness of an organism with a machine. According to SPENCER (1864), these phenomena follow from the essence of life as "the continuous adjustment of internal relations to external relations". Other authors again mention as phenomena of life: structure and function (SPENCER, 1864; HAECKEL, 1869), build and performance (HESSE, 1912), make, behaviour and relation (SCHAXEL, 1922), function and origin (BURCKHARDT, 1903), etc. The enumeration of the nine functions of life (combined with two principles) given by ROUX (1912) is well-known, *viz.*: dissimilation, secretion, absorption, assimilation, growth, motion, propagation, heredity and development. In enumerating and defining the phenomena of life the question arises, whether any more phenomena should be mentioned, or whether, on the other hand, the explanation of one or more phenomena can be found in other phenomena, while finally the question arises, whether all phenomena really should be present so as to be able to speak of "life", or whether one or more phenomena are sufficient for this. Moreover, with these phenomena of living organisms the question arises whether, and if so in what respect and to what extent, these properties differ from analogous phenomena in lifeless objects, as *e.g.* with the phenomenon: form.

Besides certain phenomena which are at issue in a positive definition of biology, there are in the second place sometimes also certain principles, underlying the phenomena. Thus, apart from the said nine functions of the living organism, Roux also acknowledges two principles, *viz.* the principle of the self-activity or autoergy or of the performance of these functions "von sich selbst aus", and the principle of the self-regulation resulting in the undisturbed preservation of the whole under normal circumstances and even under many abnormal circumstances. Finally we quote UNGERER (1919), who says: "Der Organismus ist ein Naturding von einem hohen Mannigfaltigkeitsgrad der es zusammensetzenden Stoffe, ihrer Anordnung und der an ihm vor sich gehenden Veränderung, bei dem ein grosser Teil der Vorgänge so verläuft, das sie die Erhaltung der Ganzheit dieses Naturdinges bedingen oder zur Erzeugung und Erhaltung von Naturdingen derselben Art führen".

Besides certain phenomena and certain principles which are at issue in a positive definition of biology, there is, according to some authors, also: the demand of a certain method, *viz.* the induction, in the scientific assimilation of facts.

III, 5. iv. *The negative or limiting definition ("Begrenzungsdefinition") of biology*

On the ground of a certain negative or limiting definition ("Begrenzungsdefinition") two categories of phenomena are placed outside the field of biology.

In the first place biology is not the total of all sciences and not even of all natural sciences concerning the organisms and this is because also physics and chemistry may take the organism as their object. The cause of this lies in the fact that some natural sciences have classes of objects as their objects (astronomy, geology, mineralogy, botany, zoology, anthropology, etc.), whereas other natural sciences make a study of the material world (physics, chemistry) from certain points of view, without being committed to a certain class of objects of lifeless or inorganic nature, living nature or the nature of dead objects. If certain fields are separated from the latter natural sciences (physics, chemistry), within which the concentration is put on this study of phenomena or of materials from the world of the organisms and these fields are separated as biophysics and biochemistry, and the question would be asked whether such biophysics belong to physics or whether it is a "transitory discipline", it should be asked by way of criterion, what was decisive in defining the point of view in this science: is it physics applied to an organism or it is a synthesis of the two sciences in a certain field?

In the second place biology is not the total of all phenomena shown by living organisms, because certain phenomena are classed under other sciences.

Biology, therefore, is not the science of "the" or of "all" phenomena of life, since at the rise of biology as an independent science, all kinds of phenomena shown by the living organism, and among these especially the typically human objective phenomena of life (thinking, aesthetical feeling, sense of justice, etc.) were the objects of other sciences. Biology as late-born child found only certain phenomena of life left to be studied.

III, 6. The notion and the definitions of morphology with its subsciences such as anatomy, eidonomy, etc.

III, 6. i. *The name-definition ("Nominaldefinition") of morphology, etc.*

At the beginning of this treatise we gave some details about name-definitions of anatomy, morphology, eidonomy. We will now add some remarks about the notion of morphology, particularly in zoology. We are of opinion that the term morphology nowadays lends itself best as a common term for the closely related disciplines that come up for discussion here. We begin by stating that though there are the original differences between anatomy, morphology and eidonomy, following from the name-definitions of these terms, when we follow the later development, these subsciences got the same objects, the same methods, and the same ends later on, as appears from history, and with this they have become of equal meaning as sciences of the form, whether concerning an internal or an external part, or a small part attained by analysis, or a larger part understood by synthesis. With the choice of the term morphology and its name-definition, however, no choice has yet been made from the divergent opinions about the place of causal morphology, which is classed under physiology (the physiology of the growing of the form) by many authors.

A second way to come to a name-definition of morphology is by considering what investigators call themselves morphologists and anatomists in present-day practice, what institutions, preferably those without a long history, are called morphological and anatomical institutions, what kind of research is done there, and what periodicals are called morphological and anatomical periodicals, and what kind of articles are published or accepted by them. In answering these questions the point of time at which and about which the question is asked should be taken into account, further sometimes also the country and the school of investigators. Furthermore in stating the subscience under which an investigation should be classed, we must consider the fact that most investigators usually do not realize the logical meaning and value of their answer to the questions. The investigator is not obliged to realize this, either. He may do scientific research on a problem or a question which struck him and may throw light on what he thinks is necessary for the solution of his problem or question, without asking himself whether or not he remains within the limits of an accepted branch of science. An investigator may call himself a physiologist and yet establish matters and open up views that are of importance to morphology. But the logical reflection of the research done by an investigator and of the conclusions he has drawn is of value to someone who wants to fit these findings in the frame of the known facts, also in existing sciences and in the frame of biology; it is also of value to those who want to deduce new questions from these findings and for those who want to define the scheme of thinking of the subscience concerned.

III, 6. ii. *The positive or contents definition ("Inbegriffdefinition") of morphology with its subsciences, such as anatomy, eidonomy, etc.*

A positive definition of morphology with anatomy, eidonomy, etc. will have to say in positive terms about what, with what methods and with what ideal of knowledge in view these subsciences are pursued.

Such a positive definition may be: morphology is the biological natural science which is concerned with the form in a wide sense, *i.e.* the form as an outline, the build in the sense of a rougher composition and the structure in the sense of a more subtile composition – three notions without clear limits which have risen in the course of history.

These three empirical data, form, build and structure, concern the composition, the segmentation, the position, the direction and the connection of the composing parts or members. With the organisms these empirisms have their own character and are different from that of the non-organisms. Thus, as we will discuss more fully later on, the form of the organs in animals is essential, dynamic, non-homogeneous and is effected in its own way by differentiation. These data about the form in a wider sense, the position, etc. are also regarded in morphology as to their connection with a number of other phenomena, such as their connection with function, environment, genesis, and the like, but it is an open question whether the inquiry into the connection with the causes of the genesis of the form in growth, origin, restitution and regeneration also belongs to morphology, in other words, whether causal morphology belongs to morphology or to physiology. This depends on the answer to the question of the admissibility of certain ideals of knowledge within certain subsciences, in this case of the causality within morphology.

Within the field of our special interest, *viz.* the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of Vertebrata, the question concerns the results of the comparison of certain characters (*viz.* those which are conservative, which appears from their presence in many representatives of a smaller or larger systematic group), present in certain elements, *viz.* those that are conservative, which appears from their presence in the representatives of a smaller or larger systematic group. These "structural elements" are recognized by comparison and by analysis. In an analysis parts of the body, regions of the body, systems of organs, within these organs, within these parts of organs, within these tissues and within these cells can be distinguished in the body, so far as the "formed" parts are concerned. To the "elements" that can be called "conservative" and which constitute "conservative structural elements", belong the organs and the systems of organs and parts with their own individuality. This character of "conservative element" is not applicable to the parts of the body, the regions of the body, parts of organs without their own individuality, and the like, the tissues, cells and parts of cells being classed under subsciences other than morphology, *viz.* histology, cytology, karyology, etc.

III, 6. iii. *The negative or limiting definition ("Begrenzungsdefinition") of morphology, etc.*

In such a negative definition is said what morphology is not, what does not belong to it.

We saw that morphological data used for the solution of physiological problems, do not constitute morphology, but they may supply the material for a morphological problem. The same is not only the case with data of the form used in physiology, but also with data of the form used in the field of diagnostical systematics, classification, doctrine of variation, history of organisms or biohistory, partly also phylogeny, pathology, etc. So it occurs with subsciences in which a synthesis has been laid between two data of the form, as well as with subsciences in which a synthesis has been laid between a datum of the form and a datum of a different kind. – Different opinions exist about the place of causal morphology, which is engaged in the causes of the origin of an element during ontogeny, during restitution and during regeneration.

III, 6. iv. *The definitions of morphology, etc. on the basis of a system of biological subsciences*

III, 6. iv, A. *Introduction*

In the accepted systems, analytical or descriptive anatomy, systematic anatomy, topographic anatomy, functional anatomy, œcological morphology and structural morphology, all of adult specimens and of ontogenetic stages, are usually classed under the morphology of animals. These subsciences may comprise the relative data for a specimen, race or species or a higher systematic unity, for one or more stages, but they may also handle the data comparatively (comparative anatomy, comparative ontogeny, etc.).

On the basis of a number of systems of biological subsciences ordered according to their type, we want to point out the data for a limitation of the domain and a definition of morphology with its subsciences such as anatomy, eidonomy, etc. on the ground of a system of biological subsciences. We will discuss here two artificial systems on practical grounds, two artificial systems on the basis of sciences other than biology and seven systems which must be called natural systems.

III, 6. iv, B. *Artificial systems*

The artificial systems based on practical grounds apply classifying principles which are not characteristic or basal for the science concerned, in this case biology, but which are either not specially characteristic or basal, or characteristic or basal for more groups of biological phenomena. On further investigation it often appears that a classifying principle which is considered as being natural, is nevertheless artificial. We mention two artificial systems:

(1) Artificial is the system of the classification of science, also that of morphology, into that of fossil animals, of recent animals, of man and of the remaining recent animals, based on the practice of the four groups of investigators and the four groups of those who have to possess or acquire knowledge in these separate fields.

(2) Artificial is the system of the study of certain subsciences, etc. by investigators who should logically be reckoned among the students of another subscience, but who, on practical grounds of knowledge or equipment of institutes and the like, perform investigations as meant in the former sense. Thus in anatomic institutes much investigation is done by morphologists or anatomists in the field of developmental mechanics, developmental physiology or causal morphology, for which much knowledge and schooling in the field of morphology is indispensable, although as a rule these investigations are classed under physiology. The same is true in the study of normal bodily movements. – On the other hand, much microscopic-anatomic investigation is done by histologists and cytologists, which investigation is scientifically worked up in a way which does not essentially differ from anatomic investigation with the naked eye and by means of a magnifying-glass, but which does essentially differ from the investigation in the field of tissues and cells – it is however, in the same hands of the same investigators only because of the equipment of instruments and the parallel schooling.

The artificial systems of which the classifying principles are based on sciences other than the pertaining science, in this case biology, form a second category. This should not be confounded with the phenomenon that in other sciences the same terms can be used, if general notions, general methods, etc. are concerned, but which have their own special character in the various sciences, as *e.g.* in the case of causality, mathematical methods, etc. We have to do with artificial systems, when we transfer specific terms from other sciences to biology. However, in such cases artificial classifying principles are not applied by those authors who think that biology should indeed be classed under that other science and should be interpreted according to that other science. We mention two of such systems:

(1) Artificial is the system based on the dimension real-ideal. In this way TSCHULOK (1910) divides biology into ideal biotaxis and real biophysics. According to other authors this division is artificial and incorrect, because this dimension may distinguish the ideal sciences ("Idealwissenschaften") from the real sciences ("Realwissenschaften"), but it cannot be used within biology. It cannot be argued that biology is one of the real sciences ("Realwissenschaften"); within biology nothing is purely ideal, but everything is objectified, through which morphology can never be ideal stereometry.

(2) Artificial is the system based on the contrast statics-dynamics as a classifying principle of biology, in the sense as it is applied in physics in the division into hydrostatics and hydrodynamics and in the division into electrostatics and electrodynamics. HAECKEL (1866) saw the entire nature as a system of forces in motion, resulting in either an equilibrium, or a motion, so that according to Haeckel in the whole of natural science a doctrine of equilibrium or statics can be distinguished by the side of a doctrine of motion or dynamics. Thus to Haeckel the form is the result of this equilibrium of forces and so morphology belongs to statics, to which further also belong histology, paleontology, phylogeny, ontogeny, etc. So here static and dynamic refer to data from empiricism, to properties which are empirically observable. (We describe this contrast static-dynamic in detail, because, apart from this contrast as empirisms, it may also have a contrast as methods and as a definition of the "essential").

III, 6. iv, C. *Natural systems*

Natural systems are those systems which derive their classifying principles from the logic of the relevant domain of the science, so in our case biology. The natural systems are not based on one single criterion, but on many criteria. However, no natural system whatever is purely logical; history and practice always play a part in it, for there is no system which is detached from the time in which it was made and concessions are always made to the practical usefulness. There are seven different categories of natural systems of classification of biology. We will mention these seven categories of natural systems and as far as morphology is further defined in them, we will go into them somewhat more profoundly. We will not make a classification – even if this were possible – according to empirical-natural systems and apriorical-natural systems, which are the systems which work in the direction of a theory, respectively are the consequences of a theory.

The seven categories of natural systems are the following:

(1) A classification of biology into subsciences, which is based on the objective classes of natural objects which are empirically given and which

are determined by the groups accepted in systematics, based on the classification of the organismal kingdom accepted in systematics. Formerly such treatment of the scientific subject-matter was known in the so-called "natural history" and to-day is usually called "special zoology". Thus there is a special zoology of the Vertebrata, Mammalia, Primates, etc., but also of the Lepidoptera, etc. Under such a special zoology everything is classed that can biologically be communicated about this systematic group, both systematically and morphologically, physiologically as well as genetically and zoogeographically, etc. But we do not find a separate morphology within special zoology, where the treatment of the systematic group is central.

(2) A classification of biology into subsciences according to the nature of objective classes of natural objects, as they are empirically given and which are based on the "size" of the considered part, which is formed by an empirically given distinguishable biological connection of organisms belonging to one or more species, by a specimen, by empirically given distinguishable parts of specimens. Morphology usually concerns the entire body, parts of the body, regions of the body, organ systems, apparatuses, organs, parts of organs with their proper individualities. Morphology has not as its object communities of living plants and animals (herds, colonies, biocenoses, etc.), tissues, cells, nuclei, chromosomes, which cover the field of other subsciences.

(3) A classification of biology into subsciences according to the design and the method applied. According to the design and the method applied, a morphology can be isolated within general biology and within general zoology. Then the discussion of the form and properties of the form as a certain phenomenon or a certain property is considered centrally in a general biology and in a general zoology and the choice of examples, as far as the systematic group is concerned, is relatively unimportant. Centring the discussion of a certain phenomenon often involves separate discussion in a morphology by the side of a physiology, an autoecology, etc.

(4) A classification of biology into subsciences on the ground of an apriorism, on which the system of subsciences is built. The thing given a priori is that logic moment wich is dependent on experience, it is true, but from which – once it has been given or stated – various things are derived or deduced without returning to the experience. This system can be deduced from a definition of biology on the ground of the essential characteristics of "life". In our epoch we do not know a more or less generally accepted system of biological subsciences for biology as a whole, based on an apriorism. The a priori is greatly dependent on the accepted conceptions in a certain period. In our epoch, therefore, there is no definition and limitation of morphology on this basis, as there was in former days with the deduction of a system of subsciences from an apriorism, such as: the living organism has the properties of a machine, whereby also the form plays a part.

(5) A classification of biology into subsciences on the basis of the methods, *i.e.* the purely logical procedures in the acquisition and the absorption of knowledge, used as a principle or as a dimension in classifying the various subsciences. Morphology cannot be isolated or limited with the help of methods. The methods, however, are suitable to isolate certain subjects within a subscience, *e.g.* analytic or descriptive anatomy within morphology.

(6) A classification of biology into subsciences on the ground of the nature of the so-called empirisms or aspects or facets shown by the living organism. According to Ad. Meyer(-Abich) these so-called empirisms are: empirically given moments of object-systematics ("empirisch gegebene Momente einer Gegenstandssystematik"), which then must be contingent, *i.e.* directly or indirectly underivable from each other ("kontingent, d.h. auseinander direkt oder indirekt unableitbar"). Only with regard to some biological instances, such as: the entire body in undamaged specimens, parts of the body, regions of the body, organsystems, apparatuses, organs, parts of organs, separate subsciences such as morphology, physiology, etc. have risen and this has led to independent subsciences based on the said empirisms. – This is not the case with the (by their size) less comprising objective classes of natural objects, such as tissues, cells, nuclei; here many of the aspects meant are distinguished, but they did not lead to a complete bifurcation into subsciences of the distinguishable aspects. – With the more comprising objective classes of natural objects, such as the organism-complexes, the classification into subsciences is sometimes drawn parallel to that of idiobiology, sometimes an independent classification is made.

Form, and what belongs to it: build and structure are the empirisms of the subscience of morphology in so far as these empirisms are not synthesized with a different kind of empirism (function, environment, etc.) within morphology.

Apart from the empirisms form, build and structure, some more empirisms can be distinguished, which form the basis of a number of subsciences (in the following lines put behind the name of the empirism). We mention: genesis of the form (causal morphology or form-physiology), function (physiology), variability (doctrine of variation), heredity (doctrine of heredity), genesis of race and species (speciation), adaptation (autoecology), distribution on the earth (biogeography), behaviour (ethology), psychic phenomena (psychology), descent, rise, flourish, decline, pedigree, all throughout history (phylogeny or biohistory), illness of the body (physiopathology), illness of the soul (psychopathology) and pattern, "Gestalt", and the like, of formelements, of causal chains, of psychic elements (doctrine of the structure).

Now there is no unanimous opinion as to how many contingent empirisms there are: fourteen, as mentioned above, or two (form and function), as has been assumed for many years, or a different number. Naturally this has its effect on the number of subsciences one wants to acknowledge, and hence on the relative scope of morphology.

When the above list of fourteen subsciences is considered, it is found that, besides in morphology the empirism "form" also occurs in other subsciences, *viz.* as individually growing form in formphysiology, as individually variable form in the doctrine in variation, as hereditary form in the doctrine of heredity, as form-adaptation in autoecology, as ever changing form in the doctrine of speciation and in phylogeny, as the form diverging from the normal in pathology. Hence the notion "form" does not lead to one subscience, but to many. The causes of this are:

(a) the notion "form" is further differentiated, as we saw above, on the ground of the various aspects that may be shown by "form" in general.

(b) the wider notion "form" with all its little facets, distinguished as separate empirisms, is worked up into various directions, to various ideals of knowledge. As examples we give: to causal in causal morphology, to mathematical forms in the doctrine of variation, to teleology in autoecology, to the historical ideal of knowledge in phylogeny and in phylogenetical comparative anatomy of conservative characters of conservative structural elements, to the typological ideal of knowledge in the idealistic-morphological comparative anatomy of conservative characters of conservative structural elements, etc.

(c) within the wider notion "form", parallel empirisms and also parallel ideals of knowledge have led to bundling scientific questions and problems about divergent empirisms to different subsciences with a different bundling of scientific questions, etc. Thus the phenomena of heredity in the field of the form are united with those in the field of other empirisms in the separate subscience of the doctrine of heredity. Thus the phenomena in the field of variability of the form are likewise united with those in the field of other empirisms in the subscience of variation. Thus the phenomena of adaptability in the field of the form are likewise united with those in the field of other empirisms in the separate subscience of autoecology.

(d) within the wider notion "form", the difference in material and in methods of the investigators concerned has also led to a separation of subsciences. Thus the doctrine of genesis of species or the doctrine of "speciation" or the inductive doctrine of descent is separated from phylogeny.

We will now consider a number of examples of systems of biological subsciences, which classify these subsciences on the ground of two or three empirisms which are contrasted or placed side by side. Six examples follow below, in which morphology figures as a separate subscience. This is the case with the rest of all biology at the separation by application of the couple of empirisms: structure – function, which HAECKEL (1869) used to divide biology into two parts. SPENCER (1864) used this couple of empirisms to classify part of biology. According to HAECKEL (1866) the couple of empirisms: structure – function coincides with another couple of empirisms: static – dynamic; as empirisms this couple refers to: matter at rest as distinct from matter in motion; matter at rest shows us the form, matter in motion shows us the processes and the function; Haeckel used the couple of empirisms: static – dynamic to divide the entire biology into two parts. – A third couple of empirisms: build – performance was used by HESSE (1912) to classify part of biology. – A fourth example is the couple of empirisms: form – process; according to LUBOSCH (1925) each empirism determines a special field, *viz.* morphology, respectively physiology; beside this they have a common transitional field in the physiology of the form or genesis of the form, in which both contingent empirisms have equal attention. – A fifth example is: make – behaviour – relation, which was applied by SCHAXEL (1922); within each of the three subsciences belonging to it (morphology, physiology, oecology) there is a law-bound genesis (causal morphology, causal physiology, causal oecology), as well as regulated existence (classification of the forms, of the functions, of the adaptations). – As sixth and last example we mention the couple of empirisms: function – origin, which was used by BURCKHARDT (1903) for the classification of a part of biology.

(7) A classification of biology into subsciences on the ground of the character of the so-called ideas or ideals of knowledge, by which the working up of the data is guided. In a natural-scientific theory the ideas are those logical moments which help to compose theories, guiding the formation of theories. These ideas in the sense of Adolf Meyer(-Abich) have a regulative meaning ("regulative Bedeutung"); they only explain something about the question which general-scientific theoretic end is pursued by a certain theory; they are guiding ideas ("Leitideen"). According to Adolf-Meyer(-Abich) these ideas within natural sciences are "Naturalismus" and "Historismus", within biology they are only causal ideas, resulting in the mathematical idea and the historical idea. In the biological subsciences we find, according to Meyer(-Abich), one of these ideas in certain subsciences, in mixed subsciences they both occur side by side, whereas in other subsciences they are both absent, as – according to Meyer(-Abich) – in morphology. One may also wonder (VAN DER KLAAUW, 1932), what ideas are reached in modern biology, if one does not only proceed deductively from final ideals of science, but if in all biological subsciences the guiding ideas are looked for and accepted without immediately making a separation between fully developed ideas and those with a propaedeutic value. Within the biological subsciences with their theories and little theories it was the ideas in a wider sense which guided the investigators in working up the data; they are like compass-indications, for they do not state their final form, but they only indicate their general-

formal character. To give an example: they do not indicate what exact form the mathematical curve should have, but only that it must be a mathematical curve; they do not indicate what exact form the phylogenetic pedigree should have, but only that it must be a pedigree. Consequently the ideas may also be formulated as aims to find the form in which one would finally like to see one's results laid down, as guide or as tendency of our thinking, or as general-scientific theoretical aim or as ideal of knowledge. The ideas direct our scientific thinking, wrapped in a formal appearance to the final form, as the compass directs the traveller to the magnetic North, so without indicating how to phrase this formal appearance. As the ideas are more comprising, they make a higher and wider synthesis possible.

ADOLF MEYER(-ABICH) (1926) gave a system of biological subsciences of his own, which may be called a natural system, because the subsciences of biology are distinguished according to the empirisms as well as to the methods and the ideas. A critical consideration of this system, however, shows that the ideas have supplied the decisive dimension (VAN DER KLAAUW, 1931). In Meyer(-Abich)'s opinion there are only two ideas in biology, which form causal ideas based on empiricism. They are the causal idea of the physical-chemical causality, to be expressed in a mathematical form, in other words the mathematical idea, and the historical idea. Neutrally opposite these two ideas acknowledged by Meyer(-Abich) stands typology, which has a theoretical aim, it is true, but which makes purely ideal connections; descriptive morphology belonging to this, forms a logically pure group. Beside these three logically pure groups of biological subsciences are a number of logically mixed subsciences, which are governed by two or more logically pure groups of theories. According to Meyer (-Abich) such logically mixed biological subsciences are oecology, biogeography, paleontology and pathology.

In studying the ideas in a slightly different sense, *viz.* as guiding ideas in the acknowledged biological subsciences which are accepted without immediately making a separation between fully developed ideas and those with a propaedeutic value, I (VAN DER KLAAUW, 1932) obtained a series of no less than eight ideas, if we also include the systematical or typological idea, *viz.*: 1. mathematical idea; 2. systematical idea or typological idea; 3. causal idea; 4. historical idea; 5. teleological idea; 6. organismological idea; 7. idea of individuality; 8. idea of essence.

In a later study I (VAN DER KLAAUW, 1962) showed that many of these ideas are usually applied in different special forms. We will not discuss them here, but we will only mention which ideas are equivalent and which are not, which ideas are only of propaedeutic value, whether perhaps some ideas can or must be taken together. Separated from the answer to these questions, I wish to communicate that in my opinion three ideas play a very important part in morphology (the typological idea, the historical idea and the teleological idea), that one idea plays a rather inextensive part (the mathematical idea), that three ideas are of little or no account (the organismological idea, the idea of individuality and the idea of essence), while there is a difference of opinion whether one special idea (the causal idea) is of importance in morphology or not.

The typological or systematical idea arranges the data in the order of "type" according to the idealistic morphology, so according to the typological affinity underlying the studied systematic group.

The historical idea arranges the data in the order of "pedigree" according to the doctrine of descent, so according to the historical consanguinity underlying the studied group of species descending from each other.

The teleogical idea arranges data occurring side by side throughout time and forming a united whole, such as data of the form of various empirisms, such as data of the form next to functional data, such as data of the form next to data of environment.

The mathematical idea arranges data in some mathematical way.

No doubt the organismological idea, the idea of individuality and the idea of essence use morphological data, but only in a few cases will they apply exclusively morphological data to be led to theories in these fields.

Whether the causal idea plays a part in morphology or not is a subject on which opinions differ. There is difference of opinion as to whether developmental physiology or developmental mechanics ("Entwicklungsmechanik") or causal morphology belongs to morphology or to physiology or to a transitional field in between. With the acception of solutions 2 and 3, causal morphology does not belong to morphology, which in this case, therefore, is considered as an acausal science.

IV

THE NOTION AND THE DEFINITION OF SUPRASPECIFIC COMPARATIVE ANATOMY OF CONSERVATIVE CHARACTERS OF ADULT STAGES OF CONSERVATIVE ELEMENTS OF VERTEBRATA

IV, 1. THE NAME-DEFINITION ("NOMINALDEFINITION") OF SUPRASPECIFIC COMPARATIVE ANATOMY OF CONSERVATIVE CHARACTERS OF ADULT STAGES OF CONSERVATIVE ELEMENTS OF VERTEBRATA

This name-definition means to state that the anatomical and morphological data concerning the conservative characters of conservative elements are compared in various species and groups of Vertebrata in the adult stage.

The word conservative means that these characters and also the elements remain "conserved" and are present in a plural or in a series of systematic unities (races, species, genera, families, ordines, etc.), which naturally are affined or consanguine. – Opposite to these conservative characters and conservative elements are the specific characters and the specific elements, which are supposed to be present in only one or a few representatives within this systematic group or series. Among the conservative elements characters of different value occur; they show conservative characters which remain "conserved" in all studied representatives of a studied systematic group, as well as specific characters which only occur in one or in a few representatives within this systematic group or series. In this way a conservative character, characteristic of a certain systematic group which forms part of a wider systematic group, may (within this wider systematic group) be specific for the first-meant smaller systematic group or series.

In principle the conservative characters are present in all representatives of the systematic unities to which they apply, of whatever size the above-meant groups may be. Each of these groups shows a unity of construction plan of its own, however this notion is interpreted. The construction plan may be interpreted in terms of the collective races belonging to one species, the collective species belonging to one genus, the collective genera belonging to one family, the collective families belonging to one order, the collective ordines belonging to one class, the collective classes belonging to one phylum, and possibly even wider.

It is a subject of scientific controversy, how widely such a systematic group can finally be taken, while we still have to do with a unity of construction plan. Formulated in other words: it is the problem of how many major unities of construction plans are acknowledged; is a phylum the largest systematic unity showing a unity of construction plan, or is this also due to even larger groups? This is connected with the problem of the transitions of the construction plans of the large systematic groups. *(Note 9)*.

IV, 2. The positive or contents definition ("Inbegriffdefinition") of supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata

This positive definition states in positive terms, what this subscience comprises, what should be understood by comparison, by conservative characters, by adult stages, by conservative elements.

Thus a positive definition may state that in this connection comparison may be a comparative description of conditions which occur in affined or consanguine systematic groups and which can be traced back to a relationship of a subjective nature or to a relationship of an objective nature and which in the latter case is assumed on the ground of idealistic morphology or a phylogenetic pedigree of that systematic group, on which ground comparability may be searched for. – Such a comparison will lead to the summarizing description of a multitude of differences ("die zusammenfassende Darstellung einer Vielheit von Differentem") (Gegenbaur).

As to a definition in a positive sense of conservative characters and conservative elements, we may refer to what has been said above about the "Nominaldefinition". Also the notions conservative characters and conservative elements reach back to a systematic classification and a systematic relationship; this relationship, too, may be subjective, idealistic-morphological or phylogenetic. – These positive definitions agree with what is classed under comparative anatomy, *viz.* the organ systems, organs and parts of organs with an individuality of their own.

IV, 3. The negative or limiting definition ("Begrenzungsdefinition") of supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata

This negative definition implies that Invertebrata are excluded in this exposition.

Excluded are also the characters and elements of the bodies of Vertebrata which do not belong to the conservative characters and elements, in other words: the specific characters and the specific elements do not come up for discussion.

Excluded are the very young stages in the individual development (the ontogenesis), because in these stages organ-systems, organs and parts of organs with an individuality of their own do not exist. – Excluded are the data in which comparison is not applied, as in the data in the field of analytic anatomy (which concerns parts of the body of one species in the various stages separately). – Excluded are the data in which comparison is not applied, as is the case with the data in the field of systematic anatomy (which concerns parts of one and the same organisation of one species in the various stages separately).

Excluded are the comparisons between non-systematically related groups which have no common conservative elements; they come up for discussion in a comparative anatomy "in general".

Excluded are any aspects other than the morphological aspects of form-elements and parts of forms, such as *i.a.*: aspects of adaptation, which show both conservative and specific elements; they come up for discussion in œcologic morphology and also in functional anatomy.

Excluded are data of the form which, whether or not in combination with other data, play a part in the arrangement of organisms in a system; they come up for discussion in systematics.

Excluded are parts and sub-parts of the body other than those which are or may be conservative, so parts of the body, regions of the body, apparatuses and the like; they come up for discussion in an anatomy "in general".

To only a small extent come up for discussion the syntheses of the empirisms form, build and structure, with the empirisms to be mentioned in the following lines; with the empirism genesis (as causal process in the genesis of the form; takes place in causal morphology); with the empirism variation (takes place in the doctrine of variation); with the empirism heredity (takes place in the doctrine of heredity); with the empirism distribution over the earth (takes place in biogeography); with the empirism behaviour (takes place in ethology); with the empirism ill and abnormal (takes place in pathology); with the empirism shape or "gestalt" or pattern in a wide sense (takes place in the doctrine of construction plan) and with the empirism relation to the soul (takes place in the psychophysical relation).

Opposite to these many syntheses which do not come up for discussion, there are a number which do come up for discussion in supraspecific comparative anatomy of conservative characters in the adult stages of conservative elements of Vertebrata, but only as subsidiary elements of knowledge and which as a rule have been subjected to a less profound investigation than is the case with form, build and structure, or are some data from a whole, resulting from a profound investigation to which they have been subjected, and which is not inferior to that of the form, etc. They are elements of knowledge from the following fields of synthesis, which belong to this category: synthesis in the field of form with genesis, which are not of a causal nature (take place in ontogeny); syntheses in the field of form with function (take place in functional anatomy); syntheses in the field of form with environment (take place in oecological morphology); syntheses in the field of form with genesis of races and species (take place in the inductive doctrine of the genesis of races and species); syntheses in the field of form with descent (take place in the doctrine of descent) and syntheses in the field of form with structure, pattern, etc. of form, function, etc. (take place in the doctrine of construction plan).

V

THE LOGICAL COMPONENTS OF THE SUPRASPECIFIC COMPARATIVE ANATOMY OF CONSERVATIVE CHARACTERS OF ADULT STAGES OF CONSERVATIVE ELEMENTS OF VERTEBRATA

V, 1. Term and definition

In this chapter we will first give a summarizing positive definition of the subscience of supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata, the elements of which have been given at different places in the preceding chapter and for which the arguments can be found there.

Supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata is based on:

(1) the apriorisms of

(1a) the comparability, whether a subjective comparability, or an objective comparability according to idealistic morphology, or the objective comparability according to phylogeny, of the data to be obtained;

(1b) the possession of structural elements and the building up out of structural elements, and considers:

(2) the empirisms of

(2a) the form (outline), build (rough composition) and structure (detailed composition) with the allied questions as to composition, joint, position, direction and connection of the composing parts or members with their properties characteristic of the Vertebrata, while attention may be paid to:

(2b) the differentiations of the aspects of this form, etc. as growing form, as individually variable form, as form-adaptation, as historically changing form, as form diverging from the normal, on which differentiations of the empirism "form", etc. are based any subsciences other than morphology in the narrower sense restricted by us here; this morphology in the sense meant by us would derive these empirical data from:

(2c) adult specimens, in certain cases where such is necessary for an explanation and the solution of a problem, also from senile, young and developmental stages, with the exception of very young stages, because these do not yet show the conservative characters of conservative elements to be mentioned in the following lines; these empirical data in the field of the form, etc., so in stages which already show organs, etc., are related to:

(2d) parts of the body of a certain size, about which a separate consideration of the aspects such as form, function, adaptation, etc. has developed into separate subsciences within general zoology; these empirical data, however, are the subject of the subscience to be defined here, only if they are constituted by:

(2e) conservative characters of conservative elements, *i.e.* the characters and the elements which remain "conserved" and are present in a group or in a series of affine or consanguine systematic unities, in which the conservative elements constitute the conservative structural elements of the constituting ground elements in the architectural constitution of the body, as is the case with organ-systems, organs, and perhaps also with certain parts of organs with an individuality of their own, which may be situated internally as well as externally; the discipline of the form starts from elements which are determined by their function. In acquiring then data and working them up into knowledge we find the application of:

(3) many methods, among which the comparative description is of special importance, the analysis plays a very great part and the synthesis plays a special part, as for instance the synthesis of comparable conditions in affine and consanguine systematic groups and series, but also – as a subsidiary element of knowledge – the synthesis of form with genesis (if not of a causal nature), with function, with environment ("milieu"), with genesis of races and species, with descent and with structure, pattern and the like; in working up this knowledge into its final form are of importance:

(4) the ideas, among which three ideas in a very high degree, *viz.* in the first place the typological idea (arrangement of the structural elements in a comparative anatomy by the "type", according to idealistic morphology), in the second place the historical idea (arrangement of structural elements in a comparative anatomy by genealogy according to the doctrine of descent) and in the third place the teleological idea (arrangement of data occurring side by side throughout time), among which in the fourth place the mathematical idea plays a minor part, while in only a few cases exclusively morphological data are guided by the organismological idea, the idea of individuality and the idea of essence in the formation of theories; with such a building-up scheme of comparative anatomy are connected the rules and demands of science of:

(5) biology as the science of phenomena of life, *i.e.* certain phenomena of life and not "all" or "the" phenomena of life within this science, which is the sum of Protistology, botany, zoology and physical anthropology; finally this comparative anatomy should also fit within the rules and demands of science of:

(6) natural science as a science of the material world, based on experiences of a mainly empirical character and in most cases proceeding inductively, forming a (sub-)science which obeys the commands of a:

(7) science as the complete whole of the logically and objectively arranged "growing" system of a united coherent whole of the multitude of human

knowledge, as the result of thinking about the contents of knowledge, comprising:

(7a) the truth or truths, with its (their) true notions, true judgments, judgments of "being" as well as judgments of "value", analytical as well as synthetical judgments and true conclusions,

(7b) the probabilities, such as hypotheses, theories, etc.

(7c) questions and problems, with:

(7d) the investigations and motivations (argumentation) belonging to these questions and problems and connecting them, all of them with relation to that domain of comparative anatomy, put down in words and formulas which can not be misunderstood.

V, 2. Apriorisms

V, 2. i. *Introduction*

The apriorisms belong to the logical components of natural-scientific theories, also of biological theories, also of those in the field of supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of Vertebrata. The apriorisms constitute the theories also in this field of science. The apriorisms have a logical or a mathematical form.

Among all empirisms in each subscience one or more empirisms appear as logical components, which empirisms are independent of all experience within the subscience concerned, and which therefore may be called apriorisms. In this respect the apriorisms may be independent of the experience, but in another respect they are dependent on the experience and they did not arise without the experience. In a subscience one may have to do with apriorisms which have been derived from other subsciences in which they act as empirisms. But in the same subscience one may also have to do with empirisms which have arisen within this subscience and which have validity in it, while they have obtained the character of an apriorism within this subscience.

In the framework of their theory, all apriorisms can be transformed into all other possible apriorisms, which is connected with the natural-scientific transformability. For all apriorisms the rule ("Satz") applies that historically and mathematically they can be transformed into each other, which is only restricted by the contingency of the empirisms to which the apriorisms belong.

The apriorisms which in a certain respect are independent of experience, but in another respect are dependent on experience, are dependent on experience in a second respect, too, *viz.* in their application within the subscience concerned. From a few moments appearing as apriorisms many special empirisms can be derived. The principles of logic and mathesis as such are independent of experience, it is true, but they have such a wording ("Gestalt") that they can easily be applied to experience.

V, 2. ii. *The apriorisms in comparative anatomy*

V, 2. ii, A. *Introduction to the equal value and the comparability of structural elements*

The apriorism, which has arisen from the subscience of comparative anatomy of the conservative characters in the adult stage of conservative elements, is:

(1) The apriorism of the equivalence of structural elements, styled and distinguished as homology, in which homology is an individual form of the wider notion of analogy within this subscience. Homology is restricted to equivalence of structural elements in morphological respect, which gives the application of the principle of the formal equality ("formale Aehnlichkeit").

Other apriorisms in the subscience of comparative anatomy of conservative characters in the adult stage of conservative elements are empirisms introduced from other subsciences, which are independent of the experience in this new field and are therefore apriorisms. They are:

(2) The apriorism of the character of the structural elements or that of the construction of the body out of conservative elements, whereby within this subscience the structural element, respectively conservative element is the individual form of the wider notion "element", respectively of "occurring more widely". As a rule this notion "element" does not mean here a "part", pluralized and united to a sum, but a "member" ("Glied"), pluralized and united to a "whole", a totality ("Ganzheit"). "Members" are those elements which cannot be combined into various constructions in different ways, but which, as "members" of a "whole", are specific for that "whole" and therefore belong to one definite "whole".

(3) The apriorism of the equivalence of allied structural elements occurring in two or more allied species, with the possibility of application of the principle of homology in the strict sense as a result. In this conception of the equivalence of allied structural elements in two or more allied species, the general principle of ancient Greek philosophy finds its form and application within comparative anatomy, *viz.* the principle which contains the ancient Platonic notion of "being", in the double sense of the "common" as a property of things and—if this is present—in the sense of the unity ("Einheitlichkeit"). This "unity" should be understood as "unity" of allied phenomena, of allied organs, etc. (a different notion of "unity" refers to the "unity" of all organs, etc. within one single specimen in the sense of alliance of all organs within one single specimen as an individual).

(4) The apriorism of the transition of the properties of these structural elements into those in allied species, with the possibility of the application of the principle of metamorphosis as a result. In some cases this transition is continuous. The general conception of metamorphosis and that of the

idea of continuity is most closely connected with the above-mentioned conception of "unity" ("Einheitlichkeit").

(5) The apriorism of the sequence of condition of the properties of these structural elements, with the possibility of the application of the principle of systematizing the rows as a result.

(6) The apriorism of the historical judgment, with the possibility of the application of the principle of historization as a result.

The above-mentioned apriorisms in comparative anatomy of conservative characters in the adult stage of conservative elements of Vertebrata have yielded various further philosophic interpretations, connected with some main trends in the conceptions of the basis of the equivalence and comparability in this field. These main trends can be traced back to the subjective basis and the objective basis on the ground of idealistic morphology and to the objective basis on the ground of descent.

A separate discussion of the above-mentioned three main trends may follow here.

V, 2. ii, B. *Subjective basis of the equivalence and the comparability of the structural elements as apriorisms*

The supporters and defenders of this principle are of opinion that when an investigator wants to "sort" certain parts of the bodies of specimens of different races, *e.g.* dog races, or of specimens of different species, *e.g.* of the closely related species of dog, fox and wolf, or of specimens of less closely related species within one single class of Vertebrata, *e.g.* dog, fox, wolf, cow and horse, or of specimens of much less closely related species within the phylum of Vertebrata, *e.g.* dog, fox, wolf, cow, horse, crow, lizard, frog, salmon, selachian, etc. by their properties, it is merely a human, subjective principle that underlies this "sorting". Only human thinking would contain the basis of the judgment of equivalent and unequivalent, of similar and dissimilar, of comparable and incomparable, of the correctness of placing together and placing separately. In these proceedings certain characteristics and features will be regarded as more important and more essential for this aim and others as less important and less essential. This opinion of what is essential finds its source in human thinking only. The investigator can only see through and "survey" what is essential; however, he can also define it in words in a notion. From these conceptions about the essential the thought of a basic form or type will arise, which therefore, according to the followers of this main trend, is subjective and only exists in human thinking. Also the basic form or the type can be seen through and "surveyed", but it can also be defined with words in notions. According to this main trend the "sorting" by the properties, the judgment on equivalence, on similar and dissimilar, on comparability, on essential, on basic form or type, would be exclusively a question of human thinking, so subjective. The basic forms, types and notions discussed above only exist in the world of thought of man; they are present only in name (conception of nominalism). The followers of the subjective basis of equivalence and comparability further think that in the first place these thoughts and ideas are only possible and only appear on the ground of the material and the facts and therefore also only after acquaintance of the facts ("idea post res"). – In the second place the subjectively established assorted equivalent and comparable properties of the subjectively established basic forms or types may be likewise subjectively arranged into a row, called a metamorphosis, which therefore is also subjective. – In the third place the subjectively established types etc. and the subjectively established metamorphoses can be arranged into a system which is likewise subjective and forms a so-called "artificial system". – This subjective principle also has its supporters among comparative anatomists, who are of opinion that there can be no certainty about the so-called objective bases to be mentioned below. But throughout history many investigators were not satisfied with this subjective basis. Naturally they do acknowledge the subjective element in every scientific formulation, as this is connected with a certain investigator and a certain period. Naturally they know that science is the assimilation of experiences on phenomena in and by human thinking, but they are of opinion that in some cases an objective background or basis underlies the formulation produced by thinking. Objective means here: the datum also outside the thinking subject. Assuming an objective background, they think an objective principle for science should be sought for, which they think they can find, too. The opinions as to the nature of this objective basis differ, as may be seen with supporters of idealism and realism.

V, 2. ii, C. *Objective basis of the equivalence and the comparability of structural elements in the idealistic morphological comparative anatomy as apriorisms*

The adherents and defenders of the objective principle can partly be found among the supporters of idealistic morphology. This idealistic morphology, sometimes also called "pure morphology" ("reine Morphologie"), dates back to times before the work of CHARLES DARWIN (1859); it has its leading representatives in Goethe and Richard Owen, and today it goes through a revival.

The supporters of the objective basis of the equivalence and the comparability according to idealistic-morphological comparative anatomy take the view that something objective underlies the "assorting" mentioned above. These investigators are of the opinion that our thinking in "sorting" and the further actions of thinking has some analogy with the ground of things with the world beyond the world of the phenomena and that in science we "find again" the idea underlying nature in science.

As to the philosophic background, the opinions of those who support idealism and those who follow realism are divergent.

According to idealism the idea as the basis of things as such is present, without having been realized in the phenomena of nature. In this conception according to idealism the idea exists prior to the facts ("idea ante res"). According to idealism this objective idea is present not inside, but only outside the world of phenomena, hence not inside but only outside the animal objects, either in a platonic world of ideas or in the Creator. According to the Greek, philosophy meant: this world of immaterial ideas is the world of the constant, the invariable, the permanent, the eternal and has its separate existence, both along with its adumbration in nature and along with the multitude, the growing and the decaying. The problem of the multitude, the growing, the decaying, has an existence outside that of the eternal, etc. According to idealism equivalence, comparability, essential, basic form or type are based in an objective idea, exclusively present outside the world of phenomena. The immaterial ideas, therefore, are the examples of the objects in nature which are adumbrated in this nature, but not the immaterial cause. – Our thinking shows some analogy with this objective idea outside the world of phenomena and finds the idea again. In this way the idea of dog would underlie all dog specimens, as an example according to idealism, not as the cause; the idea of carnivore would not only underlie all dogs, but also other carnivores; the idea of mammal would not only underlie all dogs and all other carnivores, but also all other mammals, etc. The idea of dog of idealism underlies the relevant phenomena in nature as an example. This is also called the "type". The bearer of this "type" is the "archetype" ("Urform") (not to be confused with the "ancestral type"). According to idealism this "archetype" or "type" is purely ideal, *i.e.* only present in the thought of the Creator or in the platonic world of ideas. The idea of dog *e.g.* exists only in the world of ideas and not in the world of phenomena as well, exactly as is the case with the "ideal circle". The latter has sometimes been compared with a torch-bearer in a subterranean gallery and the silhouette on the wall of a side-gallery, on which we see the silhouette. So the immaterial ideas have the phenomena in nature as their adumbrations. If a similar immaterial idea underlies the phenomena in nature, these phenomena show relationship or affinity and animal objects show *i.a.* affinity in their build. It is sometimes also expressed as an affinity in build, found in animals that have the same structural plan or show the same type. Hence idealistic morphology is sometimes also called typology. "Typus" is used here in the sense of "structural plan", which may be defined as the connection of parts in their positions, or as the ordered relation of the members to a whole. "Typus" may be used in the sense of the real expression of a platonic idea and as a notion of reality ("Realbegriff") in the cases that the typus is "darstellbar" by taxa and the like.

In this world of contemplation of idealism this objective ground of the equivalence involves some consequences. – In the first place such a consequence is a basis of comparability. – In the second place the equivalent and comparable properties of the basic forms and types, established according to the rules of idealism, also in idealistic morphology, may thus be objectively arranged, into a row, called a metamorphosis, which is objective here. – In the third place the types and metamorphoses thus objectively established may be arranged into a system which is objective and forms a "natural system". So situations with the same structural plan are arranged together according to similarity, separated from other structural plans and finally also the structural plans are arranged according to similarity.

This system of anatomical structural plans according to comparative anatomy of the elements considered, shows some connection with the systematic arrangement of animals, naturally likewise composed according to the objective principle. The comparative anatomy and systematics meant have much in common in their processes. If the considered organs show the same order in their systematic sequence as the specimens of the species concerned, the two systematic arrangements coincide. In principle, however, this need not always be the case. It will certainly be the case if we consider the comparative anatomy of an organ which has been used as an essential element for the systematic arrangement of the species of organisms.

We will now consider the other category of supporters of the objective basis of equivalence and comparability in idealistic-morphological comparative anatomy, *viz.* those who do not support idealism, but realism.

Realism takes the view that the idea is exclusively realized or also realized in the phenomena of nature, by its real presence ("idea in rebus"), whether single or double. Part of the supporters of realism are of the opinion that this idea has been realized and is present in the phenomena of nature only. Realism takes the view that our thinking discovers the idea which has been realized and is present in the phenomena of nature only (realism). Among some ancient Greek philosophers (Parmenides) the conception prevailed that in all allied animals the common and the constant was physically present as "pre-formed being".

Another part of the supporters of realism assumes a two-sided presence of the idea, both in the world of phenomena, in this case the animal objects in which it is reflected, and in the world of ideas (Aristotelism) or in the Creator. In Aristotelism the objective idea which has been realized in the phenomena of nature, is the causer of things as aim-effecting psyche. This two-sided presence holds for the idea of dog, the idea of carnivore, the idea of mammal, it also holds for the archetype or type. The idea can be read from all specimens or certain specimens or one certain specimen in the world of phenomena as the "essential" of the type meant. It is to be read on the ground of specimens with a related build, or of specimens built according to the same structural plan as the evidently typical or essential of that group. What is meant by this typical or essential according to the author, is connected with his conceptions of "typical" and "essential", notions which in their turn are connected with those about "norm" and "normal". To many investigators the latter notions are connected with "the common", shown by all specimens belonging to the systematic group concerned.

Thus two notions of "archetype" or "type" have been arrived at. In the first conception the "archetype" or "type" can only comprise the common, laid down in one single value. In the second conception we can see the total of all possible form-properties of the whole group, which total of this multitude can be imagined as "geistig geschaut". – The archetype or the type, therefore is real in so far, as it occurs in a specimen as the common characteristics of the more comprising groups (systematically higher categories) (the Vertebrata-like, mammal-like, carnivore-like, dog-like), in a certain dog specimen. – Only most rarely (as with Goethe) has the conception been proclaimed that also these archetypes were realized as separate forms of appearance (species).

In the second place, as to the metamorphoses which have an objective basis, there is not much to be added to what has been said in connection with idealism. – In the third place the types etc. and metamorphoses objectively established in this manner, may be arranged into a system which therefore is objective and a so-called "natural system". The greater or less gradualness in the transition from one condition into another has been thought of differently, as we shall further discuss in a following section.

The origin of idealistic comparative morphology or pure morphology ("reine Morphologie") lies farther back in time than the origin of phylogenetic comparative anatomy. The basis of idealistic morphology therefore, has sometimes also been called the "principle of praecedency". However, this does not imply that the two main conceptions of morphology should not have their own principles.

V, 2. ii. D. *Objective basis of the equivalence and the comparability of structural elements in the phylogenetic comparative anatomy as apriorisms*

An objective basis as meant here is not only found in certain forms of idealistic morphology, but also in phylogenetic comparative anatomy, which goes back to the work of CHARLES DARWIN (1859). The defenders of an objective basis of the equivalence and the comparability according to phylogenetic comparative anatomy take the view that an objective principle underlies the "sorting" mentioned above. These investigators, too, are of opinion that in this "sorting" and further actions of thought our thinking has some analogy with the ground of things, with the world which lies beyond the world of phenomena, and that in science we "find again" the idea underlying nature.

The investigators of comparative anatomy within phylogenetic comparative anatomy, who have an established opinion about these bases, as a rule do not support idealism with its "idea ante res", in which the view is taken that this idea as the basis of things is only present outside the world of phenomena, *viz.* only in the Creator or in Plato's world of ideas, be it as an idea developing in the course of history and changing itself in the reflection of this idea in animal objects.

Most investigators of phylogenetic comparative anatomy, who have an established opinion about the bases, support realism, according to which conception the "idea", apart from being present in the world outside the phenomena, is also present in the phenomena of nature themselves ("idea in rebus"), whereby usually only this latter presence is stressed. In the course of history this objective history "develops" in these phenomena of nature. This "growing idea", therefore, occurs really in every specimen *i.e.* that of every lower and higher systematic category to which the specimen belongs, in other words of the species, the genus, the family, the order, the class, etc. In this school of thinking an "ancestor" which has lived or is still alive, is spoken of. Thoughts of descent, of blood-relationship or consanguinity of the species, etc. also fit in this world of thought.

In the second place the arrangement of the forms which may be compared with the metamorphoses, is an arrangement according to the row of descendants or genealogy. The form of these rows of descendants varies, dependent on the group and on the investigator (arboform, shrubform, etc.).

In the third place the objectively established types, etc. and the objectively established genealogical rows may be arranged into a system which is objective and phylogenetic and therefore a natural system. Here, too, the less or greater gradualness in the transition from one condition into another is a problem.

V, 2. iii. *Introduction to the structural elements as apriorisms*

As the second important apriorism in the subscience of comparative anatomy of conservative characters in the adult stage of conservative elements we mentioned above the character of structural element of the conservative elements, which can be distinguished in the bodies of Vertebrata.

In general, the term structural elements is applied to those parts of the body of a specimen showing the following properties:

(1) structural elements are parts with the character of a closed system, both in morphological and in functional respect;
(2) structural elements are parts with the character of an "individual", *i.e.* parts which are undivided, which does not imply that they are undivisible;
(3) structural elements are parts with the character of individuality, *i.e.* showing the tendency to remain undivided.

Those who are of opinion that parts of the body in various animal species may with good reasons and rightly be compared, will as a rule take the view that this also implies the structural elements, so parts with the character of a closed system, with the character of an "individual" and with the character of "individuality". The latter parts are of equal value in morphological respect and on this ground they are comparable, too.

Such morphologically equivalent and therefore also comparable parts are not characterized by a certain absolute or relative size. *(Note 10).*

Such morphologically equivalent parts, namely, may be very large. *(Note 11).*

Such morphologically equivalent parts, however, may also be very small. *(Note 12).*

Reversely, very large parts of the body may lack the character of structural elements. *(Note 13).*

Now one may be of opinion that this character of structural element holds for some parts of the body which show very clear limitations themselves, which property returns in specimens of various animal species that are compared on this point. One may be of opinion that the notion of "individual" does not only hold for these few very clearly limited parts of the body, but for a large number of parts, may be even for all limitable parts with a characteristic form; however the filling masses of connective tissue in the body would not belong to this. The other limitable parts of the body which can be regarded as the structural elements, are sharply limitable, if the in- and outgoing nerves, bloodvessels and lymphvessels are neglected. If the restriction implied in this is paid attention to the conception that the body as a whole is built up out of structural elements is comprehensible.

Sometimes the limitation of organs, etc. in certain species and groups of animals is not so clear and is established arbitrarily. *(Note 14).*

The above imparted conception about the structure of the body out of certain structural elements holds good, if the situations are established at one single stage, *viz.* the adult stage; for in a young stage organs etc. may still be undivided. *(Note 15).*

The comparison of parts on the basis of equivalent structural elements has yet another reason, if one is of opinion that the bodies of allied animal species consist of the same conservative elements or structural elements, *i.e.* of the same number of structural elements and of the same types of structural elements, or in other words: show the same construction plan. With this question the problem of the number of construction plans in the entire animal kingdom is connected, at least where the main construction plans are concerned. *(Note 16).* On the one side are the investigators, who at least factually and for the time being, acknowledge more than one construction plan up to many construction plans. On the other side there was Etienne de Geoffroy St. Hilaire, who said: "philosophiquement il n'y a qu'un animal". However many construction plans of the first order are distinguished, within each of these one can nearly always distinguish construction plans of the second order; these are the construction plans of systematically smaller groups.

Now it may happen that a certain structural element is not a clearly limited structural element in the adult stage and in general not in all stages, but only in part of the stages, sometimes only in one single stage. In that case such an element remains homologous with a resembling organ in a different animal species with which it is homologized in the independent stage, also if the limitations become indistinct or are omitted of if it changes its place.

It may happen that apparently a part or parts of such a larger structural element in a certain species of animals is connected with a neighbouring structural element in another animal species and has released itself from the structural element in the former animal species, so that the structural elements in the two animal species are not completely equivalent nor completely comparable, but that they are only partially equivalent and comparable, because they are incompletely equivalent and incompletely comparable.

This conception of the structure of the body out of structural elements holds good, both with a summative conception and with a structural conception or conception of totality. A body as a whole namely, may be considered as a "sum of parts", in a certain sense loose parts (summative conception), but also as a "whole of members" (conception of the body as a totality, a structure, a mosaic, a "whole", a "tout", a "Ganzheit", etc.). – A "sum" is something else than a "whole". In the first place a whole is more than a sum of parts, for a whole also has other characteristics besides those that follow from the addition of the characteristics of the parts. In the second place the members of a whole can be substituted by other members while the whole is retained.

V, 2. iv. *Homology and analogy as apriorisms*

V, 2. iv, A. *Introduction*

Resemblance or agreement in features, characteristics and relations, so in some respect or other, and therefore comparability in these respects, is called analogy in its general original sense.

From this general conception of analogy the notion of homology was separated later on, which restricts equivalence and comparability to those in morphological respect.

Because of this separation of homology from the general conception of analogy, the term analogy can be reserved for equivalence and comparability in other respects than the morphological respect, so *e.g.* in functional respect.

V, 2. iv, B. *Homology*

The word homology may be used for morphological features in equivalent and comparable conservative structural elements, for they are morphological parts, which occur together in all representatives of a systematic animal group characterized by one and the same construction plan. The notion of homology is then restricted to interspecific equal structural elements.

Nowadays an extension of the notion of homology is also applied to intraspecific structural elements in the case of extreme sexual dimorphism.

In former times, certain authors, by whom this conception of homology was sometimes also called special homology, also acknowledged general homology, also called homonomy of organs. This term of general homology was applied to strongly resembling structural elements in or on one single body of a certain specimen of a certain animal species. Within the notion of general homology or homonomy were distinguished:

(a) general homonomy, as in the case of hairs in one single specimen.
(b) homonomy of antimere organs, as in the case of left and right organs in pairs.
(c) homonomy of paramere organs, as in the case of longitudinally non-metameric repetition.
(d) homonomy of metamere organs, as in the case of metamere homonomy in a narrower sense (in the case of segments), in the case of numeral homonomy (in other cases than segments, as with vertebrae), together sometimes called serial homonomy, based on homoplasy (humerus and femur; basioccipital and centrum vertebrae).

The notion of general homology, therefore, was formerly applied to cases of resemblance of organs occurring in plural in one single specimen. As we saw, we also know the resemblances of intraspecific character, occurring in various specimens of one and the same species. A special case of this is the resemblance in the case of extreme sexual dimorphism, which up to now has been referred to as homology. The notion of homology is especially used in cases of resemblance with an interspecific character.

V, 2. iv, C. *Criteria for homology*

A closer consideration of what is thought of as homologous shows that this equivalence and comparability on the ground of morphological characteristics are based on resemblance in this respect and (or) in that respect, in other words, that they are measured by one or more criteria.

In the choice of these criteria the notion of homology has passed through a historical development, the elements of which are still in this notion. The historical phases and these present elements in the notion of homology, which will be further discussed, are the following seven: equal form, build and structure, equal topography, equal ontogeny, equal phylogeny, equal genetic disposition ("Anlage") and equal developmental material and equal developmental mechanic causes. It goes without saying that nowadays, if it is possible, all criteria should be applied where homologization of two or more organs is concerned.

With each criterion for homologization we meet with some recurrent experiences, questions and conclusions, which may be formulated as follows.

As to the experiences we find the following:

(a) Experience teaches that in some cases the similarity in a certain feature is very striking, sometimes so much that even the superficial observer is inclined to come to the conclusion of homology. This conclusion, however, is not always right; the case may also be one of superficial resemblance.

(b) Experience teaches that in many cases the similarity in a certain feature between comparable organs, etc., is a similarity in a greater or less degree, because the organs, etc. that are compared, are never completely identical.

(c) Experience teaches that in a number of cases there is not any similarity in a certain feature in compared species, so that evidently homology is out of the question.

The questions and the conclusions that are arrived at on the ground of this experience, are the following.

(*i*) Also comparable organs show divergent characteristics with relation to the value for comparability. – In view of this a distinction should be made between unessential and essential characteristics. It should be stated on what grounds certain characteristics are considered as unessential, others as essential for homologization. The unessential characteristics are of no use in connection with homologization; this holds good both for the differences and the agreements.

(*ii*) The differences in such unessential characteristics between the compared objects are therefore meaningless for a homologization or non-homologization, since it concerns unessential characteristics. The fact that there are characteristics that are regarded as unessential explains that in homologous organs there may even be very striking and great differences in certain characteristics at first sight, which, however, are then restricted to these unessential characteristics.

(*iii*) Also the agreements in such unessential characteristics between the compared objects are worthless in connection with homologization. Among the unessential characteristics there may even occur striking resemblances. However, as unessential characteristics are concerned here, the similarities are only superficial and seeming similarities.

(*iv*) A great agreement or negligible differences between essential characteristics between compared objects will lead to homologization. The same holds true, if the differences can be neutralized by an explanation.

(*v*) In spite of certain differences, even with the character of absolute unequality, one may still conclude homology in the essential characteristics, if these show a relative similarity.

(*vi*) In the essential characteristics fundamental differences must lead to the negation of homology. This may even take place on the ground of minute differences, provided that these are of a fundamental nature and concern essential characteristics.

V, 2. iv, D. *Different kinds, types and grades of homology*

V, 2. iv, D, a. Introduction

"True homology" is distinguished from a "subjective arrangement according to similarity" and from a "similarity by convergence", whereby the bearers are either not closely related or closely related (in the latter case the term homoiologous is applied).

True homology is found *i.a.* in comparable morphological parts, under which fall the conservative elements or structural elements.

Within "true homology" are distinguished imitatoric homology (leading to a homoplastic organ and to a homogeneous organ), allomeric homology, complete homology and incomplete homology. Within incomplete homology are distinguished partial homology, which presents itself in two forms, *viz.* as augmentative and as defective homology.

The notions mentioned may be described as follows.

V, 2. iv, D, b. True homology

In true homology there is equality in all applicable criteria for homologization, so the applicable criteria from the series: form, build and structure, topography, ontogeny, phylogeny, genetic disposition ("Anlage"), developmental material and developmental-mechanical causes, all this of one and the same morphological elementary structural element.

V, 2. iv, D, c. Subjective arrangement according to resemblance

In principle, the arrangement on objective grounds does not play a part in this. Thus the arrangement on this subjective basis may prove to disagree with the objective grounds of a phylogenetic arrangement, so that in these "sham-series" two important criteria, *viz.* the sequence in time and the place of occurrence do not agree with the historical reality of phylogeny. *(Note 17).*

V, 2. iv, D, d. Resemblance by convergence

In convergence organs in various animal species resemble each other very much, without this being true homology, because the bearers of the resembling organs do not take up the same places etc. according to idealistic-morphological anatomy, nor are they directly descended from each other, in other words: because they are not closely related phylogenetic-systematically. Such superficially similar organs that do not belong to the type, but are atypical, cannot be traced back to such an organ or part of organ in the common archetype or ancestral form, where such an organ or part of organ in this form is lacking. Originally the characteristics are widely divergent, but in the course of their phylogeny they more and more approach each other in form, build, etc.; if this is caused by equal forces affecting parts of organisms, this kind of agreement may be called homoplasy. In such cases ontogeny may teach us the ontogenetic convergence also present in the later ontogenetic stages. With resemblance by convergence we have to do with the polyphyletic origin of a certain form or of a certain characteristic of the form. So we have to do with analogous organs. If the bearers are closely related the term homoiologous may be used. Homologous organs may diverge at first, but after this secondary divergence they may begin to show resemblance again as a tertiary condition and so begin to show a secondary convergence. *(Note 18).*

V, 2. iv, D, e. Imitatoric homology

Imitatoric homology is that form of true homology, in which the compared organs are formed from very different groups of cells, but in which the groups of cells forming the organ of the derived animal species "imitate" the entirely different groups of cells of the original animal species. This organ, proceeding from different cellular material, is called a homoplastic organ. If the cellular material forming a certain organ is directly comparable in the compared animal species, we speak of a homogeneous organ, as is also the case if the homologous organ has shifted its place in the course of phylogeny, *e.g.* when it has sank deeper. *(Note 19).*

V, 2. iv, D, f. Allomeric homology

Allomeric homology is that form of true homology in which an organ with many sub-parts in a derived animal species is morphologically equalized with a less differentiated organ consisting of one single sub-part or only of a few sub-parts in a more primitive animal species. *(Note 20).*

V, 2. iv, D, g. Complete homology

Complete homology is that form of true homology in which an organ in two compared animal species consists of exactly the same sub-parts, so that they possess only common sub-parts.

V, 2. iv, D, h. Incomplete homology

Incomplete homology is that form of true homology in which an organ in two compared animal species, besides common sub-parts, also comprises other sub-parts which they do not have in common, whether in one or in both animal species. *(Note 21).*

V, 2. iv, D, i. Partial homology

Partial homology is that form of incomplete homology in which the organ of one animal species only possesses the common morphological sub-parts and the organ of the other animal species considered also possesses other sub-parts. It could thus be formulated that the organ of one animal species is morphologically equivalent to a part ("pars") of the organ of the other animal species.

This partial homology occurs in two forms, depending on whether the non-common sub-parts are lacking in the original animal species for the derived animal species the term augmentative homology is used or whether the non-common sub-parts are lacking in the derived animal species (in that case we speak of defective or diminuative homology).

V, 2. iv, D, j. Augmentative homology

Augmentative homology is that form of partial homology in which the considered organ of the (whether or not phylogenetically derived) animal species contains a sub-part or sub-parts which are lacking in the original animal species, so that the organ in the derived animal species shows an "increase". *(Note 22).*

V, 2. iv, D, k. Defective homology

Defective homology, also called diminuative homology, is that form of partial homology in which the considered organ of the phylogenetically or non-phylogenetically derived animal species lacks a sub-part or sub-parts which was or were present in the original animal species, so that the organ in the derived animal species shows a "defect". *(Note 23).*

So we may speak of different kinds and types of homology, but also of different grades of homology. According to some authors it is not possible to speak of "grades" of homology, because either there "is" homology, or there is "no" homology.

V, 2. iv, E. *Relation of homology and analogy*

In conservative elements or structural elements within one and the same construction plan, such organs, organ-systems, parts of organs with an individuality of their own, we may speak of homology and of analogy. In this respect four combinations are possible.

(1) The equivalent and comparable organs and other conservative structural elements are homologous as well as analogous.
(2) The equivalent and comparable organs and other conservative structural elements are analogous, but only partially homologous.
(3) The equivalent and comparable organs and other conservative structural elements are analogous, but not at the same time homologous.
(4) The equivalent and comparable organs and other conservative structural elements are homologous, but not at the same time analogous. Sometimes the functions are so widely divergent, that the organs are even treated in different organ systems. *(Note 24).*

We may point out again that the above concerns organs and other conservative structural elements and that a comparison is made of conditions in animal species that are built according to the same construction plan.

If we consider morphological sub-parts that are defined and limited in another way, such as parts of the body (head, tail, trunk), regions of the body as a whole (dorsal region), regions of parts of the body (abdominal region), other sub-parts of divisions of the body, appendices of the body as a whole (dorsal edge of the skin), appendices of separate parts of the body (extremities), appendices of sub-parts of these separate appendices, and the like, then homology according to the above definition is out of the question, because it concerns no conservative "structural elements" within one and the same construction plan. Then the morphological sub-parts may be compared (*e.g.* in a comparative morphology of construction plans), but we cannot speak of homology; however, there is analogy for functions can be compared.

If, therefore, the comparison concerns organs or parts of the body of animals showing divergent construction plans, this is not homology, but analogy.

In introducing the notion of homology in the case of conservative structural elements within one and the same construction plan, with relation to the morphological equivalence and comparability, the value and importance of different morphological parts of the body have been stated more precisely. This has not been the case with the notion of "function", which, however, is used in a wide sense and in a narrow sense.

The notion of function is also used in the sense of main function(s) or primary function(s) by the side of subsidiary function(s) or secondary function(s) of the ever multifunctional organs with active and passive functions. Owing to this multi-functionality are possible: (1) an intensification of one of the functions without a functional shift (Plate), by which one of the functions becomes a main function; (2) a shift of these functions in phylogeny (Dohrn), by which one of the subsidiary functions becomes the new main function of the same organ and (3) a widening ("Erweiterung") of functions (Plate), by new functions being included (from swimming to walking), which is the condition of a functional shift.

In addition we have to remark that some authors only speak of analogy when there is a functional agreement of morphologically unequivalent organs.

As to the relation of analogy to homology we may distinguish the following cases (a–d):

(a) within one single construction plan, organs, organ systems, apparatuses and organ complexes that are comparable in some respect, may be similar or different.

(1) these organs etc. may be homologous as well as analogous. *(Note 25).*

(2) these organs etc. may be analogous, but only partially homologous. *(Note 26).*

(3) these organs etc. may be analogous, but not homologous. *(Note 27)*.

Analogous but not homologous organs may arise in animal species descending from each other, so in the course of phylogeny according to the principle of substitution of organs (N. KLEINENBERG, 1886), whereby the function passes to another organ, the ancestral organ usually degenerates and the substituting organ often lies in the same place; sometimes the organ is not homologous, sometimes it is; in other cases there is substitution of the functions (walking by creeping). The analogy of the compared organs is due to substitution of the organs; these substituting organs are not homologous or partly homologous, in the cases that they are not homologous. *(Note 28)*.

(4) these organs etc. may be homologous, but not analogous; sometimes the functions are so widely divergent that they are even dealt with in different organ systems.

(b) within one single construction plan, parts, regions, appendices, etc. of the body that are comparable in some respect, can never be homologous in virtue of the definition that we have to do with homology only in conservative structural elements, so morphological sub-parts, but they may or may not be analogous. *(Note 29)*.

This restriction of the notion of homology to supraspecific structural elements implies that in this article such strongly resembling organs occurring in one single specimen, are not called homologous by us, but are referred to by a different term. A general term for such resembling organs within one single specimen is homonomy and homonomous. Within homonomy are distinguished homodynamic (or serial homologous; the gill-arches, the vertebrae, the ribs, the muscles of the trunk-musculature, the spinal nerves and the like, within one single specimen) and homonymous (subdivisions occurring in a reflected image; left and right femur and the like). The notions of homology and homonomy (homodynamics and homonymy) may be taken together in the term homologisms.

(1) these sub-parts, regions, appendices etc. of the body within one single construction plan or within more than one construction plan may be analogous. *(Note 30)*.

(2) these sub-parts, regions, appendices, etc. of the body within one single construction plan or within more than one construction plan may be non-analogous. *(Note 31)*.

(c) among two or more construction plans, organs, organ systems, apparatuses and organ complexes that are comparable in some respect, can never be homologous, in virtue of the definition that we have to do with homology only in conservative elements or structural elements, so morphological parts, within one single construction plan, but they may or may not be analogous:

(1) these organs, organ systems, apparatuses and organ complexes within two or more construction plans may be analogous. *(Note 32)*.

(2) these organs, organ systems, apparatuses and organ complexes within two or more construction plans may be non-analogous.

(d) among two or more construction plans, sub-parts, regions, appendices, etc. of the body that are comparable in some respect, can never be homologous, in virtue of the definition that we have to do with homology only in conservative "structural elements", so morphological sub-parts, within one construction plan, but they may or may not be analogous:

(1) these sub-parts, regions, appendices, etc. of the body within two or more construction plans may be analogous. *(Note 33).*

(2) these sub-parts, regions, appendices, etc. of the body within two or more construction plans may also be non-analogous. *(Note 34).*

V, 2. v. *Continuity and discontinuity in the transition*

In the sequences which can be drawn up on the ground of a comparison, the transitions between the elements may be continuous or discontinuous. As a rule the investigation of the given material will lead to discontinuous sequences, but the question is whether in larger and more representative material they might prove to be continuous.

Of historical importance is the conception prevalent in the 18th century that in a systematic arrangement the animal species gradually merged into one another from low to high, from simple to complicated, by which they could be arranged on an "échelle des êtres" or "Stufenleiter". Sometimes the differences between these animal species is thought of as rather great, sometimes also as small, down to minimal. In other words and expressed in an image: the distance between the steps of the stairs may be from great to minute, indeed so minute that the "steps" form a slanting plane. – The discovery of transitional forms and the establishment of such transitions was considered of great importance in the 18th century. Nowadays it is still important. *(Note 35).*

The arrangement of the conditions of the homologous organs etc. was connected with the systematic arrangement of the animal species based on the whole of the animal specimens.

According to the conceptions prevailing in the 18th century the individual development (ontogeny) would run parallel to this systematic of animals. In this individual development the specimen would grow and develop slowly and gradually, in which process, according to the conception then prevailing, it had to be un-wrapped out of its "bandages", literally: had to undergo an "e-volution". On the basis of this parallelism the idea of evolution was transferred to the systematic arrangement of animals. This systematic arrangement would show us the "evolution" in the sense of development of the idea. This development of the idea would become the basis of comparability. It should be remarked that this original idea of evolution has nothing to do with consanguinity and descent: it indicates a development of the idea in different forms, through which the latter are allied, but it does not follow that they are consanguine. If the view of descent and phylogeny is taken in this arrangement, we also speak of descent.

Also in the case of descent we speak of "evolution", but this is not always a further development, for this evolution may also be degenerating and may lead to simpler conditions with fewer complications (parasites).

Forms showing consanguinity, go back to a common "ancestral form" (not a primitive form), which has lived, so which is real, even though we may not, or not yet, know it.

V, 3. EMPIRISMS

V, 3. i. *Introduction*

Empirisms are empirically given logical moments of the subsciences concerned that have been discussed, in our case of comparative anatomy of conservative characters of conservative elements.

Empirisms are naturally not reality itself. Empirisms are abstractions of reality, so notions of reality, notions that directly or eventually are based on reality, belonging to different categories. *(Note 36)*.

Distinction of types among empirisms is possible in the following categories:

(1a) notions of reality in a direct sense, such as the notion of the shape of the heart of a certain specimen of the white human race, etc.

(1b) pure notions in the sense of "notions of notions", provided these notions are eventually based on reality, such as the notion of the shape of the heart in Carnivora pinnipedia, such as the notion of the position of the ovary in Aves, etc.

(2a) general ideas, such as those of growth, quadrangle, etc.

(2b) separate ideas; with regard to the general ideas these are accessory ideas, such as those of square, trapezium, isosceles trapezium, etc.

(3a) sub-empirisms of each other, such as triangle, quadrangle, pentagon as sub-empirisms of polygon, such as various kinds of quadrangle as sub-empirisms of quadrangle, such as isosceles, equilateral triangle as sub-empirisms of triangle, etc.

(3b) neighbour-empirisms of each other, such as triangle as neighbour-empirisms of quadrangle of pentagon, etc.

(4a) qualitative empirisms, such as red-coloured feathers beside black feathers, etc.

(4b) quantitative empirisms, such as the dorsal fin with ten radii, such as the skeleton of the hand with five digiti, etc.

(5a) contingent empirisms, such as those empirisms that occur within one single theory and cannot directly or indirectly be derived from each other, such as the empirisms form and position, etc.

(5b) non-contingent empirisms such as those which can be derived from each other. This opposition does not only occur with empirisms, but also with theories.

(6a) empirically given moments of object-systematics ("Gegenstands-systematik"). By this a definition and separation of a subscience is possible. For the construction of systematics of subsciences, the empirisms applied must in general be contingent, *i.e.* directly or indirectly not derivable from each other, or – which does not occur here – must be antagonistic or correlative ("gegensätzlich").

(6b) empirically given objects of investigation and objects about which answers to questions have been collected. These are partly the same empirisms, partly empirisms other than those which were applied in the definition and separation from the subscience morphology.

V, 3. ii. *Empirisms in the comparative anatomy of conservative characters of conservative elements*

A survey of the empirisms in the supraspecific comparative anatomy of conservative characters in the adult stages of conservative elements in Vertebrata may comprise the following classes and categories of empirisms. Part of these empirisms give rise to scientific questions, which in virtue of the applicable subsciences are permissible. The empirisms meant are:

(1) Form, build and structure. In the course of the investigation the necessity has been felt to make a distinction within the broadly conceived empirisms of "form" between:

(1a) form in the sense of circumference in stereometric sense, or of external figure or of a fixed circumscription, owing to a certain independence of the surroundings, whether also owing to internal coherence or not;

(1b) form in the sense of build, which got the meaning of rougher build and rougher internal articulation, showing the divergent rougher sub-parts of the considered part of the body with its divergent sub-parts with an outline and a topography of their own;

(1c) form in the sense of structure, which got the meaning of finer build of the considered part of the body, showing even more divergent sub-parts with an outline and a topography of their own.

The notions of form, build and structure are not sharply separated, and the definitions that have been given do not make such a sharp separation possible either. Both the form in a special sense and the structure in a wider sense refer to the mutual position ("Lageverhältnis") of the sub-parts of the body, as far as this is preserved in the living body of the natural coherence of the parts, if we do not pay attention to physiological transpositions and to ontogenetic alterations.

In the application of the empirisms of form in the sense of outline, build and structure in a current, narrower sense, empirisms such as the following also play a part: the number, the measures, such as size (absolute and relative), length (absolute and relative), the weight (absolute and relative), the proportions of the parts, the possible articulation, the position and the direction and the connection of the sub-parts and the like.

With this inhomogeneous structure is connected the organization in the sense of internal, articulated figure ("Gestalt") and also the individuality in the sense of the individual figure ("Gestalt").

(2) The said empirisms form, etc. belong to the comparative anatomy meant as far as they are present in certain empirically given sub-parts of the body, *viz.* those with the character of structural elements and of conservative elements. The latter characters would show: the organs, the organ systems, certain parts of organs, apparatuses, organ complexes, etc., all of them as far as they show the character of structural elements. Different kinds of sub-parts of the body without the character of structural or conservative elements are *i.a.* divisions of the body, such as the head, regions of the body, such as the heart region, etc.

(3) As regards the restriction of the consideration of these phenomena to sub-parts of the body in the adult stage or to the whole body in the adult stage, this stage plays the leading part, as well as in allied kinds of phenomena of neoteny, foetalization and allied phenomena. With this a consideration will have to link up on the biogenetic principle and the recapitulation-rules and on certain developmental stages.

(4) These considerations of the said phenomena are restricted to certain adult specimens belonging to one single race or sub-species, or to two or some closely related species belonging to a smaller or wider systematic group, such as one single race, sub-species, species, genus, family, etc.

V, 3. iii. *The empirisms form, build and structure in the comparative anatomy of conservative characters of conservative elements*

V, 3. iii, A. *The principal characters of the form, build and structure*

The form, build and structure of organisms, particularly of Vertebrata, are chiefly characterized by four principal properties. These principal properties are:

(1) Form, build and structure are "essential" in organisms, i.e. characteristic of the biological object and not accidental or casual. Essential and not accidental are not only the form, etc. of organisms, but also those of crystals and those of instruments; this, however, is not the case with a heap of snow.

(2) Form, build and structure in organisms are "changeable" or "dynamic" and not such – at any rate not as far as the rougher sub-parts are concerned – that the sub-parts are unchangeable in form and build, but only move relatively to each other. The form is changeable or dynamic only in organisms (example: a growing extremity; a muscle in function); this is not the case with a machine.

(3) The structure in organisms is "inhomogeneous", *i.e.* the build and structure of organs, tissues and cells at different places are divergent. Inhomogeneous is the structure in organisms and in machines; but this is not the case in crystals, which are homogeneous in their build, at least on the supra-molecular level. In organisms these composing sub-parts are characteristic and they are situated in a characteristic way. This characteristic position is similar in allied animal species. Therefore a common "Abbild" or general conception of such comparable morphological "individuals" or developments can be "geschaut" or (and) a "bildähnliche Formindividualität oder Gestalt" can be graphically designed as a scheme.

(4) The origin of form, build and structure in organisms takes place by "differentiation" from an unarticulated whole and not by conjunction or assembly of originally separate parts. The form of organisms arises by differentiation and not by assembly; this is not the case with a crystal or with an instrument.

In the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of the Vertebrata, some other empirisms, besides the principal empirisms (form, build and structure) play an adventitious part, such as the genesis of the form during ontogeny (not causal) and during the formation of races and species, and descent, variability, pattern or structure, all of which may play an assistant part. Yet other empirisms play an even smaller part in the subscience considered here, though they are not entirely left out of consideration; it is the case with the empirisms function, heredity, adaptation to the environment, abnormal.

V, 3. iii, B. *Certain empirical parts of the body, of interest in relation to the empirisms form, build and structure, etc.*

Above we already saw that the supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata only concerns organs, organ-systems and parts of organs with the property of individuality, because these sub-parts only possess the character of conservative structural elements. A second group of other sub-parts of the body do not belong to this, such as the parts of the body, regions of the body. We will have a closer look at these two kinds of sub-parts of the body.

These two kinds of sub-parts of the body together form only one of the five levels within the biological level, beside the molecular level, the cellular level, the individual level, the biocoenotic level.

V, 3. iii, C. *Organs, organ systems, certain parts of organs, apparatuses and organ complexes in the cases that such empirisms are of interest in relation to the empirisms form, etc. in comparative anatomy, etc.*

The first-mentioned conservative elements or structural elements are empirically given elements, in which this specific character only appears from investigation.

In connection with the structural elements we mention the following elements of the body.

(1) ORGANS. An organ is a small functional unity distinguishing itself as a morphologically limitable part. An organ is an "instrument" with one or more functions. An organ consists of various concrete sub-parts of organs which in their turn may consist entirely or almost entirely of one particular tissue. Organs may reach the external surface of the body or remain completely limited to the interior. The outer surface of an organ is usually sharply limited; it is given by the nature of the object and therefore not arbitrary. *(Note 37).*

As for the external limitation, which is usually sharp, we have to remark that the supplying and discharging blood-vessels, lymph-vessels and nerves are left unconsidered, for these continue both inside and outside the organ. The technique of the preparation with the naked eye has led to leaving blood-vessels, lymph-vessels and nerves out of consideration.

With a number of organs the external limitation, *i.e.* the limitation to the outer surface of the specimen, is sharp and clear, but this limitation does not continue at the same place in the interior and there is no clean-cut limitation. *(Note 38).*

In spite of all this, the organ would possess a certain degree of individuality in functional respect. This individuality does not imply that it could not be divided, but it does imply that it is undivided and that it tends to remain undivided. This latter property is also shown by organ systems and apparatuses.

(2) ORGAN SYSTEMS. These are systems which either form one single functional unity, or consist of some mutually connected functional unities, which distinguish themselves as a morphologically limitable larger whole. The single unity or the mutually connected unities consist of a number of mutually connected organs, which are morphologically coherent. *(Note 39).*

We speak of an organ system, if three properties are present in it; as an exception, the latter is not realized. These three properties are:

a) all sub-parts have something in common in their finer build; in certain cases this may have the character of a tissue. *(Note 40).*

b) these sub-parts ontogenetically originate from a less markedly articulated whole. *(Note 41).*

c) this organ system is less articulated in systematically lower animal species than it is in higher ones. *(Note 42).*

(3) SUB-PARTS of organs with a certain degree of individuality. *(Note 43).*

(4) APPARATUSES in a restricted sense as a part of an organ system. *(Note 44).* An apparatus in a restricted sense and in the usual sense has a functional tendency. Apparatuses in a very restricted sense, so referring to

very small sub-parts of an organ system, may approach the limit of an organ.

(5) APPARATUSES in a more comprising sense. *(Note 45)*. Such apparatuses comprise two or more apparatuses in a restricted sense.

(6) ORGAN COMPLEXES. These are complexes of organs, belonging to different organ systems forming a morphological whole with each other, in connection with a certain function. *(Note 46)*.

V, 3. iii, D. *Other parts of the body without the character of structural elements as such empirisms*

Not to the above empirically given sub-parts of the body, which have the character of conservative elements or structural elements, but to a different category of empirically given morphological sub-parts of the body, we rank all those sub-parts of the body that are not conservative structural elements, nor show a limitation given by the nature of the sub-part, but which can only artificially and arbitrarily be limited, so according to a certain agreement. Compared to different species, these arbitrarily limited parts are extended to a divergent degree.

Of these sub-parts of the body, which are lacking the character of conservative elements or structural elements, we mention the following categories:

(*a*) Parts of the body or externally visible divisions of the body. The limitation of these externally conspicuous parts of the body is not sharp, is not determined by the nature of the part of the body, but is determined arbitrarily. It does not continue in the interior of the body. *(Note 47)*.

(*b*) Regions of the body as a whole, of parts of the body, and of regions surrounding a certain organ. These "regions", vaguely limited on the body, are also internally vaguely limited, and therefore not limitable. They are areas of a complex composition and contents. *(Note 48)*.

(*c*) Other superficial external parts or features in the surface of the outer contours of the animal. These may be: small, other little areas of a complex composition and contents, whether or not situated within a "region" (they are usually smaller than "regions"). We can distinguish externally visible and protuberant forms of the skin and the skeleton; externally visible openings in the surface of the body with the surrounding parts; superficial furrows in the surface of the body; spots and patches in the coloured skin and some other formations. Here, too, the limitation of these external parts is not sharp in a number of cases, it is not determined by the nature of the part, but is determined arbitrarily and the external limitation does not continue in the interior. *(Note 49)*.

(*d*) Appendices of the body as a whole. The appendices are carried by all divisions of the body. The limitation of these appendices – at least on the side where they are attached – is not sharp, is not given by the nature of the appendix, but is determined arbitrarily. The external limitation does not continue in the interior. These appendices may either be continuous or discontinuous. *(Note 50).*

(*e*) Appendices and protuberances of the separate divisions of the body and of its sub-parts, as well as the sub-parts of such appendices and protuberances. The limitation of these appendices and protuberances – at least on the side where they are attached – is not sharp, is not determined by the nature of the sub-part, but is determined arbitrarily. This external limitation does not continue in the interior either. These appendices and protuberances, too, may either be continuous or discontinuous. *(Note 51).*

V, 3. iii, E. *Certain stages of age and development, of interest in relation to the empirisms form, build and structure in the comparative anatomy, etc.*

In certain groups we may distinguish a number of stages during the life of the individual. *(Note 52).*

V, 3. iii, F. *Adult stages and the empirisms form, build and structure in the comparative anatomy, etc.*

The supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of Vertebrata is in the first instance concerned with adult stages. This has also been in the course which this subscience has taken in history. In a following section we shall see why the study of ontogenetic stages is kept apart and how far this is right and how far this is not permissible.

Let us now consider what should be understood by adult stages and in what way these stages are determined.

In the first place adult can be concluded for many specimens of one particular species or race, on the ground of the morphological features of these many specimens, which also show differences in senescence, age and development.

In the second place the adult stage can be concluded for the whole specimens on the ground of some morphological criterion, or for one single organ, or one single part of the body, etc.

In the third place the adult stage can be concluded on the ground of the manifestation of a certain function and the morphological, microscopic-anatomical or histological picture correlating with this.

In the fourth place the adult stage in a certain species can be concluded on the ground of conditions found in an allied species.

In investigating many specimens of one particular species or race, the adult stages can be distinguished from the other stages. The usual conception of adult places the adult stages in the following sequence of successive stages: fecundated ovum – cleavage stages – formation of the germ-layers – incipient "anlage" of organs (organogenesis) – "anlage" of ovum-membranes and embryonic membranes – alterations in form, build and structure of the developing organs, etc. – embryonic and foetal stages in direct development – larval stage or larval stages or indirect development with metamorphosis or transformation of the specimen in the course of the individual development, in which the so-called larval stage is different in form and appearance from the adult stage – juvenile stages – adult stages – senile stages.

In this consecutive sequence of stages and sometimes also in the separate stages, the following processes are concerned: origin, growth (growing bigger, differentiation, fusion, bifurcation), flourish, decay and destruction. The points of time of these processes in the development of complete specimens succeed each other, at least they differ. Sometimes the processes mentioned are restricted to one or to some stages in the development (youngest stages, larva, embryo, foetus, adult, senile).

We may realize the processes mentioned in the consecutive sequence of stages during the individual development not only for complete specimens, but we may also study these processes and their order for separate organ systems, for separate organs and for parts of organs, showing a certain degree of individuality. In doing so we should pay attention to the fact that most organs pass through the process of origin, flourish, decay, etc. only once. This once occurring process may take place within one single developmental stage. *(Note 53).* However, it may also extend over more than one developmental stage. *(Note 54).*

Apart from this we also know the phenomenon for some organs that they may pass through the stages of flourish, decay, etc. more than once in the life of one specimen. *(Note 55).*

In one respect the conclusion as to the stage of adult in Vertebrata is less complicated than in a number of Evertebrata, as the Vertebrata in the adult stage are solitary or monozootic and not colony-building or polyzootic. *(Note 56).*

The conclusion of the stage of adult in Vertebrata for whole specimens will have to be drawn on the ground of some criterion, chosen as starting-point or standard. This criterion could be a certain feature or a certain property, in which a certain value is reached or remains preserved. As such criteria we mention *i.a.*: the length of the body, the condition of the gonads, etc. If it is difficult to state such a criterion, or if, on account of the condition of the material, it is difficult to use this one right criterion, then the condition in many other criteria, or as many other criteria as possible, is usually taken.

The conclusion as to the length of the body or the size of a certain organ for the adult stage should, if possible, be drawn on the basis of a growth curve to be determined. As to the body and the various organs etc., the slope of the growth curve may widely diverge. This slope of the growth curve is connected with the time, the rate and the degree of growth. For several organs etc. the value of the feature or the property, according to which the value of adult specimens is determined, lies at different points of time and also differs in duration; it may occur once during the individual life, but it may also be repeated. Such a peak or peak-area may be followed by a situation indicated by a downward slope, which indicates a senile stage, following the adult stage.

The stage of adult may also be concluded from the manifestation of a certain function and from the morphological, microscopic-anatomical and histological pictures correlating with this, as is the case if adult is held as the beginning of sexual function, or rather, of sexual maturity.

The adult stage in a certain species may also be concluded on the ground of conditions found in an allied species.

In comparing one and the same stage in different species, it appears that certain organs do not reach the adult stage simultaneously, that certain processes and formations are bound to certain stages in ontogenesis and *e.g.* only occur during one stage in the development. The same appears, if we compare the conditions in different sub-parts of a body in one single specimen and if we compare the conditions in different developmental stages of one and the same specimen.

V, 3. iii, G. *Neoteny, foetalization and allied phenomena and the empirisms form, build and structure, etc. in the comparative anatomy, etc.*

By neoteny, foetalization and allied phenomena we understand the phenomena of those specimens or representatives showing sexual maturity of the animal species, but which bears features by which it resembles the young specimen, the larva, the embryo or the foetus of a systematically allied group of animal species. Expressed in another way: by neoteny, foetalization and allied phenomena we understand the phenomena of a form, showing the features of a juvenile specimen, a larva, an embryo, a foetus, etc. of this phenotypically allied and systematically allied group, features which have been retained in the sexually mature form of the allied normal species. The study of these first-mentioned species, showing neoteny, foetalization, etc. has its importance in the study of the comparative anatomy of the conservative elements.

The species showing features of neoteny, foetalization and allied phenomena, are considered as secondary species, as derived species, as descendant species of the other more normal species, which build up the group of the primary species, the original species, the ancestor species.

The phenomena of neoteny, foetalization and allied phenomena, have not only been expressed in terms of the description of the morphological status of the soma, but they have also been expressed in terms of development and rate of development of the reproductive organs and the body in the species bearing these phenomena as well as in the allied more normal species.

Expressed in terms of development of body and reproductive organs we find that the organs of the body do not reach the adult stage of the reproductive organs, nor the adult stage of the organs of the body of the systematically allied group of more normal animal species, as really is the case in these more normal species, as the comparison between the secondary derived species and the primary original species shows. In the cases of neoteny, foetalization and allied phenomena, we find precocious sexual maturity of the reproductive organs while the soma (body) is still in the condition of a young specimen, a larva, an embryo or a foetus. In these cases the specimens retain there larval etc. form either temporarily or permanently and become sexually mature in that condition, without undergoing the final developmental changes which produce the adult. The body of this secondary species is retained in the condition of partially arrested development as compared with the group of primary systematically allied species. The development of the body of these neotenic etc. species proceeds less far than in the systematically allied species.

Expressed in terms of rate of development such as acceleration and retardation of the reproductive organs and of the body of the species bearing these phenomena of neoteny, foetalization, etc. and of the body of the allied group of more normal species, the following descriptions are given. The cases showing neoteny, etc. imply a relative retardation in the rate of development of the soma (body) as compared with the reproductive glands (germen), so that in respect of certain characters the body does not develop as much in the ontogeny of the secondary systematically allied species as it did in that of the primary systematically allied species.

In terms of acceleration and retardation we can consider the rate of development in two ways: in the first place, as an acceleration of sexual maturity and as an acceleration of the rate of development of the reproductive organs, but as a retardation in the rate of development of the body. In the second place the rate of development can be considered as an acceleration in the rate of development of the reproductive organs, but as a comparatively greater retardation in the rate of development of the body. The consequences of this retardation in the rate of development of the body can be: retardation in the rate of development of the body relative to that of the reproductive organs, retardation of structures to vestiges, characters becoming reduced and vestigial, as the original adult characters arise too late to be fully formed; degeneration; specialization; simplification, often associated with parasitism.

These features of neoteny, foetalization, etc. occur in a comparatively small number of animal species. We will discuss the three main forms here.

(1) Real neoteny or neoteny s.s. It occurs in the larval stage. In this form of neoteny the specimen reaches sexual maturity in the larval stage and many organs and organ systems – or rather: all organs and organ systems, except for the sexual organs – do not reach the adult stage, which systematically allied animal species do reach. With regard to the latter group, these neotenic forms are larval or juvenile, except, of course for the sexual organs. *(Note 57).*

(2) Partial neoteny or neoteny s.l. In this form of neoteny the sexually

mature form retains larval or juvenile features in only one organ or in a small number of organs or organ systems, and so it does not reach the adult stage in these features, which systematically allied species do reach. *(Note 58)*.

(3) Foetalization. This occurs in the sexually mature stage, if this has retained a great number of foetal characters *(Note 59)* or only a few foetal characters *(Note 60)*. This category comprises cases in which characters in the adult secondary or derived animal species or descendant species remain in the same condition as in the foetus or juvenile specimen of the primary or original or ancestor species. This foetalization of certain features of the body is associated with a retardation of the development. Foetalization can be considered as a special form of neoteny. Some authors also call this phenomenon neoteny, even in animal species without a larval stage.

Foetalization without retardation of development may also occur. *(Note 61)*. There is also retardation of development without foetalization. *(Note 62)*.

V, 3. iv, A. *Developmental stages, related to the research of the empirisms form, build and structure in the comparative anatomy, etc.*

V, 3. iv, A, a. Introduction

In the supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata, the developmental stages are not dealt with in such detail and not with the same interest on the same level as the adult stages. They are only inserted as expedients in drawing conclusions in the field of the comparative anatomy in adult stages. This is done in determining the adult stage in certain species, in giving evidence for homology, etc.

The very first stages of ovum-cleavage, organogenesis, the youngest embryonic stages and the ovum-membranes and embryonic membranes deal with problems of the developmental stages which are so different from those occurring in the adult stages, that they deserve separate treatment outside comparative anatomy, in an ontogeny that may also be comparatively dealt with. – The later conditions concerning build, etc. after these very first stages could be treated per stage in a way parallel to the comparative anatomy of adult stages, so not inquiring after causes, but investigating into the statically thought conditions (momentary surveys) during the development. These data might be classed under such a comparative anatomy of conservative characters of adult and of developmental stages of conservative elements. This has been done at times. It is more fruitful, however, to class these data concerning the developmental stages under a separate science, *viz.* ontogeny. Ontogeny is known to comprise, besides the comparative side meant, an important new element which is decisive, *viz.* the real interconnection of the stages in the course of the ontogenesis of one specimen or of one species. This makes it possible to fix an order of the methodically static conditions (momentary surveys) on this one real line. This new additional element is so fundamental, that the other morphological considerations are classed under it on the basis of developmental stages and that comparative anatomy in the sense of conservative characters of developmental stages of conservative elements is not separated from it; they are classed under comparative ontogeny.

We have already mentioned that facts from the anatomy of developmental stages may be used as expedients in the arguments concerning the supraspecific comparative anatomy of conservative characters of adult stages of conservative elements of Vertebrata. This use of developmental stages occurs in stating the adult stage, in giving evidence for homology on the basis of equal form, build and structure and on the ground of equal position.

V, 3. iv, A, b. Justification of the incorporation of developmental stages of different age in the investigation of the empirisms form, build and structure in adult specimens for the sake of comparative anatomy

As a ground for the justification – on the ground of negative and practical reasons, by way of an excuse – of the fact that in the comparison not only the conditions in the adult stages of animal species are implied, but also the conditions in various old developmental stages in different animal species, the following reasons are brought forward.

(1) As a negative reason it may be mentioned that the age of the specimen, expressed in the developmental stage, does not say anything about the developmental condition and the age of the organ concerned, for at a certain "age" of the specimen the degree of development of the various organs can be very different. This is connected with a number of factors, of which we mention the following.

(a) The organ concerned may not yet function at the investigated stage, it may already function, or it may have ceased to function. *(Note 63)*. The relation between "age" and functioning is highly divergent for various organs.

(b) The organ concerned may be built shortly before it begins to function, but also long before this, so that a divergent difference in time between the "anlage" and the beginning of function may occur. *(Note 64)*.

(c) At the end of its functioning the organ may be preserved or it may disappear, in other words, the destiny of the organ after its function has ceased, is divergent in morphological respect. *(Note 65)*.

The conclusion may be that also with different animal species, specimens of the same "age" or of the same developmental stage may have reached a very different degree of development. As examples we refer to two categories:

(α) At birth, the developmental condition of an examined organ is sometimes widely divergent in various animal species. *(Note 66)*.

(β) In neotenic forms, the developmental condition of many or of some organs, etc. is sometimes widely divergent.

(2) As a practical reason it may be mentioned that the comparison of the conditions of conservative elements – not only in the adult stages of various animal species, but also in differently old developmental stages – has produced a great many useful results, and this comparison is therefore regarded as highly fruitful. In connection with this we mention six categories of cases.

(1) In the adult stage in various animal species, the position of the organs may be very divergent, whereas they correspond or approach each other in position, if we consider a younger developmental stage in one or in both animal species, or if we go back in ontogenesis. *(Note 67)*.

(2) In the adult stage in various animal species, the form, build and structure of an organ may be very divergent (which is connected with the so different functional demands that are made on the organ in the adult animal), whereas they correspond or approach each other in these respects, if we regard a younger developmental stage in one or in both animal species, or go back in ontogenesis. *(Note 68)*.

These two criteria (topography and form, etc.) may be called together origin; the term origin may refer to one single stage in ontogenesis. *(Note 69)*.

(3) The size, form, build and structure of an organ in the adult stage in various animal species may be very divergent (from very large to very small or rudimentary), whereas they correspond or approach each other in these respects, if we consider a younger developmental stage in one or in both animal species, or go back in ontogenesis. *(Note 70)*.

Here the term of "rudimentary organ" has the meaning of an organ simplified and reduced in size by the loss of functions or by diminished functions. The old conception that with such organs there would actually be no question of function at all, is no longer supported by many modern authors. *(Note 71)*.

This meaning of "rudimentary organ" in the sense of simplified or reduced organ should not be mixed up with the meaning of "rudiment" in the English language, in the sense of "primordium", "Anlage" or "anlage".

(4) In the adult stage in a particular animal species, an organ may be absent, but this is only a seeming absence. In another species, this organ may be clearly present in all specimens. The ontogeny of the former species teaches that the apparently lacking element is present in a young ontogenetic stage as a separate element in all specimens, but that it fuses with a neighbour element in a later ontogenetic stage in all specimens. *(Note 72)*. This neighbour element may be a similar element, but it may also be of an entirely different nature, *e.g.* in a histogenetic respect.

(5) In a number of specimens of a particular animal species in the adult stage, an organ may be absent, and in other specimens, likewise in the adult stage, it may be present, while in a second and third animal species in the

adult stage, this organ is absent, respectively present in all specimens. The ontogeny of the firstmeant species teaches that here we have to do with a deviation in the normal development. *(Note 73)*.

(6) In a particular animal species in the adult stage and in all developmental stages, an organ may be lacking and so be really absent, whereas this organ is present in other animal species. *(Note 74)*.

V, 3. v, A. *Variability in form, build and structure of parts and of characters in empirically chosen adult specimens of one single animal species*

The study of the supraspecific comparative anatomy of conservative characters of conservative elements, also in the restriction to one stage, in this case the adult stage, comprises widely divergent specimens as to form, build and structure, as concerns these specimens as a whole, as well as their various organs, etc.

Paying attention to the specimens as a whole and to their organs, three main groups of variability can be distinguished as to the divergence in form, etc. among the specimens. These are:

(1) The specimens more or less widely deviating in form, etc. which have been injured or mutilated by an accident, or by past illness, or by the results of illness.

(2) The specimens divergent in form, dependent on the functional process and of the stage in which the function is performed (movement, flight, taking food, respiration, etc.). The form-variability is also connected with the question whether the specimen as a whole is functioning or whether its organs are functioning, or whether a particular organ is functioning, which again depends on the question as to which functional process takes place.

(3) The normal variability, present in specimens that are neither injured nor mutilated by an accident or an illness and which are in a comparable stage of function-performance.

Variability in form, build and structure of sub-parts, properties and characteristics of adult specimens of one single animal species has many forms.

The variability of the mutual developmental stages and within one single developmental stage are left out of consideration. The differences in age within the adult stage are further neglected (the senile stage is classed as a separate stage). As a result of this, the things that are considered within the subscience discussed here, are: sexual dimorphism and other somatic variability, which may appear in a number of forms. Classed according to the types of variability, the following survey is obtained.

Two main forms of variability are distinguished, *viz.* the individual variability (here it is the specimens that vary) *(Note 75)* and partial variability (here certain sub-parts of one single specimen vary, which sub-parts occur in the plural on or attached to this specimen).

Both the individual variability in the interindividual formrelationship and the partial variability in the intraindividual formrelationship reveal themselves in three forms: as alternative, as discontinuous and as continuous variability.

(I) The individual variability, in which specimens vary in the way of the alternative individual variability, so in which the variable property presents itself in two distinctly separated types, occurs in the Vertebrata:

(1) As a distinct sexual dimorphism in build and in size in adult specimens. *(Note 76)*.

(2) As a distinct difference in build between ontogenetic stages and adult forms with metamorphosis, after one juvenile stage. *(Note 77)*.

(3) As a distinct difference in build (colour) in seasonal dimorphism. *(Note 78)*.

Other forms of alternative individual variability do not occur in Vertebrata. Hence dimorphism in a dimorphous colony does not occur, nor dimorphism in metagenesis, nor dimorphism in heterogony, which three forms do occur in Evertebrata.

(II) The individual variability – in which specimens vary in the form of the discontinuous, non-gradual or interrupted variability – called so, because the variable property occurs in a number of clearly separated types, occurs in the Vertebrata:

(1) As a distinct difference in build and size among various solitary individuals. *(Note 79)*.

Other forms of discontinuous individual variability do not occur in Vertebrata. Hence trimorphism of the asexual form, the male and the female form does not occur, nor polymorphism in a colony, nor succession of three generations, nor polymorphism in alloiogenesis, and in other juvenile stages with metamorphosis, which forms do occur in Evertebrata.

(III) The individual variability – in which specimens vary in the form of the continuous, gradual or uninterrupted individual variability – called so, because the variable property shows transitions without sharp limitations, occurs in Vertebrata, where the value is fixed in a weight or a measure and gradually increases or decreases. *(Note 80)*.

(IV) Partial variability – in which certain sub-parts of the body occur in the plural in one single specimen –, appearing in the form of alternative variability, occurs in the Vertebrata:

(1) Where the variability occurs in two distinctly separated types. *(Note 81)*.

(V) Partial variability – in which certain sub-parts of the body occur in the plural in one single specimen –, appearing in the form of discontinuous, nongradual or interrupted variability, called so, because the variable property occurs in a number of clearly separated types, occurs in Vertebrata:

(1) where a number of clearly separated types occur. *(Note 82).*

(VI) Partial variability – in which certain sub-parts of the body occur in the plural in one single specimen –, appearing in the form of continuous, gradual or uninterrupted variability, called so, because the variable property shows transitions without sharp limitations. This is the case where the property is fixed in a weight or measure, and gradually increases or decreases.

(1) Where a continuous transition of properties occurs. *(Note 83).*

On the basis of their biological meaning we may distinguish the following five kinds among the variations:

(1) Pathological variations. These are assumed to be connected with the pathological condition of the individual. *(Note 84).*

Sometimes we also speak of pathological phenomena in certain animal species where a phenomenon occurs "normally" when in other animal species the same phenomenon occurs only as a pathological individual variation. *(Note 85).*

(2) Domestication-variations. These variations owe their name to their occurrence in human beings and domestic animals. Wild animals living as commensals in the neighbourhood of human beings, show some of these variations. The domestication-variations are connected with a) a negative selection, owing to the diminished struggle for life, as a result of which deviating specimens also live (in whatever way originated, by normal or by abnormal causes), or b) a positive selection, as with human beings in their choice of a partner for not strictly biological features, and with domestic animals and plants in breeding and cultivating certain desired variations. *(Note 86).*

(3) The number of variations per specimen. In one single specimen, one, some, or numerous variations may occur. These may relate to one, some, or numerous features. In some or in numerous variations we may have to do with a combination or a correlation. By a combination we understand here the combination in the sense of a casual meeting of features according to the laws of the calculation of probabilities. By a correlation we understand here the correlation in the sense of a non-casual united appearance of two or more features, which is based on a common cause of origin. The biological meaning of this may be in the hereditary back-ground, namely whether a gene manifests itself in many features (pleiotropy) *(Note 87)*, or only in one feature.

(4) Progressive or regressive variations. If in a certain specimen a variation occurs, it depends on the opinion of the investigator in the phylogenetic developmental direction whether he wants to call this variation progressive or regressive. *(Note 88).*

(*5*) Oecologic-morphological variations. These variations are assumed to have significance in connection with being adapted to, or the adaptation to the milieu, especially the climate.

In connection with this there are a number of "rules", of which we mention the following.

(*i*) The rule of Bergmann: in the warm-blooded there is an increase of the size of the body parallel to the cooling climate.

(*ii*) The rule of Allen: in the warm-blooded there is a relative shortening of the tail, extremities, bills and ears, parallel to the cooling climate.

(*iii*) The rule of Gloger: in the warm-blooded there is a decrease of the pigments phaeomelanine and finally of the eumelanine, parallel to the cooling climate.

(*iv*) The rule of the length of hair and of the number of wool-hairs: in the warm-blooded there is an increase of the relative length of hair and also of the number of wool-hairs, parallel to the cooling climate.

(*v*) The rule of the shape of the wings with Aves: in the warm-blooded the wingtips tend to become more pointed, parallel to the cooling climate.

(*vi*) The rule of the increase of the entrails: in the warm-blooded there is an increase of the relative weight of the heart and probably of the relative size of the stomach and the intestines, parallel to the cooling climate.

(*vii*) The rule of the number of eggs and young: in the warm-blooded there is an increase of the number of eggs per layer and of the number of young per litter, parallel to the cooling climate.

On the basis of the causes of the origin of the variations, the following categories in variability are distinguished:

(*A*) Modificability. This is the case when the variability has originated by modifications and therefore is not hereditary or genotypical. *(Note 89).*

(*B*) Diversity. This is the case when the variability is based on a difference in hereditary tendency and therefore is genotypically determined. *(Note 90).*

(*C*) An unknown cause of the origin of the variability. This occurs in a number of cases. *(Note 91).*

V, 3. v, B. *Norm and normal in the characters of form, build and structure of parts in empirically chosen adult specimens of a single animal species*

With this empirism it is a question of a selection from variable forms, variable regarding the somatic characteristics. Those somatic variations, however, which are the result of an accident or a disease, and those variations, which go together with the execution of the functions, when the somatic characteristics show an extreme state or condition, are left out of consideration here.

In the field of norm and normal there are also divergent opinions.

If one has or can get more specimens for examination of the anatomy of the adult stage of a certain animal species, one will not describe and picture their form, build and structure, but one will try to describe what is regarded as "normal" of the material. As "normal" is considered that which is thought to show something "typical" or "essential" of the species. If it is a question of determining the properties or characters of a certain aberrant specimen, only that one aberrant specimen is examined.

By "normal" several authors mean different stages or conditions, because these authors have a divergent view of what has to be considered as normal, typical and essential. *(Note 92)*. The most important interpretations of "norm" and "normal" are the following.

(1) HILDEBRANDT's norm (1920) is as it should be, as *e.g.* the highest value, the optimum, the best example. Those specimens would have this "norm", which would attain the special purposes of life of the organism involved and which would then become independent of external circumstances. One can gather this "norm" from one single, even imperfect, phenomenon. The "norm" is an idea, in the sense of a platonic idea. This "norm" is not realized in nature and therefore any biological significance is wanting. In nature this "norm" is only approached more or less.

(2) LUBOSCH's "norm" (1925) on the other hand is like all the following notions of norm empirically determined. With Lubosch the "norm" is the "typus" or the "rule" to which a number of separate cases belong. The differences between the separate cases are taken up in this "typus" to form a whole at a higher level. Or to put it differently: "typus" is taken here in the sense of a super-individual unity or multitude of specimens, in which the individual differences of the separate specimens are taken up synthetically. Not all specimens belong to the "norm", for the "norm" is the multitude of the individuals which comprises the most probable combinations. The most probable combinations occur most often, they form the "rule". The most probable combinations, therefore, are not all the combinations that occur and certainly not all possible combinations that have or have not yet occurred. To such a general limitation no biological significance can be attributed.

(3) RAUTMANN's "norm" (1921) is the typical, determined empirically. According to him those phenomena are typical which occur as a rule, *i.e.* most often, or anyway considerably more than certain other phenomena. We can read this from the variation-curve of the phenomenon. This "norm" may be mathematically determined. The specimens showing the so-called "normal" phenomena, would have the highest value, biologically, in the struggle for life.

(4) With some authors the "norm" is a single intermediate value, by which the typical or the essential is represented. The archetype or "Ur-

bild" would also show only one value for each property. Several authors then differ again of opinion what this one intermediate value would be. The intermediate values being empirically determined, differ fundamentally, although they may coincide in certain cases.

According to different authors the intermediate values meant may be:

(i) The value occurring most often or the "dichteste Wert" of Fechner or the "Modalwert" or the "mode" in the English literature;

(ii) the value of the separate measure of the middlemost specimen of separate measures, arranged according to the property involved, or Fechner's "Zentralwert" or Galton's "Medianwert";

(iii) the value halfway between the highest and the lowest value of the property involved or Fechner's "Mediane" or "Wertmitte" or Galton's "Zentralwert";

(iv) the value of the arithmical average.

There is no clear biological significance in these intermediate values (i) through (iv).

There are also cases of a real norm amongst the "norms", represented by a single intermediate value, but also cases of a virtual or unreal or unrealized norm, resulting from calculation. *(Note 92).*

(5) With some authors the "norm" is an empirically determinable field of a certain width on both sides of one of the intermediate values discussed above. This "norm", too, may be mathematically determined.

Here, too there is no clear biological significance, *e.g.* as a lead in the struggle for life.

(6) GROTE's "norm" (1922) has the specimen with an individual, *i.e.* a relative state of health, which shows a responsive quality towards the milieu. "Responsive life" is life which ensures the existence of the separate specimen under the given circumstances. So the question of the "norm" is shifted from the properties of the specimen of the animal species to the properties of the milieu or the circumstances.

Really only separate organs or parts of the body play a part in all these concepts of norm, in Grote's norm to a less extent. It is hardly tried to comprise the totality of the individual when judging what is "normal" and what not.

Some authors first put the ill specimens in the material aside, before they proceed to the determination of the "normal" specimens.

Determining what may be called "ill" specimens is possible with the human being, the domestic animals and the cultivated crops, because an opinion or notion has been formed about what should be called ill. With organism living in the wild this is more difficult. We cannot go into detail about what may be called "ill". It is a complicated problem of nosology and pathology, of feeling ill subjectively and objective indications of illness; furthermore there is the problem of the relation of illness to normal and abnormal.

V, 3. vi. *Comparison of conservative characters of conservative elements in various adult specimens of the same species, or in different adult specimens of systematically allied species*

V, 3. vi, A. *In various adult specimens of the same species*

In studying the comparative anatomy of conservative characters in the adult stage of conservative elements in Vertebrata, one generally has to deal with a supraspecific comparison.

Occasionally investigations are taken up into our subscience which deal with comparisons between objects that do belong to one species. To these exceptions belong, in the first place, comparisons between states or conditions in both sexes in cases when the differences among them are great, and secondly comparisons between states in different races and subspecies of one species, also in cases when the differences among them are great. The fact that both these fields are taken into the comparative anatomy of the conservative characters in the adult stage of conservative elements in the Vertebrata, is justified by the fact that in these cases the morphological differences are as great as the differences between systematically different species.

The other groups of differences between specimens of one species are not taken up into the comparative anatomy of conservative characters in the adult stage of conservative elements. In the first place these are mainly the elements which occur in specimens of one single animal-race or one animal-species without races and which are comparable; and in the second place the elements which occur more than once in one specimen and which may be called identical in spite of the differences.

V, 3. vi, B. *In different adult specimens of systematically allied species*

The study of supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in the Vertebrata has a bearing on systematically allied species amongst the Vertebrata, which relationship will be a close one, or otherwise a more remote, *i.e.* a less close one.

From our views of the systematic relationship of animals, *i.e.* from the systematics of animals an indication will be deduced about the allied species or the representatives of the systematic groups to be examined. A well-thought-out system of the animal species and the small and large groups of animals is of great importance in this examination and in the comparison of specimens of the same species, of subspecies, of closely allied, remotely allied and unrelated species. It is also of great importance when describing the results after comparing the facts in literature, when determining the relation and deducing a state from a type-situation or determining a type, either when this type represents a single form from the whole systematic group, or when it comprises all the species included in it.

When closely allied or less closely allied species are drawn into the examination in connection with the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of the Vertebrata, the question about the reality of the systematic group is not asked and is not considered, nor the question whether the species etc. are merely "pure notions" or realia.

The basis of this systematic arrangement may be a subjective one, an objective idealistic-morphological one and an objective phylogenetic one, by which we should not only think of the phylogeny of larger systematic groups but also of the formation of races, sub-species and species according to the views of "speciation". The methods of investigation of the "speciation" and of the phylogeny diverge and they manipulate divergent material.

With the formation of races and species it is a question of frequently repeated processes and sometimes also recurring processes, originating from each other, which can actually be observed. That is why we can get a considerable amount of certainty about the origin of one state of a morphological part from a historically preceding part in the ancestor. With the formation of races and species, the cause can be looked for, as a rule, in a physical-chemical phenomenon or in a mutation. This formation of races and species may be in a straight line and when we are dealing with a continuous process it may be directed and undirected. But the formation of races and species may also run in separated channels (ramified or fan-shaped). Finally it may be important for our morphological considerations to know whether there is a relation between the properties of the newly originated race or species and the properties of the climate, and those of the vegetable world and of the world of other animals.

In the phylogeny of the larger systematic groups we usually have to deal with two or more systematically remote species or with even larger systematic groups. Here we cannot rely on a perceptible descent of one race from another, of one species from another, of one systematic group from another, but we have to follow another procedure. So there are two or more animal species, about which we wonder whether the one might have originated from the other, or may both have originated from a third one, an animal species as yet unknown to us. In the case of two more or less large systematic groups, we may ask whether the usually unknown ancestral form of the one group may have originated from the ancestral form of the other group, in which case we do not penetrate into the questions of descent of a species of one group from a species of another group. We may ask ourselves in these phylogenetic considerations on which data our conclusion about the descent is founded. Apart from the chronological order and the place of origin naturally characteristics of form, build and structure also play a great part in fossils.

The character of the taxon, the unity of the systematics, is real concerning the smallest unities: the race, the subspecies, the species; the character concerning the bigger unities: the family, the order, the class, etc. is dependent of the views of the authors, either ideal or real. Ideal are the relations between the species in a typological row. Real are the relations between species succeeding each other in the formation of races and species and the relations between the interconnected species in a phylogenetic row are also real.

What is the relation between the arrangement of an organ examined on the ground of the systematic arrangement of the species being the bearer of the organ concerned and the arrangement of that organ examined on the ground of the characteristic properties of that organ itself?

If one takes the organs in the same order as is given by the order of the animal species in the line of descent, *i.e.* from the ancestral form down to a descendant occurring later, one can deduce the geological younger state of a certain organ from the geological older state, lying on one and the same line. It is a secondary matter whether we may speak of a "descent of organs" from each other, when we consider morphological parts. There are good reasons for justification when it is a case of conservative elements or morphological elements, which are present in all representatives of a single systematic group as a separate unity.

If we take the organs we are interested in, as such, without paying attention to the descent of the animal species bearing these organs and if we arrange these separate organs according to their own properties in a certain order – from simple to complicated or vice versa – there may be a possibility that such a row will run parallel with the line of descent, but such a row may also run differently and vary from the line of descent.

Whatever may be the character of the systematic arrangement or ordening or the arrangement of the organ examined, great value will always be attached to the knowledge of the intermediate and transitional forms.

In the systematics this ordening and this placing of the states in species and in intermediate and transitional forms is, in principle, an arrangement on its own regarding the arrangement in the supraspecific comparative anatomy of conservative characters in the adult stages of conservative elements of the Vertebrata.

Both kinds of ordening may run an equal course, but their course may differ too.

V, 3. vii. *The comparison of the condition of certain conservative characters of certain conservative elements in adult and in developmental stages of the same age and of different age and of the same and of different animal species*

V, 3. vii, A. *The base or ground of this comparison in the case of a subjective base of comparison or of an objective base according to a systematic ordening and the relations of form-characters of adults with the characters of ontogenetic stages; biogenetic basic rule; rules of recapitulation. Next to an idealistic and a phylogenetic ordening*

When we want to justify that it is right to use the fruitful results of the comparison of the condition of certain conservative characters of conservative elements in adult stages, in developmental stages of the same age and of different age and of the same and of different animal species for the benefit of the study and the understanding of the supraspecific comparative anatomy of conservative characters in the adult stage in the conservative elements in the Vertebrata in general – the comparison being made on a subjective base and on an objective systematic ordening – our understanding of certain "laws" in this field plays a part within the separate fields as well as between these fields.

The "laws" within the separate fields which are important for our purpose are known as (a) "laws" in the field of mutual relations between adult etc. characteristics of form, but also in their relation to (b) the relation to the systematic arrangement (next to it the idealistic-morphological arrangement *(Note 93)* and the phylogenetic arrangement *(Note 94)* require attention) and also in their relation to (c) the relation to the ontogeny.

What is of special interest to us in this chapter, is, whether there is a parallel or not and what is its nature in the relation between (a) the laws in this field of the mutual relations between adult etc. form-characteristics and the laws either (b) with the laws in the field of the relation to the systematic ordening of the species or with (c) the ontogeny. Or what is the parallel as well with (b) the laws in the field of the relation to the systematic ordening, etc. as with (c) the laws in the field of the ontogeny.

Concerning the above mentioned arrangement we have already remarked that a difference must be made between the subjective human ordening and the objective ordening on the ground of objective systematics and of an idealistic morphology *(Note 93)* and an objective arrangement on the ground of the phylogeny. *(Note 94)*.

The cases about which we have come to learn that a parallel can be drawn, as is stated above, increase our understanding of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of the Vertebrata.

(a and b) Determining a parallel in the relation between the laws in the field of the mutual relations between adult etc. characteristics of form and the laws in the field of the relation to the systematic ordening of the species, in which case the idealistic morphological and the phylogenetic ordening is left out of consideration. This is without a parallel to the laws in the field of the ontogeny. One can also think of a biogenetic principle, basic law or rule without ontogenetic arguments, *i.e.* without taking facts from the ontogeny up in the treatment and thus confining oneself to adult material of early and later forms.

Certain authors speak of a biogenetic basic law, others of a biogenetic basic rule.

After a comparison we think of determining a parallel in the relation between the laws in the field of the mutual relations between adult etc. form-characters and the laws in the field of the relation to the ordening of the animal species in the systematic field, but this may also be either idealistic-morphological or phylogenetic.

If it is not connected with the ontogeny, the biogenetic basic law or rule only puts it like this: that there is a parallel between the build of the adult species and the arrangement of the species in a system, which is a system according to the systematics. This is therefore a natural system according to the relation. Also possible is a system according to the idealistic morphology, which goes back to the adult stage of the archetype, or a system according to the phylogeny going back to the adult stage of the ancestor or ancestral form.

(a and c, and usually also b) Determining a parallel in the relation between the laws in the field of the mutual relations between adult etc. form-characters on one side and the laws in the field of the ontogeny of the individual on the other side.

This is usually also the determination of a parallel in the relation to the laws in the field of the systematic ordening of the animal species with their allied species, based on adult specimens in a system.

The system can be a natural system according to the relation, in human psychological opinion, it can be affinity or consanguinity, or a system according to the idealistic morphology, or a system according to the phylogeny. Then one speaks of a biogenetic law or a biogenetic rule and the biogenesis may be an idealistic-morphological biogenesis *(Note 93)* or a descendance-theoretic biogenesis *(Note 94)*, based on the descendance theory.

Therefore when the parallel or parallels are to be determined, a comparison can be made between two or three kinds of laws, which we touched upon.

Concerning the laws in the field of the ontogeny and drawing the ontogeny into such considerations about the biogenetic basic law or rule on the ground of a system, various opinions are defended. This applies to the idealistic-morphological system and to the phylogenetic system.

V, 3. vii, B. *The idealistic-morphological rules on the relation between adult conditions of certain conservative characters of certain conservative elements, with and without ontogeny (biogenetic basic rule; rules on recapitulation)*

The idealistic-morphological rules, as for instance the biogenetic basic rule, are based on the parallel in the relations between (à) the laws in the field of the mutual relations between adult, etc. form-characters of certain parts, in the animal species on which we have focused our attention, in comparison with the form-characters in allied animal species, and (b) the laws in the field of the relation to an ordening and arrangement on the ground of a non-phylogenetic but an idealistic-morphological natural systematic arrangement of all animal species (scale of beings; "échelle des êtres"), and directing our special attention to an arrangement of the animal species in the focus of interest, according to the definitive or adult stages of animals lower down on the scale of beings, going back to the adult stage of the archetype, and (c) the laws of all this with or without their ontogeny and this law in the field of this ontogeny.

In principle these data can be dealt with without involving the ontogeny. Then only a parallel is determined in the relation between the laws in the field of the mutual relations between form and characters of certain adult parts on the one hand and the laws in the field of the relation to the idealistic-morphological ordening of allied species according to the rules of systematics on the other hand.

As the ontogeny, however, is nearly always involved in these considerations, it will therefore be drawn into the following discussion. It is then a question of determining a parallel between the relations regarding: (a) the laws in the field of the mutual relations between adult form-characters of certain parts on the one hand, and (b) the laws in the field of the scale of beings in allied species. Also fossil animal species can be involved according to their idealistic-morphological connection and arrangement and according to their historical order. But it is also a question of (c) determining a parallel between the relations between the laws in the series of ontogenetic stages which run parallel with one another. In connection with this the developmental stages of an animal are thought to correspond to the definitive or adult stages of animals lower down on the scale.

So it may be a question of laws in three fields, in each of which may be a biogenetic basic law or rule (adult form-characters, systematic scale of beings, ontogenesis).

In the laws regarding the mutual relations between adult etc. form-characters of certain parts it may be an idealistic-morphological biogenetic system.

In the laws regarding the mutual systematic relations between animal species in the scale of beings it may be a systematic idealistic-morphological biogenetic system on the ground of adult characteristics.

In the laws regarding the mutual ontogenetic relations in the series of ontogenetic stages it may be an ontogenetic biogenetic system.

Furthermore it is also a question of parallels in the relations between laws in the field of mutual relations, which may be determined by comparison, between the laws, in these three fields, *i.e.* of the adult etc. form-characters, the systematic ordening according to the idealistic morphology and the ontogeny of the individual, also on the ground of the idealistic-morphological views.

On the idealistic-morphological rules in the field of the ontogeny and especially in the series of ontogenetic stages.

We will now trace briefly and separately the significance of the ontogenetic stages for our questions.

In such a research for idealistic-morphological rules on form-conditions about conservative characters of conservative elements some "laws of Von Baer" may play a part. We can group a number of data from the ontogeny regarding their occurrence one after the other and their originating one from the other under the following four "laws of Von Baer". Briefly formulated these four "laws" may be defined as follows:

1) In the development from the egg the general characters appear before and earlier than the special characters (first law of Von Baer).

2) From the more general characters the less general and finally the special characters are developed (second law of Von Baer).

3) During its development an animal departs more and more from the form of other animals (third law of Von Baer).

4) The young stages in the development of an animal are not like the adult stages of other animals lower down on the scale, but are like the young stages of those animals (fourth law of Von Bear).

(*ad 1*) Regarding the first law of Von Baer, according to which general characters appear early in the ontogenetic development, earlier than the special characters, we observe that the view, that in the youngest or first stages "the general" is manifested, corresponds with the well-known phenomenon that alterations in form cohere with alterations in the milieu and that during the early developmental stages of various animal species the milieu varies little. On these grounds one might also account for the fact that there is a correspondence between fossil ancient animals and the embryos of recent animals. The view of the principle of progressive deviation, implying that there is a great resemblance, fits in with this first law.

Despite a striking resemblance in the first developmental stages a closer examination proves that the young developmental stages of different animal species may show specific differences.

(*ad 2*) Regarding the second law of Von Baer, according to which during the ontogeny from the more general characters successively the less general and finally the special characters are developed, we observe that starting from the adult specimen of a recent animal species and going back into the ontogeny we will find successively the special characters, then the characters of the least remote archetype down towards the more remote archetypes.

(*ad 3*) Regarding the third law of Von Baer, according to which during its development an animal departs more and more from the form of other animals, – also of that of the archetype – we observe that this view fits in with the well-known phenomenon of cases in which the young, first or early stages of development of different animals resemble one another more than that they resemble the adult stages, and more than the adult stages resemble each other. In these cases the evidence of affinity is supplied in the young, first or early stages of development which show a great resemblance. The phenomena according to the principle of the progressive deviation show a connection with this third law. In the light of this principle of progressive deviation these phenomena of progressive deviation are caenogenetic exceptions. The biogenetic law in the sense of the theory of recapitulation is abandoned by this principle of progressive deviation or rather the biogenetic law relegates it to the state of the caenogenetic exceptions. The biogenetic law in this sense of the theory of recapitulation is really a reversion of the theory of parallelism and overstepping of Müller.

(*ad 4*) Regarding the fourth law of Von Baer the young stages in the development of an animal are not like the adult stages of other animals lower down on the scale, but are like the young stages of those animals. This is a common phenomenon, but it finds exceptions in a number of cases in which different animals resemble one another, when adult, but are markedly unlike one another in the early stages of their development.

Also in connection with the starting point of the biogenetic basic law namely the characters of adult specimens, the biogenetic basic rule speaks only of those organs which function in the adult stages in the archetypes, with which a comparison is made. The biogenetic basic rule does not speak of organs which only occur in the young developmental stages and which except in archetypes may occur also in the deduced more recent animal species (egg membranes, and such like).

Working according to the idealistic-morphological ways of examination, the sequence of states ("Reihenfolge") in the ontogeny of the characteristics of the adult specimen of the recent animal species will be determined, in which the general characters occur, occurring in the bigger systematic groups and in which the more specific characters occur, occurring in the smaller systematic groups, *i.e.* the sequence of states ("Reihenfolge") in the ontogenetic occurrence of the archetype in the most general sense to that of the archetype in a more limited sense or the sequence of states ("Reihenfolge") in the ontogenetic occurrence with regard to the generality from the less remote archetype and the ever more remote archetype onwards. In a comparative anatomical research the common stage will be searched for, with a view to the interest of the comparative anatomy of conservative characters of conservative elements.

Working according to the idealistic-morphological ways of examination the common stage will be determined, when the comparability between two or more animal species is ascertained after the determination of the sequence of states ("Reihenfolge") of each of them as is stated above, with a view to the interest of the comparative anatomy of conservative characters.

The special problems in idealistic-morphological laws in the field of the ontogeny.

When we add the ontogeny as a problem-field of its own in the idealistic-morphological considerations to our discussion examination after discussing the field which interested us most, then the ontogeny starts from either one and the same embryonic basic form for all animals, via a permanent form of all animal species, lower than the animal species to which the ontogenetic stages of the examined animal species belong, up to the full development of the animal species concerned (Kielmeyer and Meckel), or from the basic type of the construction-plan concerned by way of one of the minor variations occurring in it to the special type concerned, or to put it differently: In that case the ontogeny would go from the general (and the common) to the special (KARL ERNST VON BAER, 1828).

Discussion of the idealistic-morphological recapitulation rules.

These distinguish some alterations in the ontogeny or biometabolic modi, which are connected with the idealistic morphology. These are:

(1) Prolongation, addition, anaboly and certain forms of terminal alteration (Naef). This is the extension by prolongation of the ontogeny of the idealistic-morphologically deduced animal species with stages for the ontogenetic development of newly acquired parts and properties after those of the preceding young ontogenetic stages, which can be compared to those of the preceding animal species. This prolongation, addition, anaboly, and certain forms of terminal alteration or extension at the end of the period of the morphogenesis with a new stage of the ontogenesis, may occur in different forms. It may consist of: a relative enlargement, an alteration in the direction of the ontogenetic development, as *e.g.* alteration of form or of direction of growth, coalescence of discrete elements, separation of a single primordium in separate parts. According to the biogenetic basic rule of K. E. Von Baer the anaboly would take place in the ontogeny according to the sequence of states ("Reihenfolge") of the characters of the large and the small systematic groups and the characters of the adult animal would take place in the ontogeny not at the same time but in a certain chronological order, and according to the decreasing degree of generality. The biogenetic basic rule of Von Baer tells, concerning the characters of the archetype, which characters are still present even now, in the adult specimen and in which sequence of states ("Reihenfolge") they originated during the ontogeny. Only the cases according to the type of the anaboly would correspond to Von Baer's law.

(2) Abbreviation, *i.e.* the abbreviation of the ontogeny of the idealistic-morphologically deduced animal species in relation to the ontogeny of the preceding archetype, as is shown by it until the final stage. The development of the deduced animal species in the ontogeny can be simplified; thus this development may come to a halt in an ontogenetic stage of the archetype, but it may also be shortened by recapitulation. When the development comes to a halt in an ontogenetic stage we call this neoteny.

Two forms of neoteny are distinguished:

(i) Total neoteny or epistase. In the complete or total neoteny or epistase all organs come to a standstill in an ontogenetic stage, except the genital organs. *(Note 95)*. This total neoteny can be looked upon as an abbreviation. The neotenic form as a juvenile form shows compared with an idealistic-morphological archetype in this abbreviation a contrast to the cases that are dealt with in the biogenetic basic law or rule.

(ii) Partial neoteny. Here one or some organs or properties remain in an ontogenetic stage; partial neoteny can be regarded as an extension of a youthcharacter into the old or adult stage. *(Note 96)*.

(3) Deviation (archallaxis; caenotyposis; heterochrony or precocious segregation; acceleratio; "Hemmung"; heterotopy; desintegration; integration).

Deviation is the deviation of the ontogeny of the idealistic-morphologically deduced animal species in relation to the ontogeny of the preceding archetype. This deviation may increase with every stage; it may culminate in a certain stage. *(Note 97)*. These deviations may be subdivided into deviations in a general sense and in deviations in a more narrow sense. We know deviations in the initial stage and deviations or alterations in the middle stages.

The following deviations are distinguished:

(i) Archallaxis. This deviation in the initial stage of the ontogeny is not discussed in the biogenetic basic rule of Von Baer, for this rule deals with the most general characters regarding the very young ontogenetic stages. In the archallaxis, however, it is a question of a new character. *(Note 98)*. No recapitulation of characters of adult archetypes occurs in the archallaxis. Also in the deviations in the middle ontogenetic stages no recapitulation of characters of adult archetypes occur.

(ii) The caenotypotically marked adaptative youth stages show deviations. *(Note 99)*. One speaks of an ontogenetic caenotyposis when the ontogeny deviates from the row of the more primitive stages to the more differentiated stages according to the idealistic morphology or the typology. The biogenetic law abandons Von Baer's principle of progressive deviation, or rather the biogenetic law relegates it to the state of the caenogenetic exceptions and the biogenetic law is really a reversion to the theory of parallelism and the "overstepping" of Müller, as we remarked above. Most of the characters are due to the adaptation of the adult animal to its mode of life. *(Note 100)*.

(iii) The "heterochrony" or "precocious segregation" is a deviation of a special kind. This deviation includes the phenomenon that in the ontogeny of a certain animal species (animal group) a shifting in time takes place regarding the moment of occurrence of certain characteristics in relation to allied species or groups of animals according to the idealistic morphology or the typology. *(Note 101)*. It may occur as ontogenetic caenogenesis. *(Note 102)*. There is a relation between the phenomenon of the heterochrony and the functional requirements during the embryonic life. Within the heterochrony or precocious segregation some groups or divisions can be distinguished (we will mention three of them):

(iiiα) the precedence of certain parts and characteristics in the development with respect to other parts in contrast to the state in other animal species;

(iiiβ) the acceleration in the differentiation or the quickened differentiation in the ontogeny which may be manifested in an advanced earlier occurrence *(Note 103)*, in contrast to the time of differentiation of allied animal species or archetypes;

(iiiγ) the checking or retardation ("Hemmung") in the ontogeny in contrast to the time or the speed of alteration or growth in the archetype. *(Note 104)*. The instances in which structures are reduced to vestiges obey Von Baer's law of the greater degree of resemblance that exist between young stages of different animals than between young and adult or between adult stages inter se.

(iv) The "heterotopy" is another special kind of deviation. Heterotopy is the phenomenon in which a shifting of place occurs in the ontogeny of a certain animal species (animal group) with regard to the place of occurrence of certain characters in relation to allied species or groups of animals according to the idealistic morphology. *(Note 105)*. Sometimes this may be conceived as an omitting of an expected removal or shifting, an abbreviation in position, whereby the primordium occurs directly in another place or position.

(v) The gerontomorphosis *(Note 106)*, the transformation, the desintegration and the integration are again deviations of other special kinds.

Principles which are the startingpoints of the idealistic-morphological basic rule and the rules of recapitulation.

The following principles belong to this:

(1) The ontogeny and the archetypes show reality (Haeckel's principle). The ontogeny consists of a series of real stages. Also the idealistic-morphological archetypes are based on reality; the archetypes have an objective value, not merely a subjective one.

(2) The ontogenetic caenotyposes are of no use in a discussion of idealistic-morphological relationship (Gegenbaur's principle), and by these ontogenetic caenotyposes are meant all stages, etc., for which no independent parallel in archetypes or recent forms exists.

(3) In the case of ontogenetic palintyposes one has to look for palintyposes in the archetypes, which are proportionally remote in time of origin resp. occurrence (Naef's principle). One speaks of an ontogenetic palintyposis, when and as far as the ontogeny runs exactly parallel to the

row of the more primitive stages to the more differentiated stages according to the idealistic morphology or the typology. One speaks of an ontogenetic caenotyposis *(Note 107)*, when and as far as the ontogeny differs from the row of the more primitive stages to the more differentiated stages according to the idealistic morphology or the typology.

(4) The interpolation in the ontogenetic row is done with the help of those stages from the row of archetypes, which are closest according to the palintyposis, arranged according to the natural system (Cuvier's principle).

(5) The localisation in the sequence or order within the row of the palintypotic forms is adequately determined according to the natural system (Meckel's principle).

V, 3. vii, C. *The phylogenetic rules on the relation between adult conditions of certain conservative characters of certain conservative elements, with and without ontogeny (biogenetic basic rule; rules on recapitulation)*

The rules of the phylogenesis or descendance theory, as *e.g.* the biogenetic basic rule, are based on the parallel in the relations between (a) the laws regarding the mutual relations between adult, etc. characters of form of certain parts in the animal species on which our attention is focused, in comparison with the characteristics of form in allied species, and (b) the laws regarding the relation to the ordening according to a phylogenetic-genealogical natural systematic arrangement of all animal species (scale of beings, "échelle des êtres"), directing our special attention on an arrangement of the animal species in the focus of our interest according to the definitive or adult stages of lower animals lower down on the scale of beings, going back to the adult stage of the ancestral form, and (c) the law of all this with or without their ontogeny and this law in the field of this ontogeny, including the ontogenetic order of occurrence.

In principle these data can be dealt with without involving the ontogeny. Then, of course, only a parallel is determined in the relation between the laws regarding the mutual relations between form and characters of certain adult parts on the one hand and the laws regarding the relation to the phylogenetic arrangement of allied species according to the rules of systematics on the other hand.

However, as the ontogeny is nearly always involved in these considerations, it will therefore be drawn into the following discussion. It is then a question of determining a parallel between the relations regarding:

(a) the laws in the field of the mutual relations between adult etc. characters of form of certain parts on the one hand, and

(b) the laws in the field of the scale of beings in consanguinous animal species according to the genealogy, but also:

(c) the laws in the series of ontogenetic stages.

Therefore the point is whether the laws which are mentioned run parallel with one another or not.

Of the laws about genealogy mentioned under (b) can be put aside:

(d) the laws in the field of the historical genesis.

So there may be laws in the four fields mentioned and within each field there is question of a biogenetic basic law or rule:

(1) within the field of the laws regarding the mutual morphological relations to the adult etc. form-characters of certain parts it may be a question of a morphological-phylogenetically biogenetic system.

(2) within the field of the laws regarding the mutual systematic relations between animal species in the scale of beings, on the ground of adult characteristics, it may be a question of a systematic-phylogenetically biogenetic system.

(3) within the field of the laws regarding the mutual ontogenetic relations in the series of ontogenetic stages, it may be a question of an ontogenetically biogenetic system.

(4) within the field of the laws regarding the mutual biohistorical or the mutual historical relations, it may be a question of a phylogenetic or biohistorically biogenetic system.

On the ground of a comparison a conclusion can be drawn about the presence or absence of parallels in relations between laws in these four fields, so (1) in the field of the adult form-characters, (2) in the field of the systematic arrangement according to the phylogeny, (3) in the field of the ontogeny of the individual and (4) in the field of the biohistory.

(*ad 2*) Systematic ordening according to the phylogeny; character and examples of a phylogenetically biogenetic system of adult form-characters, *i.e.* in the morphological field. The starting-point is the morphological characteristics of the adult specimen of an animal species, either recent or fossil, and the comparison of them with each other based on a phylogenetically biogenetic system. Such a consideration based on the descendance or phylogenetically biogenetic system is guided by the historical idea. Such a way of consideration can lead to some form of historical descent or historical relationship and can lead to homology based on the supposed allied descent.

Such a way of consideration based on the descendance theory or on the phylogeny is highly probable in a number of cases, as for instance in the following seven cases:

(i) An anticipated descent is likely to arise in cases of resemblance and especially in those cases in which the young stages of development of different animals resemble one another more than they resemble the adult stages and more than the adult stages resemble each other.

(ii) An anticipated descent is likely to arise in the cases to which the method of progressive deviation applies (Müller).

(iii) An anticipated descent is very probable in the cases in which the evolutionary modification has not proceeded by superseding, so that the theory of recapitulation has to be rejected, but in which the evolutionary modification has proceeded by altering, that is to say, that each stage in the life-history, as we see it today, has proceeded from a corresponding stage in a former era by the modification of that stage and not by the creation of a new stage, *i.e.* that some of the stages of the life-history are modified and not that a stage is added on at the end of the life-history (Sedgwick).

(iv) An anticipated descent is likely to arise in those cases in which the law of terminal alteration can be applied (Naef).

(v) An anticipated descent is likely to arise in those cases, to which the principle of deviation and that of archallaxis can be applied, the archallaxis representing an extreme condition of deviation, leading to deviation so precocious that the young of the descendant no longer resembles even the young of the ancestor (Sewertzow).

(vi) An anticipated descent is likely to arise in the cases to which the principle of metakinesis can be applied (Jaekel).

(vii) An expected descent is likely to arise in cases, where there is question of "substitutions" as examples of deviation (Kleinenberg).

The above mentioned seven groups of a very probable correctness of the ways of thought of the descendance-theory or phylogeny consists, according to De Beer of cases that have been used erroneously to support the biogenetic law and to claim that the young of the descendant is a picture of the adult ancestor.

(*ad 3*) The relation in the field of the ontogeny of the individual to the phylogeny.

(i) The relation of the adult ancestors to the embryos of the descendants.

(ii) The resemblance between embryos whose adults differ, receives its natural explanation in the light of evolution from a common ancestor. Then there will be a common ancestral stage and also descendants from a common ancestor.

(iii) In the ontogeny of a recent animal species there will be tried to determine the relation between the recent adult characters and the ancestral adult characters, as well as by which characters they are represented in the ontogeny of recent animal species. For there is a correspondence between fossil ancestors and the embryos of recent animals (Darwin).

(iv) In the ontogeny there runs a line from the historically older to the historically younger (Ernst Haeckel, 1866: the biogenetic basic rule of the descendance-theory) according to the parallel between the ontogeny of a certain animal species and the phylogeny or the genealogy of the same animal species. This "biogenetic law" is a method of the embryological-phylogenetical examination and the phylogenetic reconstruction.

(v) Considerations of the relation of the ontogeny and the phylogeny as addition and as recapitulation.

(vi) As addition of ancestral adult characters; this is the first aspect of the biogenetic law in the real sense of the word (Ernst Haeckel). Evolution was brought about by means of new variations, evolution was brought about and occurred at the end of the ontogeny of the ancestor, or in other words: the evolutionary novelty first appeared in the adult adding a new link to the phylogenetic chain, phylogeny being brought about by the successive tacking new final stages on to existing adult stages of animals, and the processes of development in ontogeny and due to this processive accumulation in phylogeny. Thinking here of simply a piling up of new variations at the end of the life-history. *(Note 108).*

(vii) As a recapitulation of ancestral adult characters, *i.e.* the second aspect of the theory of recapitulation of the biogenetic basic rule of the descendance theory (HAECKEL, 1866). *(Note 109).* This theory of recapitulation says that ontogeny is a short recapitulation of phylogeny; the adult stages of the ancestors are repeated during the development of the descendants, but they are crowded back into earlier stages of ontogeny, therefore making the latter an abbreviated repetition of phylogeny. These repeated or "recapitulated" ancestral adult stages reflect the history of the race; they are called palingenetic by HAECKEL (1875). According to Haeckel this theory of recapitulation required that only those characters which appeared in the line of adults had evolutionary significance. So the ontogeny can be regarded as condensation, as retraction of the phyletic acquisitions of the mature animal deeper and deeper into the germinal history of the species. These palingenetic stages appear as phylogenetic palingenesis *(Note 110)* and as ontogenetic palingenesis. *(Note 111).*

Opposed to the palingenetic stages mentioned are set, with Haeckel, the caenogenetic stages, presenting itself as new organs *(Note 112)* or as alterations. *(Note 113).* They are those stages which have no ancestral or evolutionary significance and showed no homology with shapes and structures in adult ancestors, but present certain shapes and structures in early embryonic or larval stages of descendants, which have been intercalated in the ontogeny as an adaptation to environmental conditions, imposed by the way of life of the young animal.

(ad 3') The relation to the age of the stage and the length of the series of ontogenetical stages.

Some authors restrict phylogeny to the adults of the series. These authors have the opinion that the adult stages give phylogenetic alterations and that these do not occur when the novelty appeared in and only affected the young stages of the ontogeny. In that case there would be no phylogenetic progression.

Some of the characters which certain animals show in their early stages of development could not possibly have been present in the adult stage of any ancestor (caenogenetic cases of embryonic and larval adaptation).

Other authors do not restrict phylogeny to the adults of the series, but they share the opinion that phylogeny should be regarded as the succession of complete ontogenies, but that it is only more convenient to restrict phylogeny provisionally to the meaning in the sense of the succession of adults.

(*ad 3''*) The chronological order and the genealogy of the ancestral characters according to the ways of consideration of the descendance theory.

According to this view one will try to determine the row of sequences ("Reihenfolge") of the characters of the adult specimen in the recent animal species, in which the characters occur in the ontogeny and one will also determine the genealogical age of these ancestral characters, which occurred once in the adult ancestors. Moreover it should be considered how the characters in the ontogeny of the recent animal species have been altered or replaced by other ones.

(*ad 3'''*) The sketched and detailed formulation of the biogenetic basic rule based on the descendance theory.

Regarding the aspects of this basic rule, one may look in this question at the general aspect of the rule, as well as at the aspect of the recapitulation.

The basic rule in the rough formulation only states that ontogeny is a repetition of phylogeny. In a more detailed formulation it leads to a more precise definition, in which case we raise the following points:

1) the ontogeny of the "higher" animals is a repetition of the ontogeny of the "lower" animals, at least in a way; roughly said: the ontogeny is also a repetition of the phylogeny.

2) in the ontogeny a law of the conservative prestages would hold good, a law of the conservation of the genealogically oldest stages.

3) in the phylogeny the ontogeny would in the end be gradually lengthened step by step and in such a way that the former final stages in the course of the ontogeny are taken up in the ontogeny of the more recent animal species.

4) the ontogenetic stages of historically younger animals do not resemble the adult specimens of their historically older ancestors altogether.

5) the old ontogenetic final stage of the ancestors is replaced by a new ontogenetic final stage in the more recent animal species.

6) the ontogeny is altered in the course of the phylogeny by all kinds of influences, not only in the final stage of the ontogeny, but also in the first stages and in the middle stages of the ontogeny (caenogenesis, etc.).

7) the ontogeny of certain separate organs of historically younger animal species in their embryonic stage is a repetition of the organs of historically older animal species, in which animal species these organs functioned in the adult stage, so that Haeckel's basic rule has a limited validity.

The special problems in phylogenetic-morphological laws in the field of the ontogeny.

When we add the ontogeny as a problem-field of its own in the phylogenetic-morphological considerations to our discussion, examination after discussing the field which interested us most, then the ontogeny starts either from one and the same embryonic basic form for all animals, phylogenetically related to the examined animal species concerned, that means from the basic type of the construction-plan concerned, or it follows the abbreviated row of ancestral forms. Or to put it differently: the ontogeny going from that of the ancestor to that of the descendant, follows a more or less abbreviated course. The ontogeny would go from the ontogeny of the more ancient to the more recent forms.

When we want to link the ontogeny to the phylogeny, one can share Haeckel's view, that to the phylogeny of a descendant a stage is added in the ontogeny of this descendant after the adult stage of the last ancestor. For according to Haeckel the ontogeny would be a sequence of successive adult stages of all ancestral stages. According to Haeckel's view the successive developmental stages are the final stages of a row of various ancestors.

When we want to link the ontogeny to the phylogeny, we can also share the opinion that the ontogeny is not a sequence of the final stages of the whole row of the ancestors, but that the ontogeny is a recapitulation of this row of ancestors.

Discussion of the phylogenetic-morphological recapitulationrules.

When we look at the recapitulation and the rules to be followed more in detail, we can start to observe that the theory of recapitulation is regarded as a certain aspect of and within the biogenetic rule, next to the aspect of the biogenetic law in the real sense (HAECKEL, 1866). We can ascertain straight away that there is a widely divergent view about a number of points or questions, as *e.g.*: Does the whole row of ancestors show a recapitulation, or do only the elements from this row show a recapitulation, does recapitulation mean a condensed and abbreviated repetition of the main events, or does it mean something else, etc.

In the view that the ontogeny is a recapitulation of the row of ancestors the ontogeny can follow one out of two methods (FRITZ MÜLLER, 1864).

According to the first method an animal might pass during its ontogeny through the ontogenetic stages and beyond the final adult stage of the ancestor ("overstepping"). Following the first method the ontogeny reflects the theory of parallelism of Harvey and Serres; the Meckel-Serres Law was amplified later by Agassiz into the "law of parallelism" between systematic classification, embryonic development, and palaeontological succession.

According to a second method an animal might diverge during its ontogeny more and more from the ontogenetic stages of the ancestor, showing progressive deviation after a period of greater resemblance in younger stages.

These rules of recapitulation play an aiding part in the comparative anatomy of conservative characters of conservative elements of adult specimens, because they deal with the coherence of embryological and phylogenetic development.

In practice it is in these recapitulation-rules a question of considerations at which one arrives when one goes from the early ontogenetic stages to the conditions at the birth, etc., and when one interpretes these conditions to the more deduced conditions.

(*ad b*) Character and examples of a systematic and phylogenetic biogenetic system of adult form-characters, thus in the morphological field. Starting points are the properties of adult specimens of an animal species, recent or fossil, and the comparison of these facts with each other on the ground of a system, answering to the rules, as well of a systematic system as of a phylogenetic biogenetic system. In these cases the legal rules in relation to the mutual systematic relations between animal species in the scale of beings, on the ground of adult properties play a part. Such a way of thinking is guided by the systematic idea and by the historic idea. Such a way of thinking may bring us to one or another form of historic descendance of historic affinity, to homology on the basis of supposed affinity by descendance.

For possible categories of cases of probability of expected descendance we may refer to the group of parallel cases, mentioned in a former group, containing parallel cases (the categories I-VII), on p. 92-93.

(*ad c*) Character and examples of a systematic and phylogenetic and ontogenetic biogenetic system of form-characters, thus in the morphological field. Starting points are the properties of adult specimens of an animal species, recent or fossil, and the comparison of these facts with each other on the ground of a system, answering to the rules, as well of a systematic system as of a phylogenetic biogenetic system. Moreover it makes comparisons with stages from ontogeny.

(*ad d*) Character and examples of a systematic and phylogenetic and ontogenetic and biohistoric biogenetic system of form-characters, thus in the morphological field. An extra stress is given to the biohistoric, in the sense of the genesis, as historic element in the theory of descendance.

V, 3. viii. *Questions in the supraspecific comparative anatomy, etc. entailed in the empirically given material and the permissible questions*

Within biology and within each subscience of biology, therefore also within the supraspecific comparative anatomy of the conservative characters in the adult stages of the conservative elements in the Vertebrata, some questions are regarded permissible, questions that can be put in principle, on account of biological facts and phenomena. The questions in connection with the subscience we are here interested in, are the following:

(1) Is something there? Or rather: Is "it" there? Is the "thing" there, does the "thing in question" occur or not? In science this is the question: Can scientific evidence be given for its presence? *(Note 114)*.

(2) What is "it"? Or: What is "the thing"? What are the properties or characters of the "thing" in question? In science this would be the question: What is the scientific definition? *(Note 115)*.

(3) Is "it" this or is "it" that? Or rather: Is the "thing" this or that? Do the properties or characters of the "thing in question" resemble this or that? In science those questions are put: Does it resemble, is it related, is it directed, is it present to a high or small degree? *(Note 116)*.

4) In what way did "it" or the "thing" originate? Or to put it differently: What stages has the "thing in question" traversed? In science the questions are: What are or what were the successive stages, firstly in a repeated or repetitional process and secondly in a not-repeated historical process? Questions, which are asked in the ontogeny, the formation of races and the genealogy of the species and groups. *(Note 117)*.

(5) In what direction is "it" aimed, in what direction is the "thing" aimed? Or: What is the issue of the "thing in question"? In science the questions are: What is the provisional transitional stage or what is the final stage in a directed process, firstly in a repeated or repetitional process and secondly in a not-repeated or non-repetitional historical process? *(Note 118)*. Questions to be asked in the ontogeny, the formation of races and the genealogy of species and groups.

(6) Where does "it" fit in, where does the "thing in question" fit in? Or to put it differently: What are the relations with something else and what kind of relations are these? In science the questions are: To what is something related and what do the relations of the thing in question with something else consist of; do they match and if so, to what extent? *(Note 119)*.

Some questions that might be asked in principle and which are asked in other subsciences, are not put in the supraspecific comparative anatomy of conservative characters of conservative elements of adult Vertebrata. They are the following three questions:

A) What is its cause? *i.e.* the causal question in the causal biological subsciences;

B) What is its purpose? *i.e.* the question about its function, about the biological significance;

C) What is the essence?

The first six questions being regarded or permissible, are not sharply divided within the subsciences which we are interested in here. But further-on we will see that in these questions is not only an element of the empirically data (empirism), but also how certain methods lead to the answer, directed by an idea or ideal of knowledge.

V, 4. Methods

V, 4. i. *Introduction*

Methods are methods of thought, are ways of thought, ways of "thought" "towards something", processes of our thoughts or thinking in acquiring as well as in "digesting" the knowledge; they lead to knowledge. These methods, always being methods of thought, form a moment of logic, *i.e.* the doctrine of correct thinking, of strict argument.

The methods in the sense of methods of thought must be distinguished from the technique of the research analysis or examination, dealing with the technical treatment and the technical means in the analysis or examination, as for instance the technique with knife and scissors, x-rays, etc. in anatomy.

V, 4. ii. *Logical methods used in morphology*

When we do not start from the methods in general, but limit ourselves to the logical methods, as they are customary in the morphology, we mean that we will not pay attention to methods in mathematical terms and that we will use the logical methods without regarding ourselves forced to the presence of a well thought-out and balanced system of notions in the field of logical methods. The methods touched upon in mathematical terms, as *e.g.* lists, curves, stereometrical figures, mathematical formulas, probability-divisions, statistically variable phenomena, etc. will therefore not have our special attention.

V, 4. ii. A. *Method of the abstraction of reality, as used in morphology*

In science reality is never used as material, but always an abstraction of reality, also in cases in which all sides and aspects of reality will be kept in consideration.

V, 4. ii, B. *Method of the abstraction of certain variable sides of reality, as used in morphology*

In morphology one can abstract in this way from certain abnormal or only from pathological variants.

V, 4. ii, C. *Method of the abstraction of the specifically diverging in the aspects or sides of reality in distinctly allied systematic groups, as used in morphology*

This method is related to the method of subtractive analysis. According to this method one arrives at concepts of supra-ordened and subdivided groups, in which cases the definition becomes the poorer by abstraction, as the group becomes larger. When one pays attention to the specific divergent, this method also leads to diagnostics.

V, 4. ii, D. *Method of abstraction, i.c. of certain aspects or sides of the reality, as used in morphology*

In morphology one can abstract in this way the colours of the animal object.

V, 4. ii, E. *Method of abstraction, i.c. of time*

In morphology abstraction of time leads to static notions, static in methodical sense. One works then scientifically with "states" that can be regarded as fixed, as "instant-exposures" the word taken in the photographic sense.

V, 4. ii, F. *Method of the atomary, as used in morphology*

This is the method of analysis together with abstraction, which separates certain small parts as such and regards them in their character as "atoms" as "elements with the character of individuality".

In morphology this method leads to organs and organ systems.

V, 4. ii, G. *Method of the synscopic, as used in morphology*

This is the method which regards certain related parts as a whole.

This method is followed in "morphology in the sense of Goethe", where it is a question of connecting and studying the relation between the organs and the organ systems, etc. as a whole in the individual. A greater part has to be considered, without there being a question of synthesis which followed a preceding analysis.

V, 4. ii, H. *Methods of analysis, as used in morphology*

The method of analysis is the method, which analyses in and by our thoughts, which distinguishes by means of our thinking, independent from the fact whether this analysis is technically possible. The analysis divides complicated data from the experience in constituents, a unity in a multitude, a whole in members, a complex in its constituents or components, a process in its factors, a concept in its characteristics.

In the anatomy the analysis plays an important part. The analysis may lead to the fact that no attention is paid to the coherence in the anatomy when distinguishing within the structure.

V, 4. ii, I. *Method of synthesis, as used in morphology*

The method of synthesis is the method of composition in and through our thinking, the joining together of the distinct parts, knowledge acquired by analysis or not; this method of synthesis connects in and through our thoughts the knowledge of the constituent parts acquired by analysis or not.

In the morphology the synthesis is in some cases a combination of what is united in reality (for instance: form and function belonging to it of a certain organ) but in other cases synthesis is a combination of what is not directly connected (in the form of the hearts in different systematic main groups of animals).

In morphology the synthesis plays a great part, as in comparative anatomy.

V, 4. ii, J. *Method of induction, as used in morphology*

This is the method going from the special to the general.

In morphology induction plays an extremely great part, as in cases in which one arrives at the general notion about the part in question from all special specimens, as for instance from all individual legs to the general notion of extremity. The induction also plays a part in the morphology when a generally valid rule is arrived at from special cases as *e.g.* the relation between the variability in structure and the milieu.

V, 4. ii, K. *Method of deduction, as used in morphology*

This is the method in which one comes from the general to the special case.

In the morphology the deduction plays a part, when one wants to indicate an organ in each special case, which should be present according to the theory, because it is a conservative organ, or a conservative character of such an organ, as *e.g.* in the case of the cerebellum, etc.

V, 4. ii, L. *Method of generalisation, as used in morphology*

This is the method of generalisation of a character or property, the method according to which certain characters and properties are regarded to be present everywhere, in principle on the ground of theoretical considerations.

In morphology we mention the determination of the presence of the pancreas in all Mammalia.

V, 4. ii, M. *Method of individualisation, as used in morphology*

This is the method, in which one makes a special case of what is found.

In morphology the method of individualisation plays a part in the determination of the characteristic of the erect gait of Homo, in a certain consideration of the historical genesis, etc.

V, 4. ii, N. *Method of the description, as used in morphology*

The description is a method to determine a law, in which time either plays a part or not. Thus laws of things next to each other in time as well as laws of things after each other can be subjects of description.

Some forms of descriptive methods are distinguished.

V, 4. ii, O. *Method of the special and of the diagnostic description*

This is the kind of descriptive method, which brings forward the special and the characteristic, in which the object distinguishes itself from all other objects, and by which it can be separated from the others. The diagnostic description makes a choice from the moments of the description and limits itself to a minimum of characteristics, indispensable to or sufficient for the distinction.

The difference between them and the theoretical comparative description is not in the nature of the method, but in the logical direction.

V, 4. ii, P. *Method of the classificatory description*

The classificatory description is the kind of descriptive method, which judges the law in the multitude, orders it and describes it. In these cases, therefore, it is merely a question of "next to each other in time", without considering time.

V, 4. ii, Q. *Method of the comparative description*

The method of the comparative description is that form of descriptive method that has the purpose to bring forward what a group has in common. A comparison is made, either on the ground of a subjective principle or on the ground of an objective principle.

In the method of the comparative description for the typus-idea one has to distinguish between:

(a) the method of the comparative description for formal typifying comparison, leading to a total image of all characteristics of the examined group or species;

(b) the method of the comparative description for a comparison abstracting notion-like with understanding, ignoring the differences and holding on to similarities.

Later we will learn more about the divergent typus-ideas belonging to both.

V, 4. ii, R. *Method of the theoretical comparative description*

The method of the theoretical comparative description is that form of descriptive method, in which the knowledge acquired by way of the method of comparative description is logically arranged based on certain theoretical principles. The principles concerned are either felt intuitively or adopted hypothetically and examined for their truth by the analyst.

In the subscience, here in the focus of our interest, the method of the theoretical comparative description is a description of the typology or the type-idea, or a description of the phylogeny or the historical idea.

The method of the theoretical comparative description includes as many moments as possible, because it needs flowing transitions.

V, 4. ii, S. *Method of the constructive description*

The method of the constructive description is that form of descriptive method, which gives a description "in a superior sense" or a "constructive description" (S. Stebbing), originated from a synthesis of members of such a construction. Here too things are arranged according to a certain theoretical principle. The method of the theoretical principle here is part of the method of teleology, because it is a question of "structure" or "pattern" etc. of the "purpose" "object" ("telos") of the processes of life to be described, objectively, as we find this "structure", etc. in the construction-plan-morphology, in the functional anatomy and in the oecologic morphology.

V, 4. ii, T. *Method of the experiment*

The method of the experiment is that kind of method, which is applied when a thought-experiment is carried out, in which case this method of thought places the object to be examined in a situation invented by the investigator or analyst, to get an answer to the question which is asked.

In morphology we know one of the experimental methods, namely the descriptive experimental method; here one expects an answer which contributes to a description (*e.g.* the colouring of spots on the surface of a developmental stage to investigate how they develop in later stages).

Outside morphology we know the other experimental method, namely the causal-experimental method, which tries to answer a causal question; this experiment occurs more often.

N.B. An answer to the causal question can also be obtained without experiment.

V, 5. Ideas or tendencies of thought

V, 5. i. *Introduction*

Ideas, in the sense of tendencies of thought, as logical components of a theory of natural science, also of biological theories as well as the theories in the field of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements of Vertebrata, are components with a logical or mathematical form leading the formation of theories in the field of the science concerned.

The ideas in this sense only express which general scientific-theoretical purpose ("Ziel") a certain theory "pursues" ("verfolgt"), but they do not indicate a way to reach the purpose. The ideas in this sense are therefore guiding ideas ("Leitideen"), they have a guiding connecting function ("leitende Verknüpfungsfunktion") and form a "geistige Band" between the theoretical elements connected to a whole. The ideas in this sense form the logical principle constituting theories. They have no constituent significance whatever, but only a regulative significance. The ideas in this sense include regulatively, not constituently larger theory-complexes, which may be contingent in relation to each other.

Historical introduction

Before we explain the view following in this chapter, we will give a short historical introduction.

Within morphology, interesting to us here, prevail the ideas mentioned above, according to Meyer, in the sense that here in the morphology every causal idea is missing; this holds good for the pure morphology ("reine Morphologie"), *i.e.* the non-phylogenetic comparative anatomy with its diagnostic and typology, etc. This morphology has therefore merely propaedeutic significance for physiology and for phylogeny. Meyer came to this conclusion, in the first place because he accepted only causal "ideas" for the modern biology as natural science and secondly, because he considered the ideas as general tendencies of the scientific search and thinking and because he deduces them, setting to work in a deductive way, from the ultimate ideals of science, in which field Meyer recognizes two, the ideal of the "Naturalismus" and of the "Historismus". Working in this way Meyer therefore recognizes in biology only two ideas, namely the mathematical idea (among the physical-chemical theories) and the historical idea (among the historical theories with the phylogeny and the "Theorie des Organischen"). – In other theory-fields of biology and therefore also in other subsciences there are, according to Meyer, either mixed ideas in the mixed subsciences or the (causal) ideas are missing as we saw for instance in morphology.

The opinion of the permissible ideas now prevailing

After this short explanation we will now explain the view I follow.

When one uses also non-causal "ideas" and when one does not merely start from the widest tendency of scientific thinking, but also uses the leading ideas in the current subsciences, then one comes to another notion of the "idea" in the fields of science that interest us. Then one may arrive at a notion of "idea" with a smaller bearing (VAN DER KLAAUW, 1932). This is reached in the first place, when one starts from the current subsciences with their theories, without asking after the place of such a subscience in the hierarchic order of the subsciences within biology. In the second place it is reached when the leading ideas *s. str.* which are found are accepted without immediately wanting to divide the sound ultimate ideas and the propaedeutic provisional ideas. The latter is also important when the development of the modern biology according to the views of non-causal relations (*e.g.* of the structures) is accepted. In the third place one may accept the view, that one has to leave the valuation among what is found to the general philosopher in the profession, realizing that this is work for an expert and dependent of the philosophical system one adheres.

For these reasons the present author (1932) arrived at the following, concerning the number and character of the "ideas":

1. the mathematical idea;
2. the typological and systematic idea;
3. the causal idea;
4. the historical idea;
5. the teleological idea;
6. the organismological idea;
7. the idea of individuality;
8. the idea of being or essence.

The part each "idea" plays in a subscience of biology, or the effects a certain "idea" has in it, depends on the character of the subscience and of the period of time, while after this also the specification of the "idea" of which some have occurred in many forms, plays a part. Next to the general notions, therefore, the specific notions are very important in the sciences (VAN DER KLAAUW, 1962).

V, 5. ii. *The ideas usual in comparative anatomy*

V, 5. ii, A. *Introduction*

In the supraspecific comparative anatomy of conservative characters in the adult stages of conservative elements in the Vertebrata, two ideas or tendencies of thought play the main part (the typological with the systematic idea; the historical idea); two ideas or tendencies of thought play a minor part (the teleological idea; the mathematical idea) and a foursome ideas or tendencies of thought play no part or a negligeable one (the causal idea; the organismological idea; the idea of the individuality; the idea of being or essence).

V, 5. ii, B. *The typological and the systematic idea*

The typological idea and the systematic idea are those logical moments, which govern the formation and the composition of theories in the field of type and system, which are the guiding principle or tendency of our thoughts, which act as general scientific-theoretical object or as ideal of knowledge in searching for the form, in which one would like to see one's results embodied in a type or system. The systematic idea guides the search and the finding of knowledge of the law-like being next to each other, of the being at the same moment in which no attention is paid to time and in which order is looked for in multiplicity and is put in for instance continuous rows. The typological idea guides in the search and the finding of the type or the archetype.

The typological and the systematic idea has its effects in a number of forms, also within the subscience here discussed. We mention the following five forms; the first four play a main part in the subscience discussed here, while the fifth plays a minor part. Four deal especially with the system, the fifth specifies the notion "typus".

(i) The systematics are a pure classification or the typology is a typological ordening of what is ideally possible. Both ordenings are "artificial"; they have a theoretical background of subjective grounds or principles, which determines the "affinity" based on "formal similarity". *(Note 120)*.

(ii) The systematics are a natural system or the typology is a natural order. Both classifications are "natural"; they have a theoretical background of objective grounds and principles, as *e.g.* an objective connectedness, which is given in the organisms. *(Note 121)*.

(iii) The typology is the science of the "type" or the "archetype" in the sense of the "classification principle". *(Note 122)*. In this case all the material can be separated in the classification on the ground of distinguished types.

(iv) The typology is the science of the "type" or "archetype" in the sense of the "standard notion". *(Note 123)*. In the case of "type" as a "standard notion" one can determine on the ground of the notion taken as a standard in which degree (to a greater or less degree) each specimen which is examined belongs to the type. So there is no question of separating the material on the ground of distinguished types, in the case of a character which is represented by a multi-topped curve in a certain material.

As regards both type-notions, mentioned under (iii) and (iv), these can be defined in two divergent ways:

1) by the definition of only common characteristics, abstracted from all differences and variations. *(Note 124)*.

2) by the definition of the multitude of all properties in their full range of variation of supraspecific unities (Goethe's type-notion). *(Note 125)*.

Within each of the two typus-notions one distinguishes the simple type of a stationary or stationarily-thought kind and the developmental type, bearing relation on a vertical-ontogenetic or vertical-phylogenetic order of real conditions of types.

(v) The science of the "norm" in the sense of the expression of the "typical" or the "essential" or the "real".

Above, in another section, we already saw, that different authors have different opinions about what may be called "normal" or what conforms to the "norm" (cf. p. 77-79). The opinion of what is normal is a condition and an aid in the research in the field of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in the Vertebrata.

V, 5. ii, C. *The historical idea*

The historical "idea" or tendency of thought is that logical moment, which governs the formation and the composition of theories in the field of historical development in biohistory, which "idea" is the guiding principle or tendency of our thoughts, and which "idea" represents the general scientifical-theoretical purpose or the ideal of knowledge in finding the form, in which one would like to see one's final results cast in a historical frame. The historical idea "guides" in the search and the finding of the "historical" character and in the views about the "historical" events in time.

The phylogenetic comparative anatomy is an important part of the science of the history of the organisms. When asking for minute questions it is necessary to be conscious of the meaning of such notions as: history of the organisms, biohistory, palaeontology, phylogeny, chronology, genealogy, genealogenesis, phylogenetic systematics, etc.

In the historical sciences of the world of organisms, it is, like in every historical science a question of three logical problems, namely:

(i) the problem of the individualisation, in which a study is made of what characteristics distinguish themselves as non-historical as compared to the historical in the facts of events and how the historical has to be characterized;

(ii) the problem of the division in periods, when a study is made of how the historical facts have to be arranged in a science of the phylogenetic homology, phylogenetic metamorphoses and the phylogenetic system of the organisms, according to the course of the history;

(iii) the problem of the criteria by which the historical facts and matters are judged, to which problem also belong those of the division in systems, and of the division according to their history and of the historical ideas.

A study is made of on which basis the historical course is judged and arranged. Here we think of epacme (preflourishing period), acme (blooming time), and paracme (post-flourishing period). Acme, anyway, can be regarded as historical teleology. As to the ideas, we mention, that it is a question of "Deutung von Sinn und Wert der Dinge und Ereignisse", like in every historical science.

The historical idea is expressed in a number of forms, also within the subscience discussed here. We mention among eight forms a) the two forms mentioned first below, which play the main part, b) the next five, which play a secondary part, while c) one form, namely the historical cause, plays no part at all in the supraspecific comparative anatomy in the adult stage of conservative elements in the Vertebrata, because we do not attribute a causal character to the morphology.

We will, therefore, first discuss the two forms playing the main part. They are:

(i) The historical idea in the historic element in the genesis of the world of organisms in a systematic respect. *(Note 126).*

(ii) The historical idea in the historical element, such as is represented by the genealogy of species and by other systematic groups, and such as follows from the determination of the form of the pedigrees of the species and likewise of the organs. *(Note 127).*

The five forms, playing a secondary part, are the following:

(*i*) The determination of the criteria of the "historical" among all events in time. *(Note 128).*

(*ii*) The historic value of a certain group of organisms in a certain period, measured by notions such as rise, growth, bloom, decay, as seen in a representative. *(Note 129).*

(*iii*) The historic teleology in a directed event in a historical process. *(Note 130).*

(*iv*) The parallel of the historical genesis of two or more interdependent species or groups of organisms. *(Note 131).*

(*v*) The imitation in the ontogeny of the historical road in the phylogeny (biogenetic basic law). *(Note 132).*

V, 5. ii, D. *The teleological idea*

The teleological "idea" or tendency of thought plays a secondary part in the field of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in the Vertebrata, as we saw above.

The teleological idea is that logical moment, which governs the formation and the composition of theories in the field of the aim or purpose and of the efficiency, of structure, pattern and such like, notions, which occur besides others as formations of the "selbstdienliche Zweckmässigkeit". This idea is its guiding principle or the tendency of our thoughts, occurring as a general scientific-theoretical purpose or as ideal of knowledge in finding the form, in which one would like to see the final results in the field of purpose, efficiency, etc. The teleological idea guides the search and finding of the efficiency etc. – character and the views about the suitable, appropriate, efficient etc. conditions and events in time. – The teleological idea has its results expressed in a few forms, also within the subscience discussed here.

Two forms of the teleological idea chiefly play a secondary part in the supraspecific comparative anatomy of conservative characters in the adult stage of the conservative elements in the Vertebrata. These two forms are the following:

(i) The teleological idea in the form of the relation between the members of the living organism, respectively between the members of a mutual relation of organisms, because this relation is regarded as a "means" to reach the "purpose", which is for the living organism the specific exercise of a certain function or functions of life. This is teleology in the sense of the static teleology of Hans Driesch. The relation mentioned is the basis of the ordening of the processes of life. Such a relation is applicable on data together in a certain moment or within a short space of time (like one speaks of a chord when the notes are struck one after another). Within the organism it is then a question of a structure, pattern, plan, "gestalt", whole, totality, "Ganzheit", "tout", etc. In all these cases one speaks of the "whole" of "members" and not of the "sum" of "parts". *(Note 132)*. They show the phenomenon that the whole is more than the sum of the parts and that the members are "transportable", while the "Dingganzheiten" show a cause-relation and an interior efficiency.

(ii) The teleological idea in the form of a marked direction of an adopted course in which this direction is regarded as an indication of the "purpose". The "purpose" is only determined by the direction or the terminal point in the objective description of the road followed or covered during the ontogeny (*Note 133)* or phylogeny. Within the genealogy one speaks then of historic teleology. The causes of this direction are not regarded and taken into account.

Five other forms of teleological idea play no part, not even a secondary part, in the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in Vertebrata, although they sometimes do in a very remote connection. In the first place no part play the finalism of the Neothomism, in the second place the real notion of purpose according to Tschulok (the build of a certain "Einrichtung" as a means to the "purpose" or "end", which lies in the function of the "Einrichtung", or of the "purpose", lying in the events taking place around the "Einrichtung" and which are judged to be useful or efficient to the bearer), in the third place the "Erforderlichkeit" by Windelband (the requirements of life as a "means" to reach the "purpose", lying in the maximal development of life or at least in the maintenance of life in the sense of just staying alive) and in the fourth place part of the questions about adaptability in a broader sense, as *e.g.* being adapted or getting adapted etc. A fifth form of the teleological idea has a causal character and therefore it does not play a part within the morphology, as this is a non-causal science.

Except in a few forms just mentioned, in which the teleological idea has a causal character, the other forms of the teleological idea have another character important in other respects than the causal idea. We may put this down under four headings.

(a) The forms of the teleological idea often have a strong subjective or even a strong anthropomorphistic character, especially in the questions about "adaptability".

(b) The forms of the teleological idea are such, that the basis of these teleological questions is a regulative principle, while the basis of the causal question is a constituent principle. For, regarding the causality: there is always a cause, in movement as well as in rest, but regarding the teleology: one may expect either a positive answer or not to the question concerned. For instance, the change of colour of deep-sea-fish living in darkness. In a certain case there may, or may not be adaptation. To put it in a different way, one may put a certain question about adaptation in all cases, but in one specimen a certain characteristic may show an adaptability-character, it may be neutral in this respect and finally it may be inefficient, all regarding the specimen itself. In the third and last case the characteristic concerned may show adaptability for another individual as the so called "fremddienliche Zweckmässigkeit".

(c) In case of a positive answer to a teleological question one may ask, whether this answer has a merely subjective value to the judging person, or whether it is objectively real. Regarding the latter there is much doubt or scepsis in certain biological circles.

(d) In case of a positive answer to the teleological question, one may ask in what "degree" or to what "extent" the phenomenon is present; or: is the phenomenon well or badly adapted. Also there are the matters of optimum, peius and pessimum of the milieu in connection with the development of the specimen of the organism. *(Note 134)*.

V, 5. ii, E. *The mathematical idea*

As we saw above the mathematical idea or tendency of thought plays a secondary part in the field of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in Vertebrata.

The mathematical idea is that basical moment, which governs the formation and the composition of theories in the field of quantitative characteristics or those to be quantified, which idea is a guiding principle or tendency of our thoughts, which represents the general scientifically-theoretical aim or the ideal of knowledge in finding the form in which one likes to see the final results in the field of the quantitative characteristics and those still to be quantified. The mathematical idea guides in the search and finding of quantitative characteristics. – The mathematical idea is expressed in a number of forms, also within the subscience discussed here of the supraspecific comparative anatomy.

Several forms of the mathematical idea play a secondary part in the supraspecific comparative anatomy concerned. These forms are the following:

(i) Tables *e.g.* which state the measures and weights of elements. *(Note 135).*

(ii) Graphic representations, as curves etc. with the theoretical background in the analytical geometry. *(Note 136).*

(iii) Stereometric figures. *(Note 137).*

(iv) Formulae for conditions and characteristics, which change continuously and which have a theoretical background in the differential and integral calculus. *(Note 138).*

(v) Formulae for conditions and characteristics which diverge in different specimens and which are theoretically comparable to the cases from a probability division or calculation. *(Note 139).*

(vi) Formulae for results of measurements and numbering of biological phenomena, which have a theoretical background in the mathematical statistics. *(Note 140).*

VI

THEORIES IN THE FIELD OF SUPRASPECIFIC COMPARATIVE ANATOMY OF CONSERVATIVE CHARACTERS OF ADULT STAGES OF CONSERVATIVE ELEMENTS OF VERTEBRATA

VI, 1. Introduction

Theories in the field of natural science are co-ordinating or summarizing views of wider import with regard to a smaller or larger field of science.

Each theory is the characteristic combination of particular aspects of the four logical moments, of which the biological theories are composed. These four logical moments are the apriorisms, the empirisms, the methods and the ideas (ideals of thought, or ideals of knowledge).

In what follows we will confine ourselves to the following theory-fields within the domain of the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in Vertebrata.

These theory-fields relate to the following phenomena:

(1) homology;
(2) presence or absence of an organ;
(3) the number of organs;
(4) the size of an organ, the size taken in linear sense, or the sense of surface, or the sense of contents;
(5) the form, build and structure of an organ;
(6) adaptative and conservative characters;
(7) a completely new organ, also in connection with the conception of unity in the construction-plan of the Vertebrata;
(8) adaptative organs and conservative organs;
(9) the order of conditions of an organ in a series.

Regarding the numbers (2) through (8) it is to a great extent a matter of insight in the simple and the complicated and a matter of insight in existing and in new characteristics.

VI, 2. Theory-field in connection with "homology"

VI, 2. i. *Introduction*

Above we got acquainted with the definition of homology (p. 52), with the criteria of homology, with the questions arising with each of these criteria and with the kinds, types and grades of homology (p. 55).

We will now look more closely at the various criteria for homology separately.

VI, 2. ii. *Similar form, build and structure*

Similarity in form, build and structure is very conspicuous in many cases, and is often more conspicuous than similarity in one of the criteria discussed hereafter. *(Note 141)*. In such cases, therefore, homologization does not meet with any impediments or difficulties on the ground of this criterion. Hence similarity on the ground of this criterion has been of old (ever since Aristotle) a most important criterion for homology. The correctness of the use of this criterion appears from the nature of morphology and anatomy as sciences, which have the characteristics of form, etc. as objects.

A consideration of the six permissible questions and the conclusions drawn from them gives in connection with this point the following:

(i) In view of comparability and homologization there has to be made *a*) a difference between unessential and essential characteristics. Between characteristics there is never complete similarity; there is always similarity in a greater or less degree. There may be made *b*) a difference between the characteristics in the field of form in the sense of the shape or external form in the sense of build or in the sense of structure. There may occur a difference in value between these three fields in appearance and in seeming facts. *c*) The characteristics in these three fields show diversities and thus their similarity is small or large. Thus the similarity in part of the fields of essential characteristics may be narrow or broad. We mention as categories a great diversity in shape *(Note 142)* or in structure *(Note 143)*.

(ii) Differences in unessential characteristics have no significance for homologization or non-homologization. In such characteristics the differences may be very conspicuous and very great. *(Note 144)*.

(iii) Similarities of unessential characteristics are of no value in connection with homologization. This is also the case when the similarity is very conspicuous; but this sometimes great similarity is only a superficial and apparent similarity. Such a great, but unessential likeness is also called "similatio".

(iv) A great similarity or negligeable differences between essential qualities will lead to homologization and the differences can be removed by an explanation. The latter occurs if a series of transitions connects the differences.

(v) With essential characteristics one will be able to conclude to homology, in spite of certain differences, even of an absolute dissimilar character, because these qualities show a relative similarity.

(vi) Fundamental differences in form, build and structure in essential characteristics. These lead to denial of homology. The fundamental difference in essential characteristics of form, build and structure may even concern an apparent minor detail. *(Note 145)*. In a number of cases there is a likeness in shape, build and structure which is only seeming. *(Note 146)*.

VI, 2. iii. *Equal topography*

Equality in topography, that is in position, is clear with many organs which show similarity. Then homologization does not meet with any impediments or difficulties on account of similarity in the general topography, because this general topography is an essential characteristic. Equality in topography has therefore been of old (ever since Aristotle) a most important criterion for homology. The correctness of the use of this criterion appears from the nature of morphology as a science, which is based on the construction-plan.

The criterion of similarity in topography got a decisive significance, when ETIENNE GEOFFROY ST. HILAIRE (1818) expressed that the only general principle for homology which can be applied, is given by the position, the relations, and the dependencies of the parts, that is to say, by what Geoffroy St. Hilaire named and included under the term of "connexions". In the course of the history of the notion "homology" many authors have treated the similarity of position of conservative elements in comparative anatomy as the primary standard for the study of the homologies, or as its most important and decisive criterion, not similarity in form, etc.

The "principe des connexions" can also be called the "ensemble des dispositions". This criterion is a result of and plays a part in the "unité de système dans la composition et l'arrangement des parties organiques" or also called in an abbreviated form "unité de plan" (Geoffroy St. Hilaire).

With the criterion of topography the main point of similar position of certain examined parts of the whole in relation to other parts of the construction-plan on the ground of the arrangement in a natural coherence.

In the application of the empirism "position" also play a part: the number of organs, the distance of the organ to and the position of the organ between, inside, outside, through, above, under, behind, before, left, right, in the middle, opposite, symmetrical, etc. in relation to other organs and the direction.

A consideration of the six permissible questions and the conclusions regarding these points gives the following:

(i) Difference between unessential and essential qualities in view of comparability and homologization. There is never complete similarity, there is always similarity in a greater or less degree.

The difference between unessential and essential qualities is sometimes sought in totally different characteristics, sometimes even in opposite characteristics, but in all cases the choice will have to be accounted for. We give a number of divisions.

In the first group the absolute topography of an organ, when two or more species of animals are compared, may be essential and show similarity and identity at one end, but for the rest the topography may be unessential and dissimilar. *(Note 147)*.

As second group we mention those cases in which the absolute topography of an organ, compared in two or more species of animals, is essential at both ends and shows a similar topography, but in which the middle may have an unessential topography and may be dissimilar. *(Note 148)*.

To a third group belong those cases in which the topography in the species of animals compared is dissimilar across the whole area, but unessential, because these differences may be bridged by transitions across the whole area. *(Note 149)*.

To another, a fourth group, belong those cases with a similar topography in a relative sense, to which we will now direct our attention. *(Note 150)*.

One will have to ascertain whether the topography is unessential or essential, and one will have to explain why one considers the characteristics involved unessential respectively essential. The characteristics concerning the absolute topography may differ greatly, in the various allied species of animals, because, amongst other things, the position of homologous organs in relation to practically all surrounding organs will naturally vary greatly, because of the differences in size of those organs.

The relative topography, *i.e.* the topography in relation to organs of the same organ-system, is different, as we will discuss below.

Moreover we refer to the fact that the equality in topography is never complete.

(ii) Differences in unessential characteristics are of no significance for homologization or non-homologization. In such characteristics the differences may be very great and striking.

(iii) Similarities in unessential qualities in topographic respect are valueless in connection with homologization. This is also the case when the similarity is very conspicuous, but this sometimes very great similarity is merely a superficial and seeming resemblance. *(Note 151)*.

(iv) A great similarity or negligeable differences between essential characteristics will lead to homologization.

However, homologization is also possible, if the differences can be removed by an explanation. Then it should be shown which is the essential quality in topographic sense in the differences in form, build and structure.

We mention two groups.

Under the first group we class the cases, in which a certain region of the body in different animal species consists of a varying number of elements, *e.g.* in one animal species it consists of x and in another species of x + y elements, while there is a difference of opinion as to whether one should homologize the separate elements or the whole region, which influences our view of the character of the topography. *(Note 152)*.

To the second group belong the cases in which a certain organ of the body has partly the same topography in different animal species, but in which it is not excluded that not only it has grown or shrunk in one or more directions but also in a different degree and that there is no agreement as to which part of the organ is the most original and essential. *(Note 153).*

The phenomenon of growing in various directions entails that a certain element, which fills a certain territory, may be an outgrowth of totally different surrounding parts, assuming that it is not originally a separate element or has not been one before its growing together with its surroundings. *(Note 154).*

(v) With essential characters one will conclude to homology anyway, in spite of certain differences, even with the character of dissimilarity in absolute topography, if these characteristics show a similarity in relative topography. Because of the differences in size of the organs the topography in the absolute sense, *i.e.* in regard to the diverse surrounding organs, may diverge greatly. This absolute topography, which can differ widely, is therefore unessential. It is different with the relative topography, which is the topography regarding the organs of the same organ-system which belongs to it, because their topography is more firmly established and the organs of the same organ-system may show similarity in relative topography.

(vi) Fundamental differences in essential characteristics lead to denial of homology. The fundamental difference in essential qualities of the topography may be very great, but it may also concern an apparent minor detail. Fundamental differences in essential characteristics will occur in organs, which are analogous, but not at the same time homologous. It is one of the difficult points to determine whether organs in various allied species of animals, resembling each other in build, but having an apparent different topography, are homologous or not. *(Note 155).*

In some cases the homology is doubtful. *(Note 156).*

VI, 2. iv. *Equal ontogeny*

Since the study of the individual development has vigorously made its appearance in anatomy and morphology, including the conservative morphological elements, the similarity in individual development has become a most important criterion for the homologization.

Moreover, the application of the biogenetic law was added to this, which clearly brought out the meaning of ontogeny for our knowledge of the descent and of the phylogeny.

Above we have seen that the ontogenetic stages can be examined for the sake of the knowledge of these developmental stages and of the ontogenesis, but that for our present purpose which is concerned with the adult stages they are only of importance as a means to interpret the condition in the adult stages.

By equal ontogeny we understand the similarity of organs in ontogeny morphologically, *i.e.* in form, build and structure, or topographically, and that during one longer or shorter phase in ontogeny, *i.e.* during some successive phases or during one single phase or stage, or during one single moment.

If one examines the form, etc. and at the same time the topography in the ontogeny, one can speak of the "origin" of an organ. Furthermore we saw that one can also examine the "course of the ontogeny", that is the course of the ontogeny during a longer or a shorter period or even during one single moment, always within one single stage of development. – When we examine "the course of the ontogeny", there is still another matter apart from origin, form and topography, which is examined, but which does not produce new criteria. But in addition there is a new criterion, which is concerned with real interconnections in the successive stages. – The "equal course of ontogeny" is not only a new criterion, but it is also an important means of help in the examination of the supraspecific comparative anatomy of the conservative characters in adult stages of conservative elements in Vertebrata.

The conception "equal course of ontogeny" can be considered independently of the "rate of development", but not necessarily so. – Thus it appears that, when comparing the results of the study of the course of ontogeny, *i.e.* the course in various animal species during a longer or shorter period in certain cases the similarity of certain elements in that animal species changes more clearly in the course of that period than in another animal species, owing to the difference in rate of development. We aim in this discussion now only at the changes in form, build, structure and size. Regarding the surrounding elements or regarding the body as a whole, the examined element may show a similar relation of size. It may show an isometric growth, secondly it may grow comparatively more strongly or may show positive allometry and thirdly it may lag behind in growth or show negative allometry (as is the case with rudimentary organs). *(Note 157)*.

In a number of cases and especially in young ontogenetic stages of such organs, which are clearly homologous in older stages of ontogeny and in the adult stage (on account of form, build and structure and of topography, so on account of origin and similarity in the course of ontogeny), and then even more so in the germ-layer stage of these organs, it appears that there are sometimes no ontogenetic criteria for homology. The very opposite occurs: the condition in these very young ontogenetic stages may even deny homology. Next to the cases in which ontogenetic tissues out of which organs are formed are the same or show similarity of tissues in the sense of similarity of position in the fertilized egg or in the early embryo, there are the cases that clearly homologous organs arise from material of dissimilar original location. *(Note 158)*.

The term of homology which rests on comparative anatomy of adult recent and fossil material, is independent of the developmental mechanism evoking the formation of the structure and independent of the position in the egg of the material out of which the structure is formed. Homologous structures need not arise from the same segments of the body.

That the presumptive regions of the egg or blastula can vary in extent in time and space in different organisms, is a further illustration of the fact that, contrary to the theory of recapitulation, variations of evolutionary significance can and do arise.

Homologous structures in some cases appear from corresponding germ-layers or they do not. In the latter case they appear from "wrong", *i.e.* atypical germ-layers. It is not because the primordia arise from the same germ-layer (if they do) that organs are homologous. The germ-layer theory is of no value to the concept of homology. The germ-layer theory was misconceived in its attempt to provide an embryological criterion for homology. In general continuity of homologous structures does not necessarily imply similarity of ontogenetic processes in the production of homologous structures. For these and similar reasons some authors (*i.a.* De Beer) say that embryological criteria fail to provide a satisfactory basis for the interpretation of homology and that the concept of homology cannot be based on embryology, but must rest on comparative anatomy of adult recent and fossil material.

Similarity in ontogenesis and in the course of ontogenesis in regard to the organs in various species of animals is very conspicuous in many cases, so that there are no impediments or difficulties for homologization.

A consideration of the six permissible questions and the conclusions drawn from these points gives, with regard to the criterion of the "course of ontogeny", the following:

(i) Differences between unessential and essential characteristics as to the comparability and homologization. There is never complete similarity; there is always similarity in a greater or less degree in the ontogenesis and in the course of ontogenesis. With equal essential qualities there may often be a great similarity, but there may also be a great dissimilarity. *(Note 159)*. In the case of unessential qualities there will often be much dissimilarity, but sometimes also an apparent superficial resemblance.

As a rule the organs of various species of animals which differ greatly in form and topography in the adult stage, will also show great differences in older ontogenetic stages. In many younger ontogenetic stages form and topography will diverge much less widely in two or more allied animal species and will much more resemble each other in origin, form and topography during and in the course of ontogeny. In such young ontogenetic stages in which everything is still of very simple build, the differences between homologous organs will never be great. If they are, one will have to advance very plausible reasons to conclude homology. Among those is the phenomenon that the same result can be reached by various ways. *(Note 160)*.

(ii) Differences in unessential qualities in ontogenesis and in the "course of ontogenesis" are of no significance for homologization or non-homologization. *(Note 161)*.

(iii) Similarities in unessential characteristics, occurring during ontogenesis and in the "course of ontogenesis" are of no value in connection with homologization. *(Note 162)*. This is also the case when the similarity is very conspicuous, but this sometimes great resemblance is only a superficial and a seeming resemblance. *(Note 163)*. Yet we have to deny homology. In a very young stage in the individual development form, build and structure are still so extraordinarily simple that similarity in these respects is meaningless and may therefore be apparent.

(iv) A great similarity of negligeable differences between the essential qualities of phenomena occurring during ontogenesis and in "the course of ontogenesis" will lead to homologization. *(Note 164)*. The differences can be removed by an explanation. In this connection we refer to the changes in the sequence of events during the course of ontogenesis.

(v) With essential characteristics, occurring during ontogenesis and in the "course of ontogenesis" one will be able to conclude homology, in spite of certain differences, even with the character of absolute dissimilarity in the course of ontogenesis, because these qualities show a relative similarity.

(vi) Fundamental differences in essential characteristics of ontogeny and in the "course of ontogeny", lead to denial of homology. *(Note 165)*. The fundamental difference in such an essential quality may be very great, but it may also concern an apparent minor detail.

VI, 2. v. *Equal phylogeny*

Since the appearance of Charles Darwin's "Origin of Species by Means of Natural Selection" in 1859 and the rise of the descendance theory, the phylogenetic criterion for homologization has become extremely important. This phylogenetic criterion is also called "homogenesis". We may look for homogenesis where the bearers of homologous characteristics are real historical descendants from each other or from a third species and where with good reasons we may assume one and the same homologon with the common ancestors with regard to that characteristic. But it is well-known that in certain cases there is no visible presence of the homologous character or structure as far back as the point of divergence from the common ancestor; in this case one speaks of "latent homology".

The phylogenetic criterion for homology between homologous characters and structures and their modifications, found in the case of phylogenetic affinity in the descendants of a common ancestor, is applied to phenotypes and shows continuity of structures, descended from a representative in a common ancestor in phylogeny.

When applying this phylogenetic criterion to conservative morphological elements and their characteristics of form and topography, one starts from some premises, namely:

(1) There is descent of systematic unities; races, species, families, ordines, classes and probably also phyla descend from each other or have the same ancestor.

(2) Within the construction-plan there are organs and other parts with a certain individuality, which maintains itself within phylogeny; on account of this one can speak of phylogeny of organs and of suchlike parts with individuality, or to put it differently: one can speak of phylogeny of conservative morphological elements.

(3) Within the construction-plan certain characteristics are found which maintain themselves within phylogeny, so that one can speak of phylogeny of characters ("Merkmalsphylogenie"); this certainly also applies to the characters of form, build and structure and to the characters of topography.

In this subscience of anatomy and morphology the question about the descendance of the function and also of other characteristics is usually left out of consideration. Part of the main questions from phylogeny do not crop up either with the phylogenetic criterion for homology, such as for instance the causal question.

The phylogenetic criterion for homology is derived from the so-called "direct witnesses", which are the fossils. *(Note 166)*.

The phylogenetic criterion is also derived from the so-called "indirect witnesses", which are the ontogenetic stages, from which it is thought conclusions can be drawn about the phylogenetic systematics and about the descendance on the ground of the biogenetic law. *(Note 167)*.

Similarity in phylogeny in the sense of similarity in form, build and structure and in topography between consanguine fossils and between recent animal species and their fossil relatives may be very striking. Concerning the organs, there is usually a restriction, regarding the direct witnesses, to organ systems of a skeletal nature, while the soft organs fall outside our scope.

A consideration of the six permissible questions and the conclusions drawn from these points gives, in connection with the criterion for phylogeny, the following.

(i) Differences between unessential and essential qualities in view of comparability and homologization. There is never complete similarity; there is always similarity in a greater or less degree in phylogenesis. About these points there is nothing in general to add to what has been discussed in the previous sections about the various criteria for homology.

Going back into genealogy, the differences between homologous organs will never be very great and will certainly never become greater. If they do, going back into genealogy, one has to think of the phenomenon "convergence".

(ii) Differences in unessential characteristics are of no significance for homologization or non-homologization. Here, too, we have nothing in general to add to what has been said about the various criteria for homology in the previous sections.

(iii) Similarities in unessential qualities in phylogeny are of no value in connection with homologization. This is also the case when the resemblance is very striking, but this sometimes great similarity is merely a superficial and seeming one.

Following back the genealogy of the animal species compared, it sometimes appears that early ancestors did not much resemble each other, but that the later descendants "converged" more and more in their characteristics. *(Note 168).*

(iv) A great resemblance, or negligeable differences between essential qualities will lead to homologization, and when the differences can be removed by an explanation. Also in this case we have nothing in general to add to what has already been said about the diverse criteria for homology in previous sections. We only draw the attention to the difference in sequence of a phylogenetic event (that is according to the "pedigree") in comparison to that sequence in ontogeny or that according to the systematic arrangement of organisms.

(v) With essential qualities one will be able to conclude homology, in spite of certain differences, even with the character of dissimilarity in the characteristics in an absolute sense, because these qualities will show a relative similarity.

(vi) Fundamental differences in essential qualities in phylogeny lead to negation of homology. The fundamental difference in such an essential characteristic may be very great, but it may also concern an apparent minor detail.

VI, 2. vi. *Equal genetic disposition, tendencies and "anlage"*

Since the rise of genetics in 1900 the notion of homology has been influenced by genetics.

In so far as homology implies a common descent, it is obvious that it may be thought to involve genetic affinity.

A genetic interpretation of the notion of homology could imply that the equal ontogeny goes back to the same hereditary factors, or (and) that the ontogeny shows similar genetic (hereditary) tendencies.

Such a notion of genetic homology goes back to what is genotypically similar or comparable.

Continuity of homologous structures implies affinity among organisms in phylogeny; it does not necessarily imply similarity of genetic factors in the production of homologous structures.

The homology of phenotypes does not imply the similarity of genotypes, *i.e.* of types determined by their genetic constitution regardless of their appearance. Organs resembling each other phenotypically may diverge and be dissimilar genotypically and therefore be incomparable or not strictly homologous; however, they may be homogenetic, *i.e.* descend from a common ancestral organ, or homoplastic, *i.e.* be a similar reaction to similar causes.

The crux of genetic comparability is not the phenotypical resemblance, but the genotypical similarity. This entails the following facts and it explains the following difficulties, which arise, when we compare this genetic notion of homology with that based on the form, etc. and topography of adult recent and fossil material:

i) Genes are not restricted in their sphere of influence to the characters, which they have been found to control in a normal environment and a normal gene-complex.

ii) Under varied conditions of the gene-complex, a gene may cease to control the formation of one particular characteristic and, instead, may control another completely different character.

iii) In two related organisms a character can be under the control of a single gene (an identical gene) and the characters may nevertheless not be homologous when the common ancestor may not have possessed these characters, but these characters have developed by independent and parallel mutation in the two stocks (in a certain case this can be "latent homology").

iv) A certain gene in allied races may be homologous, whereas the gene-complex is built up by selection by each race in its own way, differently from the other.

v) The control of a character normally effected by one gene may come to be assumed by other quite different genes (*e.g.* in the eye of different races of Drosophila).

vi) This statement is also true concerning the action of "mimic" genes: different genes with identical effects. *(Note 169)*.

vii) Many organs common to all vertebrate animals, *e.g.* the eye, preserve their essential similarity in structure or function, though the genes responsible for the organ must have entirely altered during the evolutionary process.

viii) The genetic link between homologous structures cannot be analysed down to individual genes, but must be based on the gene-complex or such portions of it, or groups of genes, which control the structure in question.

The following conclusions with respect to the interpretation of the notion of genetic homology can be drawn:

a) The analysis of the concept of homology in terms of single genes breaks down. An analysis of homology in terms of cellular or precellular correspondence of position in ontogenetic development likewise fails.

b) The term homology is applied to the similarity in comparative anatomical respect and is independent of identity of genes controlling the structure.

c) Genetic criteria fail to provide a satisfactory basis for the interpretation of homology to which the surest guide is comparative anatomy.

d) The concept of homology cannot be based on genetics, but must rest on comparative anatomy and palaeontology (De Beer).

VI, 2. vii. *Equal developmental material and equal developmental mechanical causes*

Since the rise of modern developmental mechanics the notion of homology has also been influenced by developmental mechanics.

On the ground of developmental mechanics one may call those organs homologous which are able to bring forth similar forms in a causal way, even though they belong to different types (Meyer, 1926).

In these developmental mechanics ("Entwickelungsmechanik") or causal morphology two factors co-operate: a) the tissue or the germ-layer or a portion or a spot of it from which the organ arises and b) the inductor which induces the formation of the organ.

According to some authors the value of both factors for homology can be different. In certain cases and to certain authors both factors in homology are and must be similar.

Similarity of the reacting tissue, according to some authors, is estimated to be very important.

If the reacting tissue in a normal development of two organs is not the same, their homology can be denied.

The same is concluded in cases of experiments. *(Note 170).*

On the other hand, some authors (Holtfreter, 1936) restrict the notion of homology solely to those structures which develop under similar inductive influences. Homology then, is nothing but the homology between their inductors. It is known, according to these authors, that the reacting tissue need not be the "same" for structures to be homologous.

Other authors, however, are of opinion that it would be a fatal mistake to deny any significance to the reacting tissues from the standpoint of homology.

If the inductors in a normal development of two organs are not the same, their homology can be denied.

In the case of partially homologous inductors (Baltzer) these authors speak of distant homology (Holtfreter, 1936). *(Note 171).*

Some authors use the difference between causal morphological factors, *i.e.* between the inductors, which are found with so-called homologous organs during restitution after experimental interference, or during the first "anlage" as well as after experimental interference to deny homology, thus in a negative sense. *(Note 172).*

There are also authors who adhere to the view that structures can owe their origin to different methods of induction without forfeiting their homology. The same is true for stages in the substitution of one inducing mechanism for another.

These authors held the opinion that the term homology, applied to the similarity in comparative anatomy, is independent of the developmental mechanism evoking the formation of the structure, as these developmental mechanisms of homologous structures can change (De Beer).

VI, 2. viii. *The relation and the connection among the seven criteria*

We have seen already that seven criteria have been applied and are in principle applicable to the notion of homology. Now we ask ourselves what is the relation and the connection among all these criteria, whereby we state the following.

(1) As a rule not all criteria have been applied or can be applied to a certain organ. Many as yet unexamined criteria with species of animals which have been examined in other respects, could still be looked into. Many as yet unexamined animal species, can still be examined for the criteria used. Here we think of the criteria of genetic tendencies and of those of equal developmental material and equal developmental mechanic causes, which have only been examined with a small number of animal species. But with weak parts the possibilities to apply the phylogenetic criterion in the sense of direct witnesses are absent.

(2) All examined criteria lead to the same judgement about homologous or non-homologous.

(3) Part of the examined criteria leads to an identical judgement about homology or non-homology *(Note 173)*, while another part of the criteria does not allow of a judgment. *(Note 174).*

(4) Part of the examined criteria leads to the judgment of homology, while another part of the examined criteria leads to the judgment of non-homology.

These different possibilities regarding the connection among the seven criteria partly link up with phenomena like those of partial homology, etc.

When the above-mentioned different possibilities regarding the judgement based on the criteria cannot be explained, one sometimes tries to give judgement on a smaller but decisive meaning of a certain criterion. Thus one may attribute a smaller value to the ontogenetic criterion with *e.g.* a caenogenesis. And thus one may attach decisive importance to ontogeny rather than to phylogeny, to topography rather than to form. *(Note 175),* The judgment as to the presence of homology on account of these criteria may lead to an order of the conditions examined by greater or smaller similarity. This order may be the same for the different criteria, but it may also diverge.

VI, 3. Fields of theories regarding the presence or the absence of an organ

VI, 3. i. *Introduction*

The presence or the absence of an organ leads mainly to three fields of theories, *viz.* 1) what is the rule and what is the deviation from the rule; 2) what is primary and what is secondary; 3) does presence of the organ imply a new formation?

VI, 3. ii. *Presence and absence seen as rule and deviation from the rule*

The presence of an organ may be the rule and its absence sometimes occurs as a deviation from the rule, but also the reverse may occur, *i.e.* that the absence of an organ is the rule and that its presence sometimes occurs as a deviation from the rule.

(A.I.) *Presence is rule and absence is deviation from the rule*

In a certain systematic group (this may be within the group of Vertebrata as a whole, or within the group of the Amniota, the Mammalia, the Primates, etc.) the organ considered will be present and will only be absent in a few species, which may be called a "secondary" absence. Here we can distinguish two classes of cases.

(1) Presence as a rule with a "secondary" absence occurs with unpaired organs and with paired organs, but in the latter case left and right. *(Note 176)*.

(2) Presence as a rule with a "secondary" absence occurs on one side with paired organs, or with organs which are paired as a rule. *(Note 177)*.

(A.II.) *Absence is rule and presence is deviation from the rule*

Within the systematic groups concerned (these can be different in extent) the organ considered will be absent as a rule in most representatives. The organ in question will only occasionally occur within the systematic groups concerned, as an exception to the rule. *(Note 178)*.

The phenomenon that an organ is only occasionally present in a systematic group, as an exception to and deviation from the rule, is important for the supraspecific comparative anatomy of conservative characters in the adult stage of conservative elements in Vertebrata, but it sometimes plays a more important part in functional anatomy.

We can distinguish two groups of cases here: that of the "seeming" absence, of which we will enumerate six phenomena, and the group of the "real" absence, of which we will mention three phenomena.

(A.II.a) "Seeming" absence as category of cases suggesting a deviation from the rule

This phenomenon may belong to a number of categories. We mention the following six phenomena in this field.

(i) "Seeming" absence of an organ after birth is to be attributed to the prenatal disappearance of the organ built before that time. *(Note 179).*

(ii) "Seeming" absence of an organ in the adult stage is to be attributed to the disappearance in the adult stage of the organ built before or in the larval stage. *(Note 180).*

(iii) "Seeming" absence of an organ is to be attributed to the division of that organ during the individual development in two or more separate organs. *(Note 181).*

(iv) "Seeming" absence of an organ is to be attributed to the fact that the organ has given up its independent existence during ontogeny and has fused or grown together with a neighbouring element, which is sometimes similar, sometimes dissimilar. *(Note 182).*

The explanation of the organ giving up its independent existence sometimes lies in the given correlation with the size of the element. It is known that the stage of development at which the suture between praemaxillare and maxillare in Homo is obliterated, is correlated with the size of the praemaxillare: the smaller the praemaxillare, the sooner the suture between it and the maxillare is obliterated.

(v) "Seeming" absence of an organ is to be ascribed to the fact that the organ does not reveal itself as an organ externally, as opposed to internally. *(Note 183).*

(vi) "Seeming" absence of an organ is to be attributed to such very slight development, that only after comparison with allied animal species its presence is recognized. *(Note 184).*

(A.II.b.) Real absence as category of cases implying a deviation from the rule

This absence may belong to a number of categories. We mention the following three phenomena in this field.

(i) Real absence of an organ or of its adult characters is to be attributed to the fact that the development of that organ, like of so "many" other organs, except the sexual organs, has not yet started in the animal species concerned, or has stopped its development, and thus remains in a juvenile stage (neoteny in a broad sense), in contrast to allied animal species. *(Note 185).*

(ii) Real absence of an organ or of its adult characters is to be attributed to the fact that the development of that organ, like of a "few" other organs, has not yet started in the animal species concerned, or has stopped its development and thus in these respects it remains in a juvenile stage (neoteny in a narrow sense), in contrast to allied animal species. *(Note 186).*

(iii) Real absence of an organ or its adult characters in an animal species occurs where this organ is absent or has not reached adult stages in contrast to allied animal species (partial neoteny, *i.e.* neoteny in relation to that organ). *(Note 187).*

VI, 3. iii. *Primary and secondary character of presence and absence of an organ*

Besides the question of what is the rule and what is an exception to the rule in the presence and absence of an organ, we can also ask ourselves which of the two is primary and which is secondary; in the sense that we ask ourselves which was primary in the archetype in the idealistic-morphological consideration and which was primary in the ancestral type in the phylogenetic consideration: presence or absence, and which was secondary: presence or absence. *(Note 188).*

This question is also important with the question about rows, which will be discussed later.

VI, 3. iv. *Presence and the question of a new formation*

When an organ is present, there is a possibility that this organ is not present in all Vertebrata, but only occurs after the oldest fossils, or even only in one of the highest classes. In such cases we have to do with a new formation, which aspect will be discussed later.

VI, 4. FIELDS OF THEORIES REGARDING THE NUMBER OF ORGANS

VI, 4. i. *Introduction*

The number of organs leads mainly to two principal fields of theories, *viz.* 1) what is the absolute number of the organ concerned, which occurs as a rule or which may be called primary and 2) what is the rule and what is the deviation from the rule in the varying number of organs, occurring within a certain systematic group, and what is primary and secondary in this.

The fields of theories about the absolute number of the organ concerned will not be discussed here.

We will confine ourselves to the fields of theories about the variation in the number of organs, occurring within a certain systematic group. This group, therefore, will show a variety in the number of such organs.

VI, 4. ii. *A great number and a small number as a rule and a deviation from the rule*

A great number of an organ is the rule and a smaller number occurs now and then as a deviation from the rule *(Note 189)*, but also the opposite may occur, *viz.* that a small number of an organ is the rule and that a greater number only occurs now and then as a deviation. *(Note 190).*

(A.I.) *A great number is the rule and a smaller number is a deviation from the rule*

Within a certain systematic group (this may be within the Vertebrata as a total group, within the group of the Amniota, the Mammalia, the Primates, etc.) the organ considered will be present in a comparatively great number and only in a few species it will be present in a smaller number, which may be called a "secondary" condition.

We can distinguish two categories here.

1) A greater number as a rule, with a smaller number as a "secondary" condition occurs both left and right in paired organs and also unpaired organs.

2) A greater number as a rule with a smaller number as a "secondary" condition occurs in organs which are present only on one side of an organ that is usually paired. *(Note 191).*

(A.II.) *A smaller number of organs is the rule and a greater number is a deviation from the rule*

Within a certain systematic group the organ considered will be present in a comparatively small number and will be present in a greater number in only a few species, which may be called a "secondary" condition. It sometimes occurs that the number diminishes, which may be called a "tertiary" phenomenon.

(A.III.) *Regarding the number of organs there is no question of a rule and a deviation from the rule in some cases*

(A.I-A.III.) The "seeming" number and the real number of organs

Whenever we consider a greater or smaller number of organs in the different animal species, we have to be certain whether we are dealing with the real number or with the "seeming" number. The examination of the number of organs, as it occurs in one single stage of the individual development, may give us the wrong impression of the real number, because several processes during ontogeny may yield a "seeming" number.

(i) A "seeming" number of organs arises when during ontogenesis part of the various organs formed perish again. *(Note 192).*

(ii) A "seeming" number arises when during ontogeny the various organs formed occur one after another at great intervals. *(Note 193).*

(iii) A "seeming" number arises when during ontogeny there occur divisions in the organs formed. *(Note 194).*

(iv) A "seeming" number arises when during ontogeny parts of an organ separate. *(Note 195).*

(v) A "seeming" number arises when during ontogeny similar organs coalesce *(Note 196)* (organs of a different kind may also coalesce).

(vi) A "seeming" number may be suggested when during ontogeny similar organs are adjacent, without coalescing. *(Note 197)*.

(vii) A number of relative value can be found in cases of neoteny. Since in cases of neoteny the individual development of the whole animal (except the genital organs) or of certain organs, parts of the body etc. remains in an ontogenetic stage in comparison to other allied animals, also the number of organs may remain in an ontogenetic stage. *(Note 198)*. In comparing this animal species to allied animal species without neoteny, the number of organs has a relative value.

VI, 4. iii. *Primary and secondary character of a great number and a small number of organs*

Besides the question of what is the rule and what is the deviation from the rule with a great and a small number of organs or the reverse, we may also wonder which of the two is primary and which is secondary, in the sense that we ask ourselves, which was primary in the archetype, in the idealistic-morphological consideration and which was primary in the ancestral form in the phylogenetic consideration: a great or a small number and which was secondary: a great or a small number. We will look into this question below. Behind this there are some fundamental questions, which we will discuss later.

VI, 5. Fields of theories regarding the size of the organ

VI, 5. i. *Introduction*

By size is meant here the size regarding linear measurements as well as the surface and the contents. In these questions it is often of importance to know whether an organ extends so far that a certain point, a certain spot or a certain organ of the body is reached.

In questions about size it is usually the relative size one is concerned with, although the absolute size is not without importance.

The fields of theories concerning similarity and dissimilarity in the size of organs, which occur to the left as well as to the right *(Note 199)*, will not be discussed here, but we will discuss those about the size in various animal species, which is so important for the architectural morphology and the left and right problem.

VI, 5. ii. *Large and small size as a rule and as deviation from the rule*

A large size of an organ is to be considered as the rule and a small size occurs here and there as a deviation from the rule, but the opposite may also occur, *viz.* that a small size of an organ is the rule and a large size is a deviation from the rule.

(*A I*) A small size is the rule and a large size is a deviation from the rule.

This phenomenon occurs within systematic groups of very different range. The size-increase is to be considered as a "secondary" state, which may be followed by a decrease in size as a "tertiary" state. *(Note 200).*

(*A II*) A large size is the rule and a reduction in size is a deviation from the rule.

This phenomenon, too, occurs within systematic groups of very different range. A small size may occur as a "secondary" state and after that increase of size may occur as a "tertiary" state. *(Note 201).*

Under the phenomenon of a small size of an organ as deviation from the rule, the following groups of regressive development or reduction in a general sense may be discussed:

(i) Rudimentation together with deterioration of the organ, which has been reduced and simplified from the beginning. The rudimentation *(Note 202)* is manifested a) by the absence of some parts of the organ, which are not formed in the embryo (also called negative archallaxis, on account of the absence of the first "anlage"); b) by a general, respectively a partial reduction of the organ, which reduction occurs since the first "an-a ge" and is considered as negative archallaxis.

(ii) The aphanisis or reduction without leaving a remainder. *(Note 203).* This reduction only occurs after a good development in an embryonic or in a juvenile stage. After such a normal "anlage" a well-developed and well-functioning embryonic or juvenile organ arises, which later undergoes an active reduction.

VI, 5. iii. *The connection between absolute and relative size*

In examining the question of the relative size of an organ, it appears that there is some connection between the relative size of the organ and the absolute size of the animal as specimen. A few rules on this point may be summarized as follows.

(1) Comparing closely related races, species, etc. with a similar mode of life, the relative size of certain organs is larger in larger animal species, while on the other hand the relative size of other organs is smaller in larger animal species. The reverse also occurs. *(Note 204).*

(2) Comparing closely related species, etc. it appears that in the smallest animal species certain organs cannot exceed a maximum size. *(Note 205).*

(3) Comparing closely related species, etc. it appears that in the smallest animal species certain organs are absent because of the proportionately small size. *(Note 206).*

VI, 5. iv. *"Seeming" size and real size*

In cases as mentioned above we have learned to distinguish between "seeming" size and real size.

A "seeming" size may be caused by an organ growing together with a neighbouring or adjoining similar organ. Then one may get a wrong impression of the real size. *(Note 207)*.

As a negative "seeming" size one may consider the phenomenon that some markedly reduced organs are relatively smaller because certain parts are absent. Thus the most distal organs are absent in rudimentary parts of the body and the other distal organs have reduced more markedly than the more proximal organs. *(Note 208)*.

As regards the differences in real size, a few fundamental questions emerge, which will be discussed later.

VI, 6. Field of theory regarding the form, build and structure of an organ

VI, 6. i. *Introduction*

Since in problems of form, build and structure we seldom have to do with conditions which can easily be arranged in categories of yes or no, this or that, so in two categories, as was the case with absence against presence, a great number against a small number, a large size against a small size, we will not try here to classify "rule" against "deviation from the rule" – it is less suitable here.

As regards form, build and structure, we can put "simplicity" against "complexity". The latter may lead to conditions which may be indicated by the terms elevatio and perfectio ("Vervollkommnung").

By "simplicity" we mean: a fairly regular outline and hardly divergent parts, in the coarser build as well as in the finer structure. "Simplicity" can be expected when the organ carries out its functions without a local division of function.

"Simplicity" in the sense of "reduction" occurs in certain cases: in animal species in which, sometimes because of living in a simple or simplified "milieu", the organ in question has lost certain functions, whereby certain functions are carried out by a reduced organ; in both cases the function has been taken over by another organ (principle of Kleinenberg; principle of Sewertzoff), in animal species which show a shifting of functions, whereby the main function is reduced and in animal species with a reduction in the number of functions. All these cases concern "simplicity" by reduction of the ancestral organ.

By "complexity" we mean: an irregular outline and many divergent parts, in the coarser build as well as in the finer structure. "Complexity" can be expected when the organ shows a marked development of functions and a differentiation in these functions, whereby certain parts of the organ have a certain function. Such a differentiation of functions often goes together with the parts becoming morphologically different and with a morphological differentiation, but also with a morphological organization. The division of function goes together with a higher degree of differentiation and a higher organization. Many such organs with a high degree of differentiation can be further denoted by the term "specialization in build".

An extremely high degree of "complexity" occurs in cases of a highly progressive development, of a higher development, when the conceptions "elevatio" and "perfectio" ("Vervollkommnung") are applicable. – Incidentally we may remark that the opposite of "elevatio" and "perfectio" ("Vervollkommnung"), *viz.* "degeneratio", also in the adult stage, is also regarded as "progressive evolution" (as opposed to "regressive evolution" resulting in relicts and extinction). However, we will confine ourselves to the progressive evolution in the sense of "elevatio" and "perfectio" ("Vervollkommnung"). In the following these notions will only be discussed in connection with their morphological aspects and not according to the aspect of the phylogeny of a species or of a larger systematic group. Neither will be discussed the physiological elevatio going together with morphological elevatio, manifesting itself in specialization, the oecologic elevatio, manifesting itself in specialization and efficiency ("Zweckmässigkeit") as aramorphosis p.p. or aromorphosis p.p. – The morphological elevatio with its increase in complexity has two forms of progression, *viz.* the morphological differentiation and the centralization of the parts round a centre; by the latter the progression becomes elevatio. By morphological differentiation we mean that many originally similar parts become dissimilar, which results in heterogeneity; this does not always involve progression. Centralization of parts round a centre, integration or subordination are preceded by partial regression, manifesting itself in a reduced number of similar parts, by which the decentralization decreases. The subsequent centralization, integration or subordination manifest themselves as: (a) arrangement of parts round one or round some points; (b) shifting of parts to that one point or those central points; (c) enlargement of the centrally situated organs; (d) differentiation of those centrally situated organs; (e) joining or growing together of the parts shifting towards each other; (f) shifting towards the interior; (g) reduction in number of similar parts; (h) simplification or back-formation ("Rückbildung"), which puts the differentiations aside ("beseitigen").

VI, 6. ii. *Subjective and objective characterization of simplicity and complexity*

Proceeding according to the subjective principle of characterization, one may start from the simple state and come to the complex state afterwards, but one may also start from the complex state and proceed to the simple state. In the former case it is conceivable that from the secondary complex state one comes to another simple state, a tertiary state, which we would rather call a "simplified state". *(Note 209).* Such a "simplified state" can be expected when the development of the functions has decreased, the differentiation in the functions is lost and the functions have dropped out.

We can also start from a complicated state, arriving at a secondarily simplified state. *(Note 210).*

According to the objective principle of characterization on the ground of the idealistic-morphological consideration one will proceed from the state showing the "archetype" as primary state, which according to the prevailing opinions will be a simple state.

According to the objective principle of characterization on the ground of the phylogenetic consideration one will proceed from the state showing the "ancestral form", as primary state. This may be a simple or a complex state, depending on the systematic group studied.

These phenomena may be studied within a genus, a family, so within systematic groups of very different range.

VI, 6. iii. *"Seeming" and real conditions of simplicity, complexity and simplification*

Among the cases of which we have just mentioned a few, we distinguish between different categories of simplicity, complexity and simplification: categories with "seeming" and real conditions in these respects.

A "seeming" condition of complexity may occur when the organ has become complex by its taking up a neighbouring element. *(Note 211).*

A "seeming" condition of simplicity may occur when simplicity of the organ has arisen by splitting up. *(Note 212).*

The real conditions of "simplicity", "complexity" and "simplification" give rise to a number of fundamental questions which will be discussed later.

VI, 7. FIELD OF THEORY REGARDING THE ADAPTATIVE AND CONSERVATIVE QUALITIES OF AN ORGAN

VI, 7. i. *Introduction*

All organ systems and organs show characteristics in their form, build and structure, of which one aspect points to adaptative qualities and of which another aspect points to conservative qualities.

The aspect of the adaptative qualities fits in with the requirements of the function, with those of the mode of life of the animal and with those of the "milieu" in which it lives. The aspect of the conservative qualities fits in the group of characteristics which the animal species concerned has in common with its allies, sometimes even with very distant allies; these are characteristics belonging to the structural plan of the smaller or larger systematic groups involved, which are "conserved" in the representatives of that systematic group and which are therefore called "conservative" qualities. Such conservative qualities all have an adaptative aspect.

In principle the question about the adaptative qualities as an aspect of the characteristics of form, build and structure of organs may be asked for all organs and organ-parts. But, as with all questions in the field of teleology, one may expect a positive, a neutral or a negative answer to the question about adaptability; in the case of a positive answer ("there is adaptability" in the case concerned) one may expect an answer about the degree of adaptability (excellent, good, moderate, poorly adapted).

VI, 7. ii. *Striking adaptative and conservative qualities*

In a great number of cases there is a striking adaptation and there are marked adaptative qualities in form, build and structure. *(Note 213).* Sometimes the phenomena of adaptation are so extreme, that the possessor could very well live in one certain "milieu", but could not possibly live in another. *(Note 214).*

The general rule for every group of species and small systematic group is, that within one small uniform systematic group – uniform with regard to the adaptation to function(s), to the mode of life and to the "milieu" – an organ can be adapted to one single or chiefly to one single function or to one single "milieu", or equally to some functions or "milieus". The cases of adaptation within a bigger systematic group in one special sense, *i.e.* to one single function or to one single milieu or special environment frequently show the observer striking adaptative qualities. *(Note 215).*

In a larger systematic group diverse adaptations to functions and environments may occur. *(Note 216).*

In a larger systematic group the following extreme cases may occur.

(1) Uniformity prevails in the kind of adaptation within this larger systematic group, regarding the adaptation to the function(s) as well as to the mode of life and to the "milieu". As we have discussed above, there may be an adaptation of the organ in all species to one single or chiefly one single "milieu", but there may also be an equal adaptation to some functions or some "milieus".

(2) Multiformity prevails in the kinds of adaptation in the various species within this larger systematic group, regarding the adaptation to the function(s) as well as the adaptation to the mode of life and the "milieu". This multiformity in the kinds of adaptation is coupled with a great diversity in the function and therefore also in the form, build and structure, which consequently shows the adaptative qualities belonging to it. These adaptative qualities may have numerous and diverse forms in connection with the different "milieus" and the specializations belonging to them. *(Note 217).*

We will discuss later how multiformity, respectively uniformity may be connected with the place of the group, the phylogenetic development and its character.

In principle the question about the conservative qualities as an aspect of the characteristics of form, build and structure of organs may be asked for all organs and organ-parts. Here, too, one has to take into account that one will not always receive a positive answer. Some characteristics and qualities may only have significance for the species, others for the genus, yet others for the family, for the order, for the class, etc. It should also be taken into account that any significance as conservative quality may be wanting.

In certain cases the conservative qualities of the organ may strike the observer *(Note 218)*, like the adaptative qualities in other cases.

What qualities, adaptative or conservative, will strike the investigator, is sometimes connected with an extraordinary development and sometimes partly with what is of importance to the investigator and what he is looking for. We may look for consanguinity within a group and then we will be struck by the conservative qualities of the structural plan, like presence or absence of the organs, the number of organs, their build, etc. The investigator, however, may also be interested in the specific line of development, which is mainly manifested in adaptative qualities.

Our starting-point was and is that each organ and each organ-system possesses both adaptative and conservative qualities. Each organ and each organ-system has to meet the requirements of the specific function, the specific mode of life and the specific "milieu". It is bound to the conservative qualities of the structural plan of the systematic group concerned, or to put it differently: it is bound to the limitations of transformation of the fundamental qualities of the organ concerned. In other words, the form, build and structure of each organ of each animal species is a variant of the transformation-capacity of a conservative structural plan, the adaptations forming an aspect of the structural plan and of the variations in the structural plan.

VI, 7. iii. *Absence of either the adaptative or the conservative qualities*

In principle it is possible that an organ has organ-parts or shows characteristics which do not show adaptative or conservative qualities.

It is conceivable that an organ or organ-part is showing new adaptations – possibly with a morphological substratum – which have the character of a new formation, without involving a conservative quality. *(Note 219)*.

It is also conceivable that an organ or organ-part has no adaptative qualities, but has a well-conserved conservative element. Here we think of the rudimentary organs which some authors think to be without function. Moreover we think of the pre-adaptative formations, by which we mean the morphological characters which have no significant adaptability yet.

Further on we will discuss how this can change in the course of phylogeny.

VI, 8. FIELD OF THEORY REGARDING THE POSSIBILITY OF A COMPLETELY NEW ORGAN, ALSO IN CONNECTION WITH THE OPINIONS ABOUT THE UNITY IN THE STRUCTURAL PLAN OF THE VERTEBRATA

VI, 8. i. *Introduction*

In the preceding sections we have drawn provisional conclusions about certain qualities of organs for all Vertebrata, but mostly only for smaller or larger groups of Vertebrata, and we have seen that as primary phenomenon certain organs etc.

(1) can be really present or absent;

(2) can be present in a small or great number;

(3) can be small or large in length, surface or volume;

(4) can be simple or complex in form, build and structure;

(5) have nearly always both adaptative and conservative qualities, but sometimes the adaptative qualities, in other cases the conservative qualities are the most striking.

Now we will put some fundamental questions which arise in connection with this, namely the questions about the primary phenomena, about the actual loss of organs and the loss of qualities and characteristics of organs, the question about the acquisitions in organs and in qualities and characteristics of organs, about the problem of the so-called new formations and the problem of adaptative "organs".

VI, 8. ii. *Primary phenomena*

We would know what could be called primary phenomena in a small systematic group, if we knew what qualities can be attributed to the archetype, or if we knew the ancestral form and its qualities. The same question could be asked for a larger systematic group, so not for an order from the Mammalia, but for all Mammalia, for the Tetrapoda, for the Gnathostomata and all Vertebrata. However, we can only do this as long as and so far there is a unity in the structural plan of that larger systematic group. When we know the primary phenomena, qualities and characteristics of that systematic group, small or large, we can also form an opinion about the qualities of the representatives of that systematic group.

Thinking in an idealistic-morphological way, we usually imagine the archetype with all its characteristics in the original state, so all "simple" or "primary" in a series from simple to complex, etc. It is very doubtful whether any kind of animal with merely such characteristics could ever have existed and lived. Also in other respects the idealistic-morphological way of thought encounters a great number of difficulties, which run parallel to those of the phylogenetic way of thought.

Thinking in the phylogenetic way, we encounter difficulties in determining the qualities and characteristics of the ancestral form and the various parts of the ancestral form, as for instance many soft parts. We will sum up the remarks about this question in a few points.

(i) The ancestor is known, although only from a few conserved parts in the form of the so-called "direct witnesses". Hence the characteristics of the soft parts are unknown and can sometimes only be deduced indirectly.

(ii) The ancestor is unknown and we will have to try to deduce the characteristics of both the hard and the soft parts from those of closely allied recent animal species, preferably from direct descendants from the ancestor. In this way an impression can be obtained of the probable qualities and characteristics of the ancestor. *(Note 220).*

(iii) The ancestor is unknown and we will have to try to deduce the characteristics of this ancestor, of its hard and soft parts, from the conditions in recent representatives of still older animal species and groups which are systematically lower. *(Note 221).* By studying these recent animal species and groups one tries to get an impression of the probable state of the real ancestral form.

(iv) The ancestor is unknown and we will have to try to deduce characteristics and qualities of the ancestor from ontogeny. *(Note 222).* This is from the ontogeny of the animal species concerned or of representatives of the systematic animal group, of which one wants to know the characteristics of the ancestral form, whether this animal species resp. representatives are recent, or from the ontogeny of recent representatives of allied species of this ancestor.

It is very risky to approach the ancestor by way of its qualities in this manner. *(Note 223).* Firstly, because ontogeny is not a pure reflection of phylogeny, considering the ontogenetic caenogenetic alterations. Secondly, because naturally the conditions in ontogeny have to be of simple form, build and structure and so they cannot always be significant or characteristic of the knowledge of the condition in the adult ancestor.

(v) The ancestor is unknown, but sometimes there is a very certain negative indication of certain characteristics of the ancestor, on the ground of the character of the recent animal species or animal group. *(Note 224).* Thus we can say of the ancestor of a parasite that it must have been living freely and must have possessed a number of primary qualities which the parasite lacks. Thus we can say of the ancestor of a parasite that it did not show the secondary simplification which is characteristic of parasites, at least of some of their organs.

If one thinks to know something about the characteristics of the archetype or ancestor of the species or group of animals examined, one can also know in principle what is primary and what is deduced. Then, in principle, one has an opinion of the qualities of the animal species which are deduced from their archetype and about the qualities of the animal species descending from their ancestors.

VI, 8. iii. *Real loss of organs and of qualities and characteristics of organs*

As appears from the history of the comparative anatomy of conservative structural elements, there are evidently few difficulties as regards the real loss of organs and the real loss in qualities and characteristics of organs.

By loss we mean here: absence, smaller number, shorter length, smaller surface and volume, simpler form, build and structure, etc. as compared to the archetype or ancestor. The reason why apparently there are no difficulties is that so many examples are known from the embryology and the ontogeny of arising and perishing organs and of qualities of organs during the individual development and that the phenomenon of rudimentary organs is known.

By rudimentary organs *(Note 225)* we mean those organs which are slightly developed in size and build in comparison with the same organs in the archetype or ancestor. Thus defined, such rudiments are no predecessors of a developing organ. Rudiment is used here in the continental sense; in the English language "rudiment" means the primordium, the "Anlage" or the "anlage".

VI, 8. iv. *Gain in organs and in qualities and characteristics of organs*

As also appears from the history of the comparative anatomy of conservative characters of conservative elements, the gain of organs and gain of qualities and characteristics of organs may be a problem and a matter of theoretical importance.

By gain we mean here: be present, occurring in greater number, increase in length, surface and volume, becoming more complex in form, build and structure.

These features of gain often yield an organ or a quality or characteristic of an organ, which resembles a "new formation". By "new formation" we must understand something that was not there before as such. Of course it does not mean that in the archetype or ancestor there was a vacuum there; the space was filled, but by something that is not reminiscent of what occurs in the descendants or the derivatives.

What do we have to think of these new formations?

Here, too, we can distinguish between "seeming new formations" and "real new formations". In principle, one cannot exclude the "real new formations". It is conceivable that real new formations, which did not yet occur in the ancestor, occur in phylogeny.

There is, however, a strong tendency among some authors in the comparative anatomy of the conservative structural elements, saying that, on the ground of the unity of the structural plan of the Vertebrata, in principle all formations occurring in the derived species and descendants are also present in the archetype and the ancestor and vice versa. This involves two important consequences.

The first consequence that will not be easily accepted as we discussed above, is the absence of organs in the derived species, resp. the descendants, organs that do occur in the archetype resp. the ancestor. We have seen above that, when such an organ is found back in the normal ontogeny, in aberrant specimens etc., it has been accepted as a confirmation of the typological fundamental idea. If the organ cannot be found back in ontogeny as a separate "anlage", these authors think of the phenomenon that its "anlage", together with the "anlage" of an adjoining organ occurs as one single primordium (archallaxis). *(Note 226).*

The second consequence is that – just as the absence of organs in the descendants will not easily be accepted – the occurrence of formations and of characteristics in the derived species resp. in the descendants is not easily accepted either, when these did not occur in the archetype and the ancestor and would therefore be real new formations. These authors will say, when they formulate this conclusion accurately, that nothing really new can be added within the Vertebrata: that everything present in the derived species resp. the descendants, – even in the most developed, most recent ones, – was already present in the archetype resp. the ancestor. *(Note 227).*

VI, 8. v. *"Seeming" "new formations"*

Many of the formations which seem to be "new formations" are not so in reality. Numerous supporters of the view that no really new formations occur, have pointed out that many so-called new formations are in fact not new.

We may divide these "seeming new formations" into the following groups:

(I) Many "new formations" are seeming, because in form, build and structure they show alterations, which are not very radical and not really important. We mention the following cases as such alterations in form, etc.

(a) Excrescence, manifested in growing longer and bigger, in swelling, in formation of folds and in vaulting. *(Note 228).*

(b) Formation of inward cavities, also manifested in sagging. *(Note 229).*

(c) Division, also manifested in splitting up and splitting off. *(Note 230).*

(d) Stringing in and stringing off. *(Note 231).*

From a number of phenomena certain indications can be gathered as to the correctness of the view that these alterations in form, build and structure are not very radical, do not concern real alterations in form, build and structure and that these alterations are merely "seeming new formations".

In the first place the seeming new character is deduced from the phenomenon that the alterations in form, etc. do not differ fundamentally from the differences in form, etc. between closely allied species or even between the two sexes of one animal species.

Secondly this seeming new character is deduced from the phenomenon that such alterations in form also occur here and there in lower groups. *(Note 232).*

Thirdly this seeming new character is deduced from the phenomenon that the said alterations in form are closely connected with the adaptations to the function and the "milieu". *(Note 233).*

In the fourth place the seeming character of these alterations in form, the so-called "new formations", is deduced from the phenomenon that these alterations do not or hardly concern the conservative characteristics. Yet there are alterations in form which do have the character of an architectural plan. *(Note 234)*.

(II) Many "new formations" are seeming, because they are based on a differentiation in that the formation changes, which is not essentially a new formation. Differentiation can occur in three main forms:

(a) A formation occurring in a certain field may be developed in various degrees in different places in that field. *(Note 235)*.

(b) A mixture of properties occurring in a certain field may occur locally separated in various parts. *(Note 236)*.

(c) A certain field changes its tissues and becomes slightly different because of that, although it still belongs to the same main group of tissues. *(Note 237)*.

In principle these alterations in tissue are not different from those, occurring in a specimen after restitution, in various specimens as variations within the species, etc. If one should broadly explain the presence of one kind of tissue instead of another, in order to demonstrate that no essentially new formation has occurred, one runs the risk of giving a meaningless explanation, for it would imply that the organism consists of three germ-layers.

From a number of phenomena certain indications may be deduced as to the correctness of the view, that these differentiations yield no essential alterations in form, etc. and that therefore they are only "seeming new formations". These phenomena are the following.

(i) The differentiations in question do not differ fundamentally from those between closely allied animal species.

(ii) Some differentiations in tissue in higher groups are also found now and then in lower animal groups. *(Note 238)*.

(iii) The differentiations in question are often adaptations to a function of a different nature or to the different "milieu". *(Note 239)*.

(iv) The differentiations in question usually do not concern the architectural plan. From this the "seeming" character of such differentiations, as so-called "new formations", may be deduced. Yet there are cases in which the differentiations belong to the architectural plan of a larger group. *(Note 240)*.

(III) Some "new formations" are seeming, because they are based on a combination, by which we mean that heterogeneous parts lie next to each other or against each other, whether or not combined with coalescence. *(Note 241)*.

(IV) Some "new formations" are considered to be unessential, because their occurrence is thought to be understandable for purely mechanical reasons. *(Note 242)*

(V) Some "new formations" are considered to be unessential, because they only occur in one or two animal species. *(Note 243)*.

(VI) Some "new formations" are considered to be unessential, because they are supposed to be below the value of a structural element and therefore cannot be considered as "separate", because they are merely a part of such a structural element. *(Note 244)*.

(VII) A number of "new formations" are considered to be seeming, because although they cannot be deduced from organs of lower Vertebrata on the ground of our factual knowledge of the build of fossils and of recent species, this deduction and bridging can be made hypothetically. *(Note 245)*.

VI, 8. vi. *Remaining "new formations"*

If, in the above-mentioned way, many and varied new formations are reduced to "seeming new formations", there remain in fact only very few new formations, which cannot be traced to something already existing. *(Note 246)*.

From the fact that so few "new formations" are left, of which the seeming character cannot or cannot yet be proved, *(Note 247)*, some authors deduce that in principle there will not be any new formations, but that everything has to be considered as having been present in the archetype or the ancestor of the Vertebrata.

VI, 9. Field of theory with regard to "adaptative organs" and "conservative organs"

In a preceding section we have discussed the "adaptative characteristics" as opposed to the "conservative characteristics" or "characteristics of the architectural plan", which occur side by side in the organs in the body of the Vertebrata.

We will now put the question whether there are also "adaptative organs" and "conservative organs". Much depends of what is understood by these terms.

By "adaptative organs" may be understood such organs that have very striking adaptative characteristics; however, they also possess conservative characteristics. By "conservative organs" may be meant such organs that have very striking conservative characteristics or characteristics of the structural plan; however, they also possess adaptative characteristics. Again we will look into the question whether, by way of exception, there may be organs without adaptative characteristics. Besides we will examine the question whether adaptative formations occur here and there, which do not belong to an organ or organ-part. Organs without adaptative characteristics will be rare, because an organ is defined by a function. Such organs, however, may be without function in allied animal species, as is sometimes said of rudimentary organs, which we discussed in a preceding section. Moreover we saw that organs which came into existence by mutation, may have a pre-adaptative significance and so at that moment have no adaptability or serving function yet.

In a following stage of phylogeny, however, organs without adaptative characteristics may be taken by their bearer into another "milieu", by which these characteristics develop an adaptability and their pre-adaptative characteristics are realized. Usually this will not concern the organs so much as the parts of the organs.

Thus in a following stage of phylogeny, parts of organs (we can hardly imagine this to happen with organs) with a certain functional significance and therefore with adaptative characteristics, but without conservative significance, may get these conservative characteristics, because they are taken up into the architectural plan of the recently developed small animal groups. What opinion one has about how the purely adaptative characteristics come into existence and how these are taken up in a conservative element or a conservative organ-part, depends on which theory of descent is thought to be the right one and which theory is adhered.

VI, 10. Field of theories regarding the arrangement of the conditions of an organ in a sequence

VI, 10. i. *Introduction*

The degree of resemblance, *i.e.* resemblance in a greater or less degree, may lead to the arrangement of the conditions of an organ or of an organ-system in an animal group in a sequence.

When arranging and judging such sequences, some questions arise, which we will mention below. These questions are:

(1) What is the philosophic basis of such a sequence: is it a subjective sequence or is it an objective one, and in the latter case: is it an idealistic-morphological sequence or a phylogenetic one?

(2) What do we arrange in such a sequence? We arrange as objects: abstractions of the properties or characteristics of organs, organ-systems or organ-parts having an individuality of their own.

(3) In which direction should the sequence be read? In one direction only, or can it be read in both directions? *(Note 248)*.

(4) Is the transition within the sequence more or less continuous or is it discontinuous?

(5) Has the sequence a qualitative character *(Note 249)* or a quantitative character? *(Note 250)*.

(6) What is the shape of the sequence? Can the conditions be imagined in a row placed one after the other (are the graphic points on one line)? Or are the conditions to be imagined next to each other in different directions,

starting from one condition, (are the graphic points in a ramified line, whether in a single or a multiple or a complex ramified line?) etc.?

VI, 10. ii. *Arrangement of the conditions of an organ in a subjective sequence*

(1) The basis of a subjective sequence is the arrangement according to human subjective views of resemblance. A well-known representative of this is the artificial diagnostic sequence.

(2) Abstractions of the properties and characteristics of organs, organ-systems and organ-parts are arranged, in so far as they possess an individuality of their own.

(3) Both directions in which the subjective sequence may be read have equal validity. This is applicable to the single unforked line *(Note 251)* as well as to the ramified line.

(4) In principle, the transitions in a subjective sequence may be continuous as well as discontinuous.

(5) Most subjective sequences are qualitative: the differences between the members of the sequence are differences in quality. Some subjective sequences are quantitative: the differences between the members of the sequence are differences in number.

(6) The shape of the subjective sequence may vary a great deal, also considering the structure of the regulating human mind. These differences also depend on the size of the field which has to be arranged in a sequence. Large fields may yield combinations of parts of a different shape, for instance ramified parts with pieces, which graphically speaking lie in one line. Small parts of a subjective sequence may form one forked line.

Small parts of a subjective sequence may also be ramified, whether in one forked line, or a line with more branches, or a complex ramified line. *(Note 252)*.

VI, 10. iii. *Arrangement of the conditions of an organ in an idealistic-morphological sequence*

(1) The basis of an idealistic-morphological sequence is an objective one, in the sense of an elaborated idea and an affinity of the animal species concerned. Such a sequence is called a metamorphosis, or typological sequence, which forms a natural sequence. – If the resemblance between the features is not sufficient to determine a metamorphosis unequivocally ("eindeutig"), we may call in two of the principles of precedence, *viz.* the principle of the ontogenetic precedence (the sooner the characteristic occurs in ontogeny, the closer it is to that of the original type or archetype) and the principle of the systematic precedence (the more common the systematic category is in which the characteristic first occurs, the closer this characteristic is to that of the original type or archetype) (N.B. a third

principle of precedence, *viz.* the palaeontological-stratigraphic one, only plays a minor part in idealistic morphology). *(Note 253).*

(2) Abstractions are arranged of the properties and characteristics of organs, organ-systems and organ-parts, as far as they have an individuality of their own.

(3) The sequences of an idealistic-morphological series may be read in only one direction, namely from the archetype towards the deduced forms. This holds good for the sequences which can be graphically represented as one single unforked line or a ramified line. The direction away from the archetype is further determined as the direction from the primitive towards the specialized. *(Note 254)*

As a rule the idealistic-morphological view has led to the imagination of an archetype with primitive properties and characteristics in every respect, whereby primitive meant simple, original, non-specialized, etc.

All organs and properties and characteristics of such an archetype were thought to be primitive, simple, original and non-specialized. The animal species deduced from the archetype would show the properties in a progressive form; the further deduced they are, the more progressive are the properties. In intermediate forms, so less deduced forms, there would be an intermediate state of the properties.

Animal species which are even further specialized than the said progressive state, either show a reduced state leading to a rudimentary organ *(Note 255)* and regressiveness, or they may be even more progressive.

From the progressive state one may sometimes deduce a hyper-progressive state *(Note 256)*, which is harmful to the continuance of the species, also when the circumstances hardly change.

(4) In principle the transitions in an idealistic-morphological sequence may be continuous or discontinuous. This will be imagined by a step-by-step transition and merging from one state into another. This way of thinking allows the view of a metamorphosis with very gradual transitions. However, in transitions from one big systematic group to another we will often have to do with discontinuous transitions. *(Note 257).*

(5) Most idealistic-morphological sequences are qualitative *(Note 258)*; as an exception such an idealistic-morphological sequence may be quantitative. *(Note 259).*

(6) The shape of the idealistic-morphological sequence may vary widely. In the first place it is connected with the views of the affinity in these non-phylogenetically oriented systematics. Secondly it is connected with the size of the field which is comprised in a sequence. Here, too, large fields will be combinations of pieces of a different form, *e.g.* ramified parts with pieces in which the conditions, indicated by points, lie in one line. Represented graphically, small pieces from such an idealistic-morphologi-

cal sequence can either form a single unramified line, or a ramified line. whether single, or multiple, or complex. *(Note 260).*

VI, 10. iv. *Arrangement of the conditions of an organ in a phylogenetic sequence*

(1) The basis of a phylogenetic sequence is the arrangement of the conditions of an organ according to the descent of the bearers of that organ. So the arrangement of the organs takes place according to the phylogenetic consanguinity of the organisms. Such a phylogenetic sequence is a natural sequence.

This, *viz.* the arrangement of the organs according to the phylogenetic consanguinity of the organisms, – *i.e.* of the species which were the bearers of these organs –, requires some explanation.

A close connection is made between the condition of the organs in those species which descend from one another, *i.e.* which are connected by a pedigree. It may be explicitly stated here that in the first place we are not considering consanguinity, descent and pedigrees of supraspecific systematic unities, such as genera, families, ordines, classes and possibly even phyla, but species. It must be admitted immediately that as a rule the species connected by a pedigree are unknown, so that one looks for wider systematic connections. Furthermore it has to be stated that a race can be the starting-point in the historical origin of a species, a genus, a family, etc. One should not think of the species as a whole, but of certain specimens of a species.

A next item is the possible value of the lines of development of the species, one away from the other. It can be said that some species are "closer to the ancestor" and others are "further from the ancestor". The terms "primitive" and "less primitive" or "more specialized" may be mentioned in this connection. In such a "series" consisting of a "line of development", attention might also be paid to the position of some descending species in relation to each other. Then a certain species will be "primitive" in regard to a species further down from the ancestor, but it will be "more specialized" compared with a species closer to the ancestor. Primitive in respect of one animal may be specialized in respect of another animal. *(Note 261).* Furthermore it has to be considered that, dependent of the place of the ancestral form, the specialization has proceeded less or more. However far back the ancestor is placed, it is impossible, according to many authors, that this remote ancestor should be totally unspecialized, because any animal species shows a certain specialization. However, these authors think that as concerns individual characteristics of the organs separately the terms primitive or non-specialized, intermediate and specialized can be used. Within each animal species the various characteristics of the various organs come under various headings of primitive, intermediate and specialized.

As general examples of such lines of specialization we mention the following.

(i) Line of specialization to extreme "milieus" and to specialized ways of life. *(Note 262).*

(ii) Line of specialization, as formulated in the rules of Bergmann, Glover, Allen, etc., which show or do not show an adaptation character.

(iii) Line of specialization of the size of the body, as formulated in the rule of Cope. It is frequently observed that the animal species, arranged according to the typological sequence, show an increased size of the body, especially the higher Vertebrata, although this is no strict law.

(iv) Line of specialization, leading from free life to parasitical life. *(Note 263).* Line of specialization to other modes of life in phylogeny. *(Note 264).*

(v) Some lines of development in special cases, leading to characters which became disadvantageous to the adaptation to the requirements of life ("fehlgeschlagene Anpassungen" by Abel), as appears from the occurrence in the developmental stages before dying out and which may be due to excessive development of certain parts of the body.

Regarding the development of species away from each other and the valuation of such a line of development, some denominations have been given, such as a progressive development, even an anagenesis or higher development, but also a degenerate development The question arises as to what criterion is applied in these and suchlike valuations. Is the degree of adaptation of the organism the criterion, or is it the complex structure of the organisms as a whole, or the development of a single organ or organ-system, which may be selected as an indicator? The problem is then, as an indicator of what? In this connection we think of an organ or organ-system which gives a true representation of the course of the descent according to the pedigree of the animal species concerned.

Another question which we would like to examine is the relation of the directions of development in a pedigree of the animal species (as whole specimens) to the sequences which can be read from this for their separate organs and organ-systems.

These phylogenetic sequences can only be read from the pedigree of the animal species. Without any knowledge of the descent of the animal species concerned, it is impossible to arrange a phylogenetic sequence of the conditions of a certain organ, merely on the ground of the knowledge of the conditions in various organs and organ-systems in various animal species. There is no general principle, according to which the organs of animal species belonging to one single pedigree may be arranged in the phylogenetic row of descent, merely on the ground of the properties of the organs concerned. Such a principle is certainly not given by the general principle of greater or less resemblance according to the subjective judgment of the investigator. It is solved by the opinion about the relation of the "row of the shape of organs" ("Formenreihe") to the "row of ancestors" ("Ahnenreihe").

As regards the value of the current pedigrees, based on morphological characteristics of fossils and recent animals, we note the following. Great value will be attached to the knowledge of the geological age and the geographical distribution of fossils. Now there is an extremely close connection between the morphological knowledge of the extant organs and organ-systems in the fossils and the systematic knowledge, which is phylogenetic systematics. The pedigree is derived from the views of phylogenetic systematics; both are tied to our knowledge and views of certain conserved organs and organ-systems. Thus our systematic view plays a great part in indicating the descendants of a species from an older geological layer, indicating which descendants will occur among the numerous species in a younger geological layer, but this view is fed by our morphological knowledge, which again is judged in relation to the pedigree. However, the rows of different organ-systems do not run parallel and do not have the same direction – they may even have opposite directions. *(Note 265).*

Above we chiefly dealt with consanguinity, descent and pedigrees of species, indicating that these notions are also used in connection with supraspecific unities, such as genera, families, ordines, classes and sometimes even phyla. In numerous cases no pedigree could be made of species or even of genera, but yet one has an opinion about the descent of the larger systematic group to which the ancestor of the species or genus examined mut have belonged. Then the somewhat wider and vaguer view will be that one bigger systematic group descends from another bigger systematic group. The general conditions of one bigger systematic group will then be placed in a row with suchlike conditions in other bigger systematic groups, the fossil representatives of which are thought to belong to a pedigree of species. The arrangement of such an anatomic sequence goes further than is usually found in textbooks which deal with the conditions of a certain organ-system in the order of the big systematic groups, such as classes and ordines.

The true phylogenetic sequence is also important in a negative respect, because it makes us separate this true phylogenetic sequence from what must not be arranged in it. In this connection we mention particularly the so-called phylogenetic "seeming" sequences. *(Note 266).* These include sequences of fossil species, etc. which were thought to form a phylogenetic sequence, but which, as appeared later, was not possible, considering the chronological order and the geographical distribution, although, from a subjective point of view, they formed a gradual sequence.

It is understandable that it is not always easy to arrange a pure phylogenetic sequence. The data for it depend on the material about fossils and their exact dating. Besides this, many other factors play a part, for instance: is the explosive stage of long or short duration?; did the evolution of specialization proceed quickly or slowly? etc.

After this rather extensive discussion of the basis of a phylogenetic sequence, with the many items that had to be mentioned, we will now briefly discuss the other points.

(2) Abstractions of the properties or characteristics of organs, organ-systems and parts of organs are also arranged, in so far as they have an individuality of their own.

(3) The phylogenetic sequence may be read in only one direction, *viz.* from the ancestor to the descendants. Also a long single-lined pedigree may be read in only one direction, *viz.* from the ancestor to species later descending from it. Finding this direction may be difficult for want of historical data. It would even be more difficult, if in the descent the order of occurrence of the characteristics in members of the pedigree could have been reversible.

According to the rule of DOLLO (1893), however, the order of characteristics in the descent, as to their occurrence in the course of history, is an irreversible process. This "rule" is based on the view (i) that the structural changes which take place in evolution are irreversible, and (ii) that no case is known in which a race of animals, after having lost a character, acquires that identical character again. Structural reversibility appears never to have taken place in evolution. The past is indestructible, according to Dollo. A new interpretation, as a consequence of this rule, is: it is not possible to derive one form in phylogeny from another, if the latter is specialized.

According to the views now held in heredity, we may say: if the loss of a character is due to long-standing hereditary changes, these are incapable of being reversed. A character once lost is lost forever, if the genetic factors and conditions controlling its formation are irretrievably lost or irrevocably changed. There are, however, a few examples of the opposite. In most of these cases it is unlikely that the original ancestral conditions are exactly reproduced; it is unlikely that all the genetic factors which have been lost are re-acquired. – If the loss of a character, however, is due to fairly recent changes in the hereditary factors, changes may still be reversed, owing to reconstruction of the original conditions. In the case of long-standing hereditary changes, under certain genetic conditions, however, the lost element of the body with its characters can be redeveloped by particular recombinations of genes, and the original condition may be reconstituted. – A substitute character, however, may appear which fulfils the same function as the old character, but it is always structurally distinct and easily recognizable. Functional return to a previous condition, using other instruments, is not uncommon.

(4) In principle the transitions in a phylogenetic sequence may be continuous as well as discontinuous. The opinions about this depend on the authors and the theory of descent they adhere, while they further depend on the material and especially on the question whether we are dealing with small or large systematic groups. According to some authors, all transitions

within phylogenetic pedigrees are continuous, according to others they are all discontinuous, whereby these gradual transitions may be accompanied by small or big differences. Another group of authors assume a continuous transition in the formation of new races, etc., but a discontinuous transition in the formation of new species or new families, etc.

The opinion of the authors is related with the views of the role of selection, isolation and mutation in the formation of the races, species, etc. Regarding the mutations, their opinion is related with their views of the extent of the pace of mutation (micromutation, macromutation), necessary for the formation of new races, new species, new families, etc. The inductive theory of descent which experimentally examines the processes in the formation of races, sub-species and species, has had a great influence on the views of the gradualness and non-gradualness, on the views whether these sequences are (or are not) parallel to our subjective human judgment in these matters. – As concerns the transition of the big systematic groups, we are often forced to assume a discontinuous transition *(Note 267)*, also in the properties of form, position, etc.

(5) Most phylogenetic sequences are qualitative. *(Note 268)*. A few phylogenetic sequences are quantitative. *(Note 269)*.

In connection with this, the judgment of the rows of separate organs and organ-systems from the ancestor towards the successively originating species as descendants may be taken as a kind of valuation. Such a valuation would deal with the kind of specialization, the direction of the specialization, whether this specialization leads to a progressive development or a regressive one, all considering the direction of the development of the systematic group as such. Progressive development of an animal group to further progressing specialization will go together with progressive development of certain organs. *(Note 270)*. It will go also with regressive development of other organs. *(Note 271)*.

Vice versa, degenerative development of an animal species may go together with excessive development of an organ, which development in itself is progressive. It has also been expressed as follows: excessive morphological development of an organ often goes together with intensive morphological development of the chief function and suppression of one or more secondary functions, which involves a reduced number of possible directions in the evolution and hence fewer adaptations. – As regards degrading development, we must distinguish between general and partial degradation of organs. This general degradation is found in ever continuing reduction and the loss of the locomotion-organs and the free mode of life, so in sessile forms and endoparasites, which do not occur among the Vertebrata. The tenor of the notions progressive and regressive, when applied to the pedigree of the organisms as a whole, is different from when applied to the separate organs and organ-systems which are arranged in some way, *e.g.* according to the pedigree of the bearers of these organs, etc, The principle of the substitution in general is of importance to our considerations; in the first place, in view of our subject, the morphological substitutions, but also the functional ones. In this connection we mention the principles of Kleinenberg, of D.M. Fedotow and of A. N. Sewertzoff.

According to the principle of Kleinenberg, an organ is substituted by another organ, of different build, but with the same functions, but situated in another region, so situated differently from the ancestral organ and with a different embryonic anlage. Sometimes the new organ is situated in the same place as the ancestral organ which, however, is reduced; it has the same function, but a different anlage.

A physiological substitution occurs according to D. M. Fedotow.

According to A. N. Sewertzoff, one function is substituted by another, whereby the ancestral function in the descendants is replaced by a substituting function, which substituting function is not identical to the function of the ancestor; the substituting function may be resemblant or only biologically equivalent (walking by moving the vertebral column instead of the feet; attacking with horns or claws instead of with teeth; regulation of the body-temperature by a layer of fat instead of a hairy coat). In this connection we have three possibilities: (a) the substituting function ("ersetzende Funktion") is analogous and resemblant ("ähnlich") to the substituted function ("ersetzte Funktion"); (b) the substituting function ("ersetzende Funktion") is of the same nature ("Art"), although only distantly ("entfernt") analogous to the substituted function ("ersetzte Funktion"); (c) the substituting function ("ersetzende Funktion") is biologically equivalent, although of entirely different nature ("ganz anderer Art"; "ganz unähnlich")from the substituting function ("ersetzende Funktion").

There is not always substitution when functions are lost. It may happen that the number of functions decreases while yet not all these functions are substituted.

(6) The shape of the phylogenetic sequence, *i.e.* the shape of the pedigree of the organisms, may vary widely. There is much difference of opinion in this respect and there is very extensive literature about it. In the first place these differences of opinion may concern the character of the animal group examined, in the second place the views of the phylogenetic systematics of that animal group, in the third place the theory of descent which is thought to be the right one and which is adhered, and in the fourth place the size of the field of which the pedigree has been determined.

The size of the field of which the pedigree has been determined is of minor importance for us, because for our purpose it is usually sufficient to discuss certain parts from the pedigree and the many authors in this field hardly disagree about this.

The main parts from such a graphic representation of a pedigree which are important in this connection, are the following four parts.

(i) A fragment which consists of one single unramified line. This is the graphic representation of a so-called introductory stage in indifferent animal species which are specialized in few directions.

(ii) A fragment which consists of a fan-shaped bundle of ramified lines. It is the graphic representation of explosive development in several directions with specialization in size, food, mode of life, manifesting itself in the occurrence of new races, species, genera, families, ordines and classes (Haeckel's epacme or "Aufblühzeit"; Walther's anastrophes; Wedekind's "Virenzperiode"; K. Beurlen's "plastische Frühphase").

(iii) A fragment which consists of some unramified lines. It is the graphic representation of some conserved directions of development, which go on and show a continuing increase of versatile adaptations to the numerous conditions of life. This may be called the flourishing period (Haeckel's acme or "Blütezeit"). It may also be called orthogenesis, if taken in the purely descriptive sense, as the so-called program-evolution in straight lines.

Nothing is said about the possible causes of these straight lines or orthogenesis in a descriptive sense *(Note 272)*, whether they are caused by "orthogenesis" or by orthoselection. From the statement that the orthogenetic development fulfils the law of progression ("Vervollkommnungsprinzip") it cannot be gathered with certainty that we have to deal with orthogenesis in a descriptive sense.

The graphic representation consisting of a bundle of neighbouring unramified lines, which may even run parallel, should not be mixed up with the above-mentioned. The condition which is the cause of the graphic representation just described may be the result of two or more independent developments, which show great equality or similarity. The latter developments show the phenomenon of homoiogenesis.

(iv) A fragment consisting of terminating lines. This is the graphic representation of lines of development which are dying out. We also find such terminating lines in cases of sequences fulfilling the rule of irreversibility (rule of Dollo).

These four and suchlike fragments may occur in pedigrees, which comprise a larger field of consanguine animal species in time and space. All or some of them may be present. They may be combined in different ways, dependent on the size of the part of the pedigree which is reconstructed and surveyed, and dependent on the group and the opinion of the investigator.

Concerning the possible combination of the said fragments in pedigrees, we confine ourselves to referring to the well-known difference of opinion as to the place of attachment of the base of the graphic representation of the pedigree of a newly exploding group of descendants. According to some authors the base is affixed to the graphic representation of the extremities of the branches of the graphic representation of the ancestor group, which extremities represent the more differentiated higher members and then we have to do with gerontomorphosis. According to other authors the base of the graphic representation of the pedigree of the newly exploding group of descendants is likewise fixed to the base of the branches or branch of the graphic representation of the ancestor group, which points or point on the base represent the more undifferentiated lower members. According to the latter view paedomorphosis allows an escape from specialization.

ACKNOWLEDGEMENTS

My cordial thanks go to all who assisted me in the translation of my typescript in English. In the first instance to those who made a translation in English of parts of my typescript, that is to Miss A. Buys at Arnhem, and to Mrs. Ed. Moens-Kloosterhuis at Nijmegen. In the second place my hearty thanks go to Miss R. H. F. De Ru at Leiden, who uniformized these translations in a personal verbal deliberation with me.

VII

GENERAL LITERATURE

VII, 1. PREPARATORY PAPERS BY THE AUTHOR CONTAINING CRITICAL DISCUSSIONS ON LITERATURE

KLAAUW, C. J. VAN DER (1931). Normaal, norm en normbegrip in de biologie. — Vakbl. Biol. 12, p. 173–183.
On: the various notions of norm.

KLAAUW, C. J. VAN DER (1931). Plaats, omvang en betekenis der morphologie in verband met het systeem der biologie. Openbare les, Rijksuniversiteit te Leiden. — Leiden, A. W. Sijthoff, p. 1–28.
On: apriorisms see p. 12 sq.
empirisms p. 13 sq.
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methods p. 9 sq.; morphology within the system of biological sub-sciences p. 6 sq.

KLAAUW, C. J. VAN DER (1931). Kritische Bemerkungen zum Normbegriff bei RAUTMANN und LUBOSCH. — Tijdschr. ned. dierk. Ver., III serie, 2, p. 221–230.
On: the notion of norm.

KLAAUW, C. J. VAN DER (1932). Kritische Bemerkungen über das System der Biologie von LUBOSCH. — Tijdschr. ned. dierk. Ver., III serie, 3, p. 9–36.
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ideas p. 24 sq.
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On: comparative anatomy see p. 2–8.

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On: comparative anatomy see p. 2–12.

VII, 2. GENERAL LITERATURE IN THE FIELD OF THEORETICAL MORPHOLOGY AND OF LOGICS OF MORPHOLOGY

ALVERDES, F. (1931). Allgemeine Ätiologie. Der Transformismus oder die Lehre von der phyletischen Umbildung der Organisation und ihren Ursachen. — In: L. BOLK, E. GÖPPERT, E. KALLIUS und W. LUBOSCH, Handbuch der vergleichenden Anatomie der Wirbeltiere, 1. Band, p. 129–184.
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VII, 3. General literature in the field of philosophy in general

Becher, E. (1914). Naturphilosophie. — Die Kultur der Gegenwart. Ihre Entwicklung und ihre Ziele. 3. Teil. Mathematik, Naturwissenschaften, Medizin. 7. Abt. Naturphilosophie und Psychologie. 1. Band. Naturphilosophie. — Leipzig & Berlin, B. G. Teubner, x + 427 p.
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VII, 4. General literature in the field of philosophy of biology in general

Meyer-Abich, A. (1963). Geistesgeschichtliche Grundlagen der Biologie. — Stuttgart, G. Fischer, x + 322 p.

NOTES

1 a) the shape of the body as a whole – b) head – trunk – tail – c) region of the belly – region of the shoulders – d) lower jaw – ear-region – e) dorsal edge of the body – rostral extremities – external ear – external nose – upper leg – foot.

2 gland in general.

3 first premiss: in all animals possessing a chorda dorsalis, primordia of vertebrae are formed; second premiss: the chorda dorsalis lies in a part of the skull base; conclusion: in a part of the skull-base primordia of vertebrae are formed.

4 dazzle-painting.

5 dog and wolf belong to the Canidae — ovarium and testis belong to the gonads.

6 the Mammalia, which suckle their young, are oviparous or viviparous — the Mammalia possess a cloaca or a sinus urogenitalis – the Monotramata being cloaca-possessing Mammalia, show moreover an incubatorium, a left and a right genital system; they are missing teats, etc.

7 the derivation of incus and malleus of the Mammalia from quadratum and articulare of the Non-Mammalia.

8 theory of Reichert about the skeletal and non-skeletal elements of the jaw-region and the auditory region in Non-Mammalia and Mammalia.

9 connection between Vertebrata and Insecta — connection between Vertebrata and Mollusca, especially Cephalopoda.

10 parts of the integument – mandibular and hyoid skeletal arches and the last branchial skeletal arch, when the pectoral girdle is suspended on it – the five brain vesicles – ganglia in the central nervous system – foregut, midgut and hindgut as parts of the trunk intestine as opposed to the part of the alimentary canal in the head and neck, or: foregut divided into probranchial (mouth cavity) with parabranchial foregut (pharynx) and metabranchial foregut (oesophagus and stomach), midgut and hindgut – valves of the heart – Malpighian capsules in the kidney.

11 the most rostral and the most caudal brain vesicle – mouth cavity and midgut.

12 ganglia in the central nervous system.

13 parts of the surface of the gyrencephalous cortex of the cerebrum – lobes of the lungs in many Mammalia – pronephros, mesonephros and metanephros, seen as parts of the holonephros.

14 arbitrary limit between telencephalon and diencephalon – arbitrary limits of the metencephalon, rostrally and caudally, on the ventral side.

15 in Amniota the primordium of the skeleton and of the muscle system.

16 Vertebrata and Insecta – Vertébrata and Cephalopoda.

17 molars (cheek teeth) of fossil and recent Proboscidea.

18 resemblance in the build of the skeletal "fins" in swimming Vertebrata – resemblance in the build of the skeleton of the legs in Tetrapoda with bipedal locomotion – absence of the skeleton of the legs in Serpentes and Anguis – reduction of the skeleton of the wings in Struthiones and in Dodo – foramen obturatum and foramen puboischiadicum – processus oticus of the palatoquadratum – akinesis of the skull – secondary skeletal roof of the mouth cavity – electric organs – ectobranchiae – entobranchiae among the Amphibia – paired eyes in dibranchiate Cephalopoda and in Vertebrata – telescopic eyes in bathypelagic Pisces and in Strigiformes – part of the eye for vision above the water and part for vision through the water in Anableps tetrophthalmus (and in Gyrinus natator).

19 cutaneous ossifications and more deeply situated allostoses (membrane bones), such as frontale, vomer, cleithrum, clavicula, etc. — apparently homologous

muscles in different animal species, developed from different segments and innervated by different nerves – muscles, attached to homologous vertebrae, according to the theory of Rosenberg (bearing the same number, reckoning from the occipital bone), but having their origin in different somites – muscles, attached to homologous vertebrae, according to the theory of homology of the region of the vertebral column, but having their origin in somites bearing a different number and being innervated by different nerves.

20 nervous system in Amphibia and Mammalia developed from the basal layer of the ectoderm and in Pisces and Reptilia from all layers of the ectoderm – organs of sense in Amphibia and Mammalia developed from the basal layer of the ectoderm and in Pisces and Reptilia from all layers of the ectoderm – vertebral column with many vertebrae and vertebral column with a small number of vertebrae.

21 spiraculum with pseudobranchia in Pisces and cavum tympani with accessory cavities in Mammalia – vesica urinaria (urinary bladder) in Amphibia, Reptilia, Aves and Mammalia.

22 pectoral girdle without and with secondary pectoral girdle – zonosternum without and with additions from pectoral girdle and ribs – cavum cranii (cavity in the skull) for the brain without and with spatium s. cavum epiptericum – secondary skeletal palate without and with platelike extensions of the entopterygoid – skeletal lower jaw in Selachii and in higher Vertebrata – olfactory organ without and with a vestibulum – ear without and with an external auditory meatus – septum transversum and diaphragma – tongue without and with the rostral, praeopercular muscular part – stomach without and with the oesophageal part – larynx without and with cartilago thyreoides.

23 placoid scale with and bony scale without a thin layer of vitrodentin – pars coracoides consisting of pro- and metacoracoid and pars coracoides consisting of metacoracoid only – skeleton of the foreleg with all the fingers in Reptilia and that of Aves with only a few fingers – tectum posterius and tectum synoticum – tectum posterius and tectum occipitale – condylus tripartitus and paired condylus occipitalis – processus paroticus formed by extensions of exoccipitale and opisthoticum and processus paroticus formed by an extension of one of these bones – rostrum sphenoidale formed by the coalescence of basisphenoid and parasphenoid and either a rostrum basisphenoidale or a rostrum parasphenoidale – skeletal medial wall of the orbita in a primarily platybasic skull and partly skeletal, partly membranous medial wall of the orbita in tropidobasic skulls – skeletal lower jaw in Reptilia and in Mammalia – nervus glossopharyngeus and nervus vagus with and without rami branchiales – pancreas with the dorsal part consisting of a medial part and paired dorsolateral parts and with paired ventrolateral parts and pancreas without one or more of these parts – glandula thymus developed from all the thymus-buds or from part of these buds – glandula thymus in Mammalia with and without thymus thoracicus – heart with and without sinus venosus and heart with and without conus arteriosus – urogenital connection with a mesonephric and a genital part and without one of these parts.

24 function for locomotion and function for balancing – genital function and copulation function.

25 claws – glandulae sebaceae – bony scales – costae – medulla spinalis (spinal cord) – eyes – lungs – gonads.

26 placoid scales and bony scales – horns and antlers – pectoral girdle of Selachii and Mammalia – separate skeletal element and os compositum in which this element has been incorporated – processus paroticus in different groups – rostrum sphenoidale and rostrum parasphenoidale or rostrum basisphenoidale – skeletal lower jaw in Selachii, Reptilia or Mammalia – hyoidean skeleton

with three respectively one cornu branchiale – masticatory muscles (depressors and adductors of the lower jaw) in Non-Mammalia and in Mammalia – nasal cavity with and without atrium (vestibulum) and connection with choane – organ of Jacobson with or without passage to the mouth cavity – teeth with and without enamel – tongue in Pisces and Mammalia – vesica natatoria with and without extension to the labyrinth – larynx with and without cartilago thyreoides and epiglottis – atrium with sinus venosus incorporated into it or not – ventriculus with conus arteriosus incorporated into it or not.

27 (a) Function of protecting the skin and the subjacent organs: bony scales – horny scales – horny spines

(b) Function of preventing loss of warmth and of preserving warmth:
subcutaneous fat layer – plumage – coat of hair (fur) – excessively thick epidermis

(c) Function of locomotion in water:
cilia – caudal fin of Pisces – caudal fin of Cetacea – dorsal and anal fins – forelimbs of Cetacea – pelvic fins of Pisces

(d) Function of bow or break water:
rostrum supported by the rostrum of the primordial neurocranium – secondary rostrum

(e) Function of locomotion on the surface of the soil:
an axial skeleton, permitting of undulating movements of the body – extremities (limbs)

(f) Function of locomotion in the air:
remiges (quills) in Aves – patagium of Chiroptera

(g) Function of mutually connecting the vertebrae:
praezygapophyses, metazygapophyses and postzygapophyses – accessory zygapophyses – zygantrum and zygospheen – metantrum and metaspheen

(h) Function of connecting the ribs with the vertebrae:
basapophyses – parapophyses – diapophyses – synapophyses

(i) Function of a firm connection in the ventral median of the pectoral girdle:
interclaviculare – pars epicoracoidalis of the coracoids – coalesced coracoids – sternum

(j) Function of support of the abdominal entrails:
pubis – praepubis

(k) Function of protecting the brain:
roof of the primordial neurocranium – secondary roof of the skull

(l) Function of fixing and tensioning the membrana tympani:
notch in the secondary roof of the skull – cartilaginous anulus tympanicus – quadratum – tympanicum

(m) Function of skeletal covering of the orbita:
orbita in Selachii and Mammalia

(n) Function related with chemoreception:
two pairs of nostrils in Teleostomi – nostrils in Tetrapoda

(o) Function of ventilating the organ of smell:
fold of the skin over the external border of the olfactory pit in Pisces – musculi which produce oscillations of the bottom of the mouth cavity in Urodela – construction by which inspiration of the air is effected

(p) Function related with sense of equilibrium:
extension of the vesica natatoria (air bladder) as far as the aperture in the bony auditory capsule or within the auditory capsule itself – Weberian ossicles between the vesica natatoria and the sinus endolymphaticus

(q) Function of transmitting acoustic vibrations:
bony connection between superficial skeletal elements and the petrosum in

Pisces – vesica natatoria, Weberian ossicles, etc. in Ostariophysi – accessory respiratory organ in labyrinth fishes – membrana tympani, etc. in Tetrapoda

(r) Function of sound production:

mutually movable parts of the operculum – mutually movable fin rays – teeth on the ossa pharyngea rubbing along each other – muscles which contract spasmodically – ligamenta vocalia (vocal chords) – syrinx – oscillating parts of the larynx in Cetacea

(s) Function of intensifying the produced sound:

vesica natatoria – vocal sac in Urodela – resonators in several Mammalia

(t) Function related with optic sense:

paired lateral eyes – median pineal eye – median parietal eye

(u) Function of reflecting the light within the eye:

tapetum of the pigment epithelium of the retina – tapetum cellulosum of the chorioidea – tapetum fibrosum of the chorioidea – tapetum on the bordering surface between chorioidea and sclera

(v) Function of moistening the surface of the eye:

gland opening on the lower eye lid – Harderian gland – glandula lacrimalis

(w) Function of defense and attack:

fangs or tusks – electric organs, homologous with certain muscles – electric organs, homologous with certain glands of the integument

(x) Function of seizing, holding, cutting up and moving on of the food:

lower jaw in Selachii and Mammalia – horny teeth – true teeth – hard borders to the jaws – dens lacerans (carnassial) (in several groups of Carnivora) – horny masticatory plate against the base of the skull – hypapophyses in certain Serpentes – jaws in Serpentes – visceral skeleton with visceral musculature – tongue in Cyclostomata – tongue in Gnathostomata

(y) Function of gathering food:

true cheek pouches – false cheek pouches – false ingluvies – true ingluvies – stomach

(z) Function of separating the alimentary tract from the respiratory tract:

folds on the palate together with the tongue – soft secondary palate – skeletal hard palate

(aa) Function of digesting vegetable food:

complicated stomach – long intestine – coecum amplius

(bb) Function of respiration:

integument – folds of the skin – papillae on the skin – barbels – tail (Protopterus, embryos of Amphibia) – external covering of the yolk sack – allantois – allantoidal gills (Salamandra atra, Coecilia compressicauda) – ectoplacenta – externally visible extensions of the entobranchiae – true ectobranchiae – pelvic fin (Lepidosiren) – entobranchiae – closed alveoli of the lung – ramifications of the bronchioli of the lungs – epithelium of the mouth cavity – wall of the intestine – ramified evaginations on one or two branchial arches in an extension of the branchial cavity

(cc) Function of inspiration and expiration of the respiratory current of water:

both via external gill slits – inspiration through nostrils, expiration via gill slits – inspiration through spiraculum, expiration via gill slits – inspiration via mouth opening, expiration via gill slits – inspiration via mouth opening, expiration through gill slits – after aspiration inspiration by means of contraction of mouth cavity and throat, expiration by contraction of abdominal muscles and the elastic redress of the extended walls of the lungs – inspiration by means of contraction of a muscle at the ventral side of the lung, expiration by the elastic redress of the lung tissue (Testudinides) – inspiration by increasing the angle between the dorsal and ventral parts of the costae, expiration by decreasing this angle and by pressure of abdominal muscles on the air sacs – inspiration and expiration by extension respectively compression of the air sacs between the muscles of flight during the function of these muscles

(dd) Function of propulsion of the blood:

contractile bulbilli in the aorta ventralis and other contractile parts of the aorta ventralis in Branchiostoma – heart in Vertebrata

(ee) Function as an outlet for blood:

ductus arteriosus Botalli – foramen Panizzae

(ff) Function of blood supply to the fore limbs:

ventral arteriae subclaviae (branches of the arteriae carotides) – dorsal arteriae subclaviae (branches of the aorta dorsalis, of one of the radices aortae or arcus aortae)

(gg) Function of conducting blood from the posterior part of the body:

venae cardinales posteriores – vena cava posterior – vena abdominalis – venae laterales

(hh) Function of conducting urine:

primary nephric tubules in pronephros and mesonephros and opisthonephros – archinephric duct (Wolffian duct) – metanephric tubules – ureter

(ii) Function of gathering urine:

entodermal urinary bladder originating from the allantois – dorsal entodermal urinary bladder originating from the cloaca – ventral entodermal urinary bladder originating from the cloaca – mesodermal urinary bladder – urinary bladder of mixed origin

(jj) Function of producing genital cells:

gonads in Acrania – gonads in Vertebrata

(kk) Function of conducting sperma:

pori genitales – secondary ductus deferens – genital infundibulum (funnel) opening into the testis (Salmonidae) – primary ductus deferens

(ll) Function of direct conveying of the eggs to the oviduct:

ostium tubae contiguous with the ovarium – fimbriae ovaricae – bursa ovarii

(mm) Function of further conduction of the eggs:

pori genitales – secondary oviduct – Müllerian duct

(nn) Function of conducting urine and genital products:

common terminal part of urinary duct with functional spermioduct or functional oviduct – sinus urogenitalis originating from the primary urinary ducts (Holocephali) – entodermal cloaca – ectodermal cloaca (adult Monotremata)

(oo) Function of copulation:

pterygopodium – gonopodium – eversible terminal part of cloaca – eversible coeca each with groove to convey the sperma – penis

(pp) Function of breaking the egg shell:

egg tooth, being a true tooth – caruncle

(qq) Function of protecting the young:

incubatorium (temporary marsupium) – marsupium.

28 condylus occipitalis, condylus occipitalis tripartitus, condylus basioccipitalis.

29 horny bills in Aves and horny covering of the jaws in Testudinides and horny scales along the border of the mouth in other Vertebrata – hairs and certain cutaneous sense organs – placoid scales and teeth – bony scales and certain bones of the skull – bony scales and lepidotrichia and dermatotrichia – entoplastron with epiplastrons in Testudinides and the interclaviculare with the claviculae in other Vertebrata – skeleton of the fore limb and skeleton of the wing – skeleton of the wing which is a flying apparatus and of the wing as swimming apparatus and of the stump of a wing acting as an apparatus for equilibration – neural arches (basidorsals) of the foremost vertebrae and ossi-

cula Weberi (Weberian ossicles) – malleus with incus in Mammalia and articulare with quadratum in Non-Mammalia – hyomandibulare and columella auris – branchial arches (hyobranchial skeleton) and skeleton of the larynx – cartilago thyreoides and cornua branchialia II and III – last arcus branchialis with gills in Pisces and skeleton of the glottis in Amphibia – caudal part of the musculus constrictor ventralis, which in Lepisosteus and Teleostei acts as depressor of the jaws, in other Pisces as adductor of the jaws – part of the musculus constrictor dorsalis, which in Teleostei acts as musculus dilatator operculi, in other Pisces as adductor of the jaws – musculus constrictor ventralis in many Tetrapoda, which functions as musculus detrahens mandibulae in Monotremata and as the rostral belly of the musculus digastricus in Ditremata – the muscles innervated by the nervus facialis, which in Pisces act as musculus constrictor dorsalis et ventralis, as musculus levator and as musculus adductor operculi, etc., in lower Tetrapoda as musculus depressor mandibulae and as musculus constrictor colli and in Mammalia as the caudal belly of the musculus digastricus, the musculus stapedius, the musculus stylohyoideus, the musculus levator veli palatini, the musculus cutaneus colli, as muscles of the external ear, the palpebrae (eyelids), the external nose, the cheeks and as facial muscles – muscles innervated by the nervus glossopharyngeus and the nervus vagus, which in Pisces act as constrictors of the branchial arches, in Amphibia as muscles of the hyoidean skeleton and in Mammalia as muscles of the pharynx and larynx – hypobranchial musculature, which in Pisces is represented by muscles running between the pectoral girdle and the visceral arches, and by the musculus coraco-hyoideus, the musculus coraco-mandibularis and musculus rectus cervicis, in Tetrapoda by a number of muscles of the tongue – most of the electrical organs and certain muscles, sometimes axillary glands (cutaneous glands) – muscles and ligaments – pineal organ resembling an eye in Petromyzon and glandula pinealis in Mammalia, etc. – glandula parietalis in certain Vertebrata and the parietal eye in Petromyzon and certain Reptilia – endostyle in Urochordata and Cephalochordata and glandula thyreoides in Vertebrata – gill-slit and cavum tympani – visceral pouches which become gills and visceral pouches which become the glandula thyreoides – venae laterales in Selachii and venae umbilicales in Sauropsida – protonephridia in Evertebrata and thymus buds in Vertebrata – mesonephros and epididymis – primary urinary duct and oviduct.

30 cervical regions in different Vertebrata, consisting of a different number of segments.

31 caudal region of the body.

32 eyes as "Ideer"-organs in different construction plans.

33 heads – caudae.

34 head region in Annelida, Crustacea and Vertebrata.

35 Onychophora as transitional forms between Annelida and Arthropoda – Limulus as transitional form between Crustacea and Pulmonata – Archaeopteryx and Archaeornis considered as transitional forms between Reptilia and Aves – Monotremata considered as transitional forms between Aves and Mammalia – Hyracoidea considered as transitional forms between Artiodactyla and Proboscidea – Lemuroidea considered as transitional forms between Insectivora and Primates – transitional forms between Homo and anthropoid apes according to theories in the 18th century.

36 Homo sapiens L. – the Mammalia – the individual – the adult specimen – the larva – the head – the heart region – the skeletal lower jaw – the form – the function.

37 a certain skin gland – a certain skeletal lower jaw – a certain humerus – a certain muscle, as *e.g.* the musculus masseter in Homo sapiens L. – a certain brain

vesicle, as the metencephalon – a certain pharynx – certain valves of the heart – Malpighian capsules in the kidney – a certain kidney – a certain testis.

38 corpus of the gland and duct of the gland – cerebrum and medulla spinalis – heart and aorta – vesica urinaria and urethra.

39 skeletal system – muscular system – nervous system – system of the sense organs – intestinal system – respiratory system – vascular system – urogenital system.

40 bone of the skeletal system – ganglicells in the nervous system – a certain mucous tissue in the intestinal system.

41 the numerous elements of the skeletal system, comprising skeleton, joints, ligaments, developing from some continuous primordia – the complexly built brain, developing from two cerebral vesicles – the strongly differentiated intestinal system, developing from a simple tract in the embryonic stage.

42 skeletal system in recent Selachii without dermal bones and without ossifications – telencephalon in lower Vertebrata without the extraordinarily developed pallium.

43 teeth on bony scales and on horn-scales – papilla on the hair root – certain processes on skeletal elements – ganglia in brain vesicles – commissurae in brain vesicles – maculae and cristae in sense organs – organ of Corti – enamel septum in the enamel organ of tooth anlage – Malpighian capsules in the kidney.

44 apparatus for urine–secretion and apparatus for the sexual functions – apparatus for the auditory function and apparatus for the static function – apparatus of the skeletal elements and apparatus of the joints and apparatus of the ligaments.

45 locomotory apparatus, containing parts of the skeletal system and parts of the muscular system.

46 larynx as an organ-complex.

47 head – externally visible neck in Tetrapoda – torso or trunk – tail.

48 nuchal region – dorsal region – thoracal region – abdominal region – lumbal region – ear-region – heart-region – region of the stomach – region of the kidney.

49 i) (externally visible and protuberant forms of the skin and the skeleton:) integument (skin) – bony scale covering – horny scale covering – folds of the skin.

ii) (externally visible openings:) mouth slit – cloacal aperture – anus – porus urogenitalis – external branchial apertures (gill slits) – groove from the olfactory sac to the corner of the mouth slit – pupil – nares (external nostrils) – external auditory aperture.

iii) (superficial furrows:) grooves in the skin – linea lateralis in Pisces – olfactory sac.

iv) (spots and patches in the coloured skin:) colour pattern of the skin.

v) (various formations, as:) facies – cheeks – shoulders – wall of the belly – membrana tympani (tympanic membrane) – neuromasts – eye – median eye – iris.

50 median fold of the body or of the skin in head, neck, trunk and tail – feathers – hairs.

51 median fold of the body or of the skin in trunk and tail – median fins – rostrum – fold of the head – neck shield in Triceratops – brood pouch – incubatorium (temporary marsupium) – marsupium – patagium – paired fins – limbs and their parts – dactyli s. digiti (toes and fingers) – webs – bony spines – horny spines – whiskers – beard – mane – bushy tail – claws, hooves and nails – antlers – horns – mammary glands (milk glands) – barbels – external taste buds – external nose and proboscis (trunk) – pinna (external ear) – stalked eye – eye lids – muzzle – snout – bill – jaws – lips – fangs and tusks – tentacles

for luring and catching a prey – ectobranchiae (external gills) – operculum (gill cover) – vocal sac – external copulatory organs.

52 i) (ontogenetic stages during the larval development:) Marsipobranchii (Cyclostomata) with ammocoetes-larva with radical metamorphosis – Pisces with larval stages with sometimes radical metamorphoses, as in Anguilla with the Leptocephaluslarva and the Heterosomata with bilateral – symmetric larva – Amphibia.

ii) (ontogenetic stages during the direct and embryonic development:) some Pisces – Reptilia – Aves – Mammalia.

iii) (ontogenetic stages during the juvenile development:) nudicolous and nudifugous Aves – Marsupialia in contrast to the higher Mammalia.

iv) (ontogenetic stages during the ontogenetic development from adult to senile:) greying haircoat.

53 i) (processes of origin, bloom, decay, destruction in the youngest developmental stages only:) placenta.

ii) (processes of origin, bloom, decay, destruction in larval stages only:) cauda in Anura – gills in Amphibia.

iii) (processes of origin, bloom, decay, destruction in embryonic stages only:) umbilical cord in Mammalia.

iv) (processes of origin, bloom, decay, destruction in foetal stages only:) lanugo.

v) (processes of origin, bloom, decay, destruction in juvenile stages only:)

vi) (processes of origin, bloom, decay, destruction in adult stages only:) antlers in Cervidae.

vii) (processes of origin, bloom, decay, destruction in senile stages only:) thick hairs in eyebrows in Homo.

54 hair-coat – glandulae mammae.

55 glandulae mammae during periods of lactation – uterus during gravidity.

56 among Vertebrata polyembryony occurs in the embryonic Dasypodidae.

57 axolotl and the adult Ambystoma (Siredon mexicanum) – permanently neotenous Salamandridae, as Typhlomolge, Necturus, Proteus, etc. with many larval characters, as structure of the skin, absence of maxillary, presence of gills, structure of the heart, etc.

58 cartilaginous skeleton in recent Cyclostomata, Selachii and Acipenseridae as reduced descendants of their ossified ancestors.

59 Homo, according to the foetalization theory, showing: foetal covering of hair on the body; delay in closing the sutures of the skull; ossification of the skeleton at birth; general development of the vertebral column and of the skeleton of the extremities; date of eruption of the milk teeth and of the permanent teeth, especially of the last molars.

60 plumage in the ostrich, in penguins and other flightless birds, resembling the nestling down of young flying birds – delay in closing the sutures in the skull of the ostrich – dromoeognathous palate of ostriches and other ratites, considered as the foetal of juvenile condition of the carinate birds as a primitive condition in birds in general and therefore called also the palaeognathous palate (a second school of scientists has the opinion that the schizognathous or neognathous palate of many Carinata is primitive and through retention of the juvenile condition of the ancestor has given rise to the palaeognathous condition) – skeleton of the wing of ostrich and penguins derived by degeneration from that of flying birds.

61 Cetacea – Sirenia.

62 Elephas.

63 in newborn Homo: skeleton of hind limbs (legs), dentition, gonads, brain, eye, lips, umbilical cord, ductus arteriosus – in newly hatched

Aves: remiges (quills), muscles of the jaws, brain, yolk sac, caruncle,

64 gonads, etc. with early appearance of the primordium and late functioning, in contrast to plumage with nuptial colours, permanent teeth, etc.

65 mammary glands, copulatory organs, etc., in contrast with foetal membranes, caruncle, etc. with early expiration of functioning.

66 nidicolous and nidifugous Aves – newborn Marsupialia, Homo, Oryctolagus, Felis, Cavia, Equus, Bos, Sus, etc.

67 pigment cells in corium and in epidermis – ventral ribs – hyomandibulare with respect to the "gill slit" between mandibular and hyoidean arches and columella auris with respect to the cavum tympani – striated visceral muscles of the head and smooth muscle fibres and glands, which both originate from the visceral layer of the lateral plates – ganglia which have shifted stimulopetally to a different extent – organ, part or parts of the intestine in animals with a straight intestine and in animals in which the intestine is coiled up in the abdominal cavity – vesica natatoria (air bladder) and aperture of the ductus pneumaticus – visceral pouches and clefts which give rise to entobranchiae respectively to a glandula thymus, glandula thyreoides, etc. – pericardium and heart in Tetrapoda and in lower Vertebrata – testis and epididymis in Mammalia with descensus testiculorum and in Vertebrata without descensus testiculorum – ovarium in Mammalia in which descensus ovariorum occurs or not.

68 horny scale and feather of Aves – quadratum and articulare in Non-Mammalia and incus and malleus in Mammalia – goniale in Non-Mammalia and processus folianus mallei in Mammalia – angulare and tympanicum – dentale of the lower jaw of Monotremata and Felis – skeleton of the hand in Chiroptera and Aves – the organs of sense – cavum tympani and first visceral sac – glandula thymus – epididymis and mesonephros.

69 quadratum and articulare in Non-Mammalia and incus and malleus in Mammalia – cartilage in the joint of the lower jaw in Mammalia and parts of quadratum and articulare in Non-Mammalia – branchial sac and cavum tympani – tooth of Reptilia and protomeron or deuteromeron of a tooth of Mammalia, the latter conceived as concentration by fusion of two primordia, separated by the enamel septum occurring during ontogeny – buds in the primordium of the glandula thymus in Gnathostomata, primordium of the branchionephros or solenocytes in Branchiostoma (Amphioxus=) and primordia of protonephridia of Invertebrata – lung and vesica natatoria – sixth aortic arch in Pisces and arteria pulmonalis.

70 stump of the skeleton of the wing in Struthioniformes – very small skeletal fifth toe in certain Aves – duct of luminescent organs in certain Pisces – chorda dorsalis (notochord) in higher Vertebrata – coracoid in Homo – cleithrum in recent Amphibia – pelvic girdle in Serpentes – pelvic girdle in Cetacea – certain carpal and tarsal elements – second and fourth metatarsals and metacarpals (splitbones) in Equus – certain fingers in the skeleton of the wing in Aves – skeleton of the hind leg in Cetacea – ductus endolymphaticus in certain higher Vertebrata – external ear in burrowing and swimming Mammalia – tuberculum auriculae Darwinii in Homo – eyes of Vertebrata living in darkness or twilight – membrana nictitans in certain Vertebrata – primary and secondary sexual characteristics of the other sex – one of the paired sexual ducts in Aves.

71 epitrichium in mammalian embryos compared with the outmost most cornified layer of the stratum corneum in adult Reptilia – duct of luminous organs in certain Pisces – remains of horny scales in certain Mammalia, which do not possess horny scales in the adult stage – primordium of hairs close to the gland tubes of the glandula mammae – coat of hairs in Cetacea – coat of hairs in

Homo – bony scales on the ventral side in Dasypodidae – chorda dorsalis in Tetrapoda – caudal vertebrae in Homo – collum costae and capitulum in Urodela – coracoid in Homo – cleithrum in recent Amphibia – skeleton of the fore limb (wing) in Struthionidae – skeleton of the fingers in Aves – postzonal sternum in some Urodela – pelvic girdle in Serpentes – pelvic girdle in Cetacea – second and fourth metacarpalia or metatarsalia in Equus – skeleton of backward directed hallux in certain Aves – exocranium of mucous cartilage ("Schleimknorpel") in Petromyzon – septum interorbitale in Mammalia – processus ascendens of the quadratum in many Amphibia – intercalare of Versluys in the hyoidean arch in Reptilia – skeletal element of Paauw and of Spence in Mammalia – stalk of Rathke's pouch in higher Pisces – nervus olfactorius in adult Odontoceti – pars branchialis nervi vagi in Amniota – organs of sense of the linea lateralis in Amphibia after metamorphosis – ductus endolymphaticus in higher Vertebrata – porus acusticus externus in Talpa, Chrysochloris and Cetacea – eyes in Talpa europaea and Proteus anguinus – iris in telescopic eyes of deep-sea Pisces – plica semilunaris in Homo and Cetacea – teeth in Testudinides and Edentata – milk dentition in Chiroptera – spiraculum in most Teleostei, in Amia and Lepisosteus – part of the branchial clefts, branchial arches and branchial vessels in Tetrapoda – hypochord in Sauropsida – ductus pneumaticus in certain Pisces – left lung in Brachiopterygii, Neoceratodus, Gymnophiona, Serpentes and limbless Lacertilia – sinus venosus in Reptilia – arteria sacralis media in Homo – arteria and vena umbilicalis – vena caudalis in Testudinides and in Aves – ductuli of the pronephros, except in some Pisces – cranial part of the mesonephros in Petromyzontidae – mesonephros in Amniota – vesica urinaria in Aves, except in Struthio – paradidymis in male Mammalia – Bidder's organ in Bufo – right ovary and right oviduct in female Aves – ostium tubae and uterus masculinus in male Selachii – Müllerian ducts in male Holocephali, certain male Anura, many male Reptilia and in male Mammalia (as appendix testis, vagina masculina, uterus masculinus) – rete ovarii with ductuli of the mesonephros in Mammalia – epoöphoron s. parovarium and paroöphoron and Wolffian duct in female Mammalia – penis in Aves.

72 ossa composita resulting from connascentia or concrescentia – coalescence of chordacentra and arcocentra – coalescence of cervical vertebrae in fossorial Tetrapoda and in Cetacea – notarium – sacrum – pygostyl, urostyl and os coccygis – transverse processes of vertebrae with rudiments of ribs – clavicula resulting from the coalescence of a procoracoid and an os thoracale – os innominatum and os coxae – certain carpal and tarsal elements – tarso-metatarsus in Aves – cannon bone in Ungulata – cerebral skull in Aves – os occipitale – supraoccipitale in Mammalia – frontoparietale in Rana – basisphenoid coalesced with basitemporalia – os sphenoideum in Homo – os temporale in Homo – os incisivum and os maxillare in Homo – coalescence of the goniale with the articulare – lower jaw in Aves – certain ganglia in the brain – both roots of a spinal nerve – a plexus of nerves – dental plates in Dipnoi.

73 hyperthely and hypermasty in Mammalia – suture between os incisivum and os maxillare in Homo – separate "interparietale" in Homo – cleft palate and harelip in Homo – cervical fistulae in Homo – hermaphroditism in Vertebrata which normally are gonochoristic.

74 certain glands in the skin of Vertebrata and luminous organs in Pisces, which in different species occur in very different places of the body.

75 snake with large prey between its jaws and in its intestine – displaying peacock-horse in gallop.

76 sharply marked or obvious sexual dimorphism in the gonads, as testis, respectively ovarium – sharply marked or obvious sexual dimorphism in the ducts, as ductus deferens, respectively oviduct (except in Acipenser and Polyodon in

which an oviduct is present in both sexes) – sharply marked or obvious sexual dimorphism in the external genitalia, as penis with scrotum, respectively vulva s. pudendum – dimorphism in the glands of the skin in the vicinity of the external genitalia – pterygopodia present, respectively absent – gonopodium present, respectively absent – combs on the head in Gallinae – mammae – local cornifications of the skin, warts and pearl organs in Pisces – nuptial pads in male Anura – antlers present, respectively absent (except in Rangifer) – horns – plumage – coat of hair – colour pattern.

77 dimorphy between larval and adult specimens of Anura.

78 coloured, respectively albinotic plumage or coat of hair (fur) in some Carnivora in different seasons.

79 number of ceratotrichia (horny rays) in the caudal fin in various specimens of one species of Pisces – shape of finger-prints in Homo.

80 length – weight – degree of synostosis of bones of the skull – ontogenetical or temporary intersexuality.

81 spines coincident with hairs – left and right pollux (thumb) – left and right pinna (external ear).

82 thoracic vertebrae – molars.

83 size of the bony scales.

84 molars (cheek teeth) infected by caries in Homo and domesticated animals.

85 pachyostosis and osteosclerosis in certain marine Vertebrata.

86 giantism – dwarfism – achondroplasia – pugs head – local accumulation of fat at the rump, in a hump on the back, etc. – locally slack skin – very long and very short horns – absence of horns – multiple horns – baldness – angora coat – frizzled hair – curly hair – wavy hair – melanism – albinism – flavism – xanthism – erythrism – absence of difference in colour of the dorsal and ventral surfaces – slighter development of the sensory projection centres and stronger development of the association centres in the brain – turned-up or tilted nose – lop ears or drooping ears.

87 the variations at the atlanto-occipital limit in Homo are independent of the often numerous variations in the spinal column.

88 a cervical rib in Homo is a progressive variation, when in Primate phylogeny all the limits between the regions of the vertebral column are shifting in a cranial direction; in that case a thirteenth rib in Homo consequently is a regressive variation.

89 the number of vertebrae in certain species of Pisces is a modification, as it varies in relation with the intensity of light, the temperature and the salinity of the water.

90 the number of vertebrae in races of Clupea (herring) and of other Pisces, in races of Vipera berus, in the arab horse in comparison with other races of horses, are due to genetical differences – the number of digits in Homo, also in the cases of a praepolex, a praehallux and a postminimus shows in all cases probably a hereditary character.

91 eleven or thirteen thoracal vertebrae in Homo, a variability, due to unknown factors – a short rib on the seventh cervical vertebra coincident with a variation of the plexus brachialis in Homo – variations in the atlanto-occipital limit in Homo.

92 the "normal" number of cervical vertebrae in Homo is 7 or 7.5 or 7.03, depending on the size and composition of the material – the "normal" number of vertebrae enclosed in the os sacrum in Homo is 5 (containing the number 25–29 included), but variations can occur so that the os sacrum contains 4 or 5 or 6 vertebrae (the number 25–28, 24–28, 25–30, 26–30) in a different number of cases.

93 (according to the idealistic-morphologic biogenetic law of Karl Ernst von

Baer:) the development of the skull proceeds from the general cartilaginous skeleton towards the more special condition in lower Tetrapoda and from this condition to the most specialized condition in Homo.

94 (according to the phylogenetic biogenetic law of Ernst Haeckel :) the development of the skull proceeds from the condition in the skeleton in the oldest ancestral Selachii; in the case this skull was cartilaginous it developed towards the ossified ancestral Tetrapoda and from this condition to Man as a descendant; in the case this skull of the oldest ancestral Selachii was osseous a second line runs to the degenerated cartilaginous recent Selachii.

95 total neoteny except the sexual organs in the Perennibranchiata showing among other features the retention of the external gills.

96 partial neoteny in the Derotremata, showing the retention of the external gill clefts.

97 Leptocephalus-stage in the development of the eel, considered as a deviation in ontogeny, being an ontogenetic caenogenesis, culminating in a definitive stage.

98 archallaxis in halves of centra of vertebrae in certain groups of Vertebrata possessing the monospondylic type of vertebrae.

99 suckers in larvae of Anura, being adaptations of juvenile stages to their mode of living.

100 mammary glands in Mammalia – reduction of the skeleton of a number of toes in recent Equidae – heterodont dentition in Mammalia, being characters adapted to the mode of living of the adult animal.

101 time of appearance of the mesoderm in relation to that of the primitive streak in Primates in contrast to the situation in other groups – time of appearance of the median liver diverticulum in relation to that of the proper liver and bile ducts in Mammalia in contrast to lower Vertebrata – time of the formation of the primary choanae (posterior nares) in relation to the time of coalescence of the facial protuberances in Mammalia in contrast to that in Reptilia.

102 embryo of Mammalia with its gill slits resembling the embryonic stage of Pisces and the adult fish more than the adult mammal, showing ontogenetic caenogenesis with alteration in existing organs in which the deviation in ontogeny increases in ontogeny of descendant species.

103 heart and principal blood vessels in Aves and Mammalia in comparison with Pisces and Amphibia as ontogenetic caenogenesis shown as acceleration in primordium and development.

104 retention of the membrana obturans of the gill clefts in Mammalia in contrast with lower Vertebrata, as examples of lagging behind at juvenile stages.

105 the pinnae ventrales in higher Pisces, already in their early development, are lying in thoracal position – shiftings in the place of the primordium of the skeleton of the limbs, as examples of progressive paedomorphosis.

106 antlers in the ancestors of Cervidae which did not possess antlers, as an example of gerontomorphosis.

107 many mutations developing in early stages of ontogeny – penetration of the dental lamina into the mesenchyme.

108 in the ontogeny and in the phylogeny the larger and more strongly differentiated brains in Aves and Mammalia show a development with progression or addition.

109 the separated presence of astragalus and fibulare of the fossil direct ancestors of the Sauria is found in the embryos of recent Lacerta as the two centres of the coalesced tarsale proximale of recent Sauria, as illustration of the biogenetic law.

110 absence of skeleton of limbs in the recent Serpentes as an example of phylo-

genetic palingenesis – reduction of the skeleton of the wing in recent Ratitae, assuming that these recent forms are descendants from other Ratitae with reduced wings.

111 first primordia of rudimentary organs – simple primordium of the heart which later becomes complex – primordium of the branchial arches of the aorta in ontogenetic stages also of groups which have no gills in the adult state – successive appearance of pro-, meso-, and metanephros as examples of ontogenetic palingenesis.

112 ethmoturbinalia in Mammalia as examples of new organs in phylogenetic caenogenesis.

113 large development of the skeleton in only one toe in Equidae – absence of the skeleton of the limbs in the oldest blindworm – reduction of the skeleton of the wings in Dodo – reduction of the skeleton of the wings in the oldest Ratitae, assuming that these are descendants of Carinatae, as examples of alteration in existing organs, due to phylogenetic caenogenesis.

114 has the rostral part of the central nervous system in Branchiostoma (Amphioxus=) the character of a "cerebrum"?

115 what is the character of an extremity, in how far is it something else or something more than a lateral bend of the trunk?

116 what is the character of the mass of rump muscles in Pisces which show locomotion as do Serpentes and in those Pisces which do not show this; is it as this, or as that?

117 what are the stages past in a process that can be repasted, as in the ontogeny of the leg of Equus?

118 what are the stages in a historic process, as in the phylogeny of Equus caballus L. from the fossil ancestors to the recent species?

119 to which percentage of salinity does the kidney of a certain animal species show adaptation? – to which mode of life in what milieu is the locomotion apparatus of a certain animal species adapted? – to which daily rhythm do the size of the wing and the weight of the body of a certain bird of prey show adaptation?

120 seeming rows of elephant-shaped Mammalia – seeming row of the Ratitae – seeming row of the Pachydermata, as examples of pure classification or artificial classification.

121 division of the animals according to the idealistic morphology – division of the animals according to the phylogeny – division of higher affined groups according to the rules of scientific systematics – division of smaller affined groups according to the rules of scientific systematics, as examples of natural classification.

122 (typology on the basis of the type as principle of division:) illustrated by the facts that bony scales with a bony small canal belong to the side-line and that bony scales without such bony small canals belong to the remaining part of the bony covering of Pisces – a hair-cloth, milk-glands, a temporal jaw-joint, a brain-bar and the giving birth to living young belong to the Mammalia.

123 (typology on the basis of the type as a notion of standard:) illustrated in the case of standardization.

124 (definitions on the basis of only a very few common characters as in the case of:) definition of the skull of Mammalia as being characterized by a joint cavity in the squamosal and a joint knob on the dental.

125 (definitions on the basis of a multitude of common characters as in the case of:) definition of the skull of Mammalia as being characterized by consisting of a complex of bony elements separated by sutures, containing a separate intermaxillare, yes or no, containing a small to large orbita which is directed lateralwards and more or less rostralwards or dorsalwards, showing a thick or a

thin zygomatic arch, constituting a more or less wide arch, containing a stapes which in a few cases shows a perforation.

126 the transformation of certain fossil Reptilia into Mammalia in the course of history, as an example of the historic element in the field of systematics.

127 the representation of genealogy in the form of a rootless stem with a ramified crown, whether in the shape of a shrub, or in a planimetric form, etc.

128 transformation of the construction plan of a systematic group in that of the Vertebrata as a historic process.

129 the historic value of the Dinosauria in their period of florescence – the historic value of the geologically youngest Monotremata – the historic value of certain honey bearing flowers in plants the flowers of which are visited by certain humming-birds.

130 the conception of orthogenesis as an active process in opposition to orthoselection as an example of historic teleology.

131 parallel course of separate phylogenetic rows of monophagous parasites and their hosts – parallel course of the honey producing plants and the humming-birds visiting them.

132 build of the horns in Ungulata in relation to the function as defensive weapons, as an example of the true notion of aim – requirement made and demanded by aquatic life to the development of the excretory organs in the warm-blooded animals to the build of the skin, as an example of the principle of necessity ("Erforderlichkeit") for life – pattern of the thoracal vertebral column, costae, intercostal muscles, diaphragma as an example of static teleology – pattern of the skull components, the mouth cavity, the sense organs, the muscles, etc. in the head as an example of static teleology – build of the teat of the mother animal and of the mouth cavity of the young in Marsupialia as an example of the fact of being adapted.

133 ontogenetic processes in their course directed to the adult stage.

134 judgement of an animal by Man in an anthropomorphistic way, as if it were an entirely modern pure technical product – judgment by Man in an anthropomorphistic way of animals, living in deep sea, as to the problem of cold isolation, of rising velocity in water, etc. – coloured skin of animals, living in light, but also in the entire darkness of deep sea and of caves on land, as examples of the regulative character and of the subjective and objective value of the characters – coloured plumage in Aves in the times of courtship and outside these times as examples of the subjective and objective value – measure and degree of adaptation to keep the skin dry in water – degree of adaptation of the kidney for the life of the animal to live in fresh water and in saltish water.

135 tables of body weight.

136 variation curve – growth curve as example of graphs.

137 promorphologic symmetry planes – schemes of the development of folds as examples of stereometric figures.

138 formula for the growth of the body, as an uninterrupted changing character.

139 certain hereditary phenomena in the field of the conditions of the form, as formulas, comparable to those found in examples of division of probability.

140 variable length – variable number of scales – variable colour as examples of mathematic-statistical variable phenomena.

141 rectrix (tail quill) – horn – atlas – scapula – femur – cerebellum – lens of the eye – caninus – trachea – kidney among the Mammalia, as example of similar essential characters of shape, build and structure.

142 (examples of similar essential characters of build and structure; those of shape are also similar and essential, though showing a broad diversity which is not essential:) glandulae sebaceae – horny glanular scales, horny scales, horny plates and horny spurs – hairs and horny spines – claws, hooves and nails –

procoelous, opisthocoelous, amphicoelous, biconcave and biconvex vertebral centra – vertebrae from different animals and out of different regions of the vertebral column with their non-essential diversity in shape – basal plate of placoid scales with their diversity of shape – corpora mammillaria in Non-Mammalia and in Mammalia – stalk of the hypophysial sac or pituitary pouch in which the olfactory sac opens, in Myxinoidea and remaining Cyclostomata – neuromasts in Anamnia and tactile spots in Reptilia with their diversity in shape – the single semicircular canal with two ampullae in Myxinoidea and the two semicircular canals each with one ampulla in Petromyzon, thus with diversity in shape – tooth of one of the lower Vertebrata and a tooth with crown, neck and root in Mammalia – compact and diffuse pancreas with the non-essential diversity in shape – compact and diffuse glandula thyreoides – lungs in Dipnoi and vesica natatoria in most Pisces, where it opens ventrally into the pharynx (the vesica natatoria in Lepisosteus, in Amia and in Gymnarchus opens dorsally into the pharynx) – sinus venosus in Branchiostoma (Amphioxus =) and Vertebrata – systems of blood capillaries with the non-essential diversity in shape – pronephros, mesonephros and metanephros according to the holonephros theory with their superficial diversity in shape of the three portions of the kidney – band-shaped ovary in Salmonidae and sack-shaped ovary in most Teleostei, this shape being unessential – short oviducts in many ganoids and genital or peritoneal funnel in Salmonidae, the shape thus being non-essential – cavity of the genital or peritoneal funnel in male and female Salmonidae and ovarial cavity in the remaining Teleostei, the shape thus showing a broad diversity which is not essential – corpus fibrosum s. cavernosum in penis and in clitoris showing a similar build and structure, the difference in shape being unessential.

143 (examples of similar essential characters of build and shape; those of structure are also similar and essential, though showing a broad diversity which is not essential:) ribs and intermuscular bones in Pisces – basal plate in placoid scales, in bony scales and in certain allostoses (membrane bones) showing a broad diversity in the finer structure – placoid scales with vitrodentin and teeth with enamel.

144 (the differences in shape, build and structure of non-essential characters, thus non-stating the homology:) between visceral or branchial arches and primitive free extremities and their girdles for those authors who derive these formations from each other – the histological differences between the pineal eye in Reptilia and the pineal gland in Mammalia.

145 (essential or principal dissimilarity in shape, build and structure in essential characters and thus denial of homology:) in placoid, ganoid and bony scales according to the histological structure of the layers – cuticula of the epidermis and stratum corneum – primary and secundary platybasic skull – monorhinal and amphirhinal condition – pronephros, mesonephros and metanephros according to the opponents of the holonephros theory (protovertebral stalk – "Ursegmentstiel" or nephrogenic cord, nephrostomes, external glomerulus, external pronephric chamber) – pronephric ductule and mesonephric ductule which open into one and the same complementary nephrostomal ductule – mesonephros and opisthonephros.

146 (likeness in shape, build and structure of non-essential characters, which is only seeming and thus denial of homology:) mammary glands – vertebrae from different regions of the spinal column according to Rosenberg – denial of homology in caudal fins – skeletal lower jaw in Non-Mammalia and in Mammalia – cartilage in the joint of the lower jaw in Mammalia and articulare and quadratum in Non-Mammalia – corpus cerebelli and pars auricularis in Plagiostomi and corpus cerebelli together with pars auricularis and valvula in Teleo-

stomi – eye in Vertebrata and in Cephalopoda – truncus brachiocephalicus in Testudinides and Loricata and that in certain Mammalia.

147 (striking likeness and obviously identical topography in essential characters, at: one and at least equal or similar or identical topography at one of the ends of essential parts that of the rest being unessential and dissimilar, as occurs in the following cases:) stratum compactum corii respectively stratum laxum corii in lower Vertebrata and stratum reticulare respectively stratum papillare in Mammalia – the topography of the free end of the duct of a dermal gland is essential in contrast to that of the body (secretory part) of the gland – hairs and certain dermal organs of sense with respect to their position behind or on the caudal margin of horny scales – the topography of the proximal part of the nasal tunnel with respect to the cerebral skull is essential in contrast to that of the distal part (position: praecerebral, praeorbital or subcerebral) – the topography of the proximal part of the skeletal upper jaw with respect to the cerebral skull is essential as contrasted with that of the distal part in Reptilia, most Aves (there are Aves with skulls of the straight and with skulls of the deflected type), Cetacea and Homo – the topography of the rostral part of the vomeres in Non-Mammalia and of this part of the vomer in Mammalia is essential in contrast with the topography of the caudal part of the vomer in Mammalia – the topography of the caudal part of the vomer in Mammalia – the topography of the caudal part of the pars palatina of the palatoquadratum with respect to the pars quadrata is essential in contrast with the rostral part of the pars palatina with respect to the median plane, the trabeculae and the regio ethmoidalis in Selachii, Teleostomi and Tetrapoda – the topography of the rostral part of the entopterygoid is essential as contrasted with that of the caudal part with respect to the quadratum in Non-Mammalia and Mammalia – the topography of the ventral part of the epipterygoid (which can have a very different length) is essential in contrast to its dorsal end – the topography of the ventral part of the alisphenoid in Mammalia and that of the proximal end of the processus basipterygoideus in Non-Mammalia is essential – the topography of that part of the tympanicum that lies near the cartilage of Meckel is essential in contrast to the topography of the arciform caudal part of the tympanicum – the topography of the rostral part of the splanchnocranium, especially the hyoid arch, with respect to the primordial neurocranium is essential in contrast to the topography of the caudal part in Pisces, Tetrapoda, especially Homo – articulare in Non-Mammalia and malleus in Mammalia according to their position with respect to Meckel's cartilage – quadratum in Non-Mammalia and incus in Mammalia according to their position with respect to articulare respectively malleus – processus folianus of the malleus respectively goniale according to their position as to the malleus respectively articulare and with respect to the chorda tympani – hyomandibulare and stapes with respect to their position to the regio otica – the topography of the scapular end of the os coracoideum is essential in contrast to that of the sternal end – the topography of a muscle with respect to the nerve which innervates it, is essential as contrasted with that of the tip at the origin and tip at the innervation (difficulties arise when the muscles themselves develop from ontogenetically different material, as in the muscles of the eye, or when an additional innervation occurs as in the muscles of the larynx in Sauropsida and in the musculus trapezius in Tetrapoda and when this additional innervation, occurring in a lower group remains as the only innervation in a higher group as is the case in the musculus trapezius of the Mammalia – connection of the musculus stylohyoideus with the hyoid, which shows a perforation of its tendon by the tendon between the two bellies of the musculus digastricus in many Ditremata and the connection of the musculus detrahens mandibulae with the hyoid in Monotre-

mata, part of the muscle being homologous with a part of the musculus digastricus – electrical organs in certain Pisces and muscle respectively dermal glands in other Pisces according to their position with respect to the same (innervating) nerve (difficulties arise when the electrical organ is homologous with more than one muscle which have fused into one, while it is innervated by the nerve of only one of the component muscles as in Astroscopus) – the primary topography of the aperture of the ductus pneumaticus in the cranial part of the fore gut is essential in contrast with the topography of the vesica natatoria itself – the topography of the distal end of the duct of liver and pancreas (ductus choledochus) opening into the duodenum is essential as contrasted with that of the remaining part of this duct and the bodies of liver and pancreas themselves – the topography of the spiraculum in Pisces and of the cavum tympani in Sauropsida and Mammalia, according to the topography of their para-axial end – lungs and an eighth pair of branchial sacs, also with respect to the nervus vagus and the visceral muscles of the branchial apparatus round the aperture of the vestibulum of the lung in Neoceratodus and Polypterus, but not with respect to the bloodvessels – elements of the skeleton of the larynx and the most caudal branchial arch with muscles belonging to the larynx and muscles of the branchial muscular system, both innervated by the nervus vagus – the topography of the proximal part of a large bloodvessel is essential as compared to that of the distal part, in some cases also in a small bloodvessel (arteria stapedia) – the topography of the distal part of the arteria pulmonalis is essential compared with that of the proximal part in Protopterus (from the aorta dorsalis) as contrasted with other Vertebrata (from arteria branchialis VI) –the topography of the distal part of the right and left arteria subclavia is essential compared with that of the proximal part in Lacertilia (both from the right arcus aortae), in Sphenodon (from the left and the right arcus aortae), in contrast with other Sauropsida (from arteriae carotides in Testudinides, Loricata and Aves) – the topography of the distal part of the left and right arteria subclavia is essential, compared with that of the proximal part in some Cetacea as contrasted with other Mammalia – system of blood capillaries in the wall of the intestine, etc. – portal vene system in the kidney between the venae renales advehentes and venae renales revehentes – portal vene system in the liver between vena portae and venae hepaticae – epididymis and epoöphoron s. parovarium – paradidymis and paroöphoron – porus genitalis in male and female Salmonidae and in females of other Teleostei – the topography of the rostral and the middle part of the oviduct is essential compared with that of the aperture of the distal end in Loricata (in the proctodaeum), Testudinides (in the sinus urogenitalis) in contrast to most Reptilia (in the cloaca).

148 (similar or identical topography at two ends of the essential part occurs in the following cases; the topography of the rest or of the middle is unessential and may be dissimilar:) in the case of nerves of which the intermediate parts between both ends lie in a movable part of the body, whereas both ends lie in mutually fixed parts of the body; the intermediate parts of the nerves also show an identical topography in the case of the chorda tympani and of the nervus obturatorius – portal vene system in the kidney between the venae renales advehentes and venae renales revehentes – portal vene system in the liver between vena portae and venae hepaticae.

149 (seemingly unidentical or dissimilar topography across the whole area, but this topography is unessential, the topography may be bridged by transitions:) mammary glands in Homo and in Bos – secondary roof of the skull and roof of the primordial neurocranium in lower and higher Vertebrata – masticating muscles and muscles of the neck in the temporal groove in Reptilia and those

of the external surface of the skull in Aves and Mammalia – position of the lungs in the Dipnoi and of the vesica natatoria in other Pisces, position of the aperture of their ducts and the afferent blood vessels – position of the heart in relation to the head.

150 (topography in the absolute sense is unequal, the topography in the relative sense is identical and essential, *e.g.* in the case of the topography in relation to organs of the proper or the same organ system:) superficial ossifications of the skin and membrane bones, which are situated deeper – position of the scapula and the os ilei along the spinal column – orientation of the skeleton of the paired fins and the "Streckseite" and the "Beugeseite" of the free extremities – mutual orientation of parts of the skeleton of an extremity – position of the knee joint and the heel in Homo and in Equus – mutual position of the trabeculae cranii in primary platybasic and in tropidobasic skulls – position of the foramen occipitale in Squalus and in Homo – position of the tectum synoticum (occipital roof) of the primordial neurocranium in lower Vertebrata and in the Primates – position of the condyli occipitales and the caudal border of the skull in relation to the length of the neurocranium – position of the lateral wall of the primordial neurocranium in lower and in higher Vertebrata – position of the septum interorbitale in the medial wall of the orbita – position of certain membrane bones of the skull either in a certain ringlike segment of elements of the skull, or in relation to the mucous canals or in relation to the mouth, the region of the nose, the orbita, etc. – position of the squamosum in relation to the primordial neurocranium with its ala pterotica and in relation to the direct covering of the brain – position of the foramen pineale between the parietalia or between the frontalia – distance between the nostrils in the skull – metapterygoid and epipterygoid – epipterygoid and the alisphenoid of the Mammalia – palatoquadratum in Selachii and higher Vertebrata – position of the mediobasal, basicranial connections between the palatoquadratum and the base of the primordial neurocranium – processus orbitalis in some Selachii in which the position of the palatoquadratum, the processus ethmoidalis and the basipterygoid connection is divergent, assuming that these are homologous – position of a muscle with respect to the nerve which innervates it – mutual position of the four parts of grey matter in the medulla spinalis and the medulla oblongata – position of the nucleus of the nervus trochlearis in Petromyzon and in higher Vertebrata – position of the spinooccipital nerves and the spinal nerves which are homologous to each other – alternating position on the right and left side of the places of emergence of the dorsal and ventral roots of the spinal nerves in Branchiostoma and lower Pisces and position on the same level in higher Vertebrata – position of the place where the dorsal and ventral root of a spinal nerve merge with each other – position of the caudal end of the spinal cord and of the roots of the spinal nerves with respect to the vertebrae – position of the plexus brachialis – position of the plexus lumbosacralis – position of the organs of taste with respect to the visceral rami of the cranial nerves VII (nervus facialis), IX (nervus glossopharyngeus), X (nervus vagus) – monorhinal and amphirhinal condition (supposing, that they can be considered as homologous) – position of the neuromasts with respect to the nervus facialis, nervus glossopharyngeus and nervus vagus which innervate them and not with respect to the bony scales – orientation of the membrana tympani in lower Tetrapoda, Monotremata and higher Mammalia – position of the pericardium in Vertebrata in which the pleural cavities extend far rostralward or not – position of the base of the teeth in acrodont, pleurodont, protothecodont or thecodont dentitions (Reptilia and Mammalia) – position of labial glands in Non-Mammalia and glandulae buccales (cheek glands) in Mammalia – position of the parts of an intestine which is coiled and a straight

intestine with respect to the longitudinal axis of the animal – position of the spiracular gill in Selachii and the opercular gill in Teleostei with respect to homologous bloodvessels, while the totally divergent innervation is considered as irrelevant – position of the suprapericardial, postbranchial or ultimobranchial body – position of the heart with respect to the branchial region and not with respect to the pectoral girdle – position of the chambers in the straight and in the twisted heart – position of the origin of the arteria carotis interna, and of the arteria carotis externa on the arteriae carotides communes or on a truncus caroticus – vena abdominalis, of which the divergent opening in the ductus Cuvieri in Dipnoi and in the vena portae in Amphibia, is irrelevant – position of the largest, large and medium sized arteriae, of the largest and large venae and of the largest lymph vessels – position of ureters with their distal ends opening into a cloaca or not, either in a ductus urogenitalis or not or either in a vesica urinaria or not – position of the testis in Non-Mammalia and in Mammalia with descensus testiculorum – position of the secondary ductus deferens in Pisces with its distal end opening either separately or not, either in the urethra or not and either in a canalis urogenitalis or not – position of the free top of the penis in Mammalia – position of the ovaria in Homo and in lower Mammalia.

151 (likeness in topography of non-essential characters, thus without homology as the topography only seems to be identical, but in reality is not identical, because of an only ostensibly equal topography or because the identical topography is irrelevant:) foramen occipitale and condyli occipitales of the skull when the neocranium does not extend equally far caudalwards – parasphenoid in Non-Mammalia and vomer in Mammalia – identical position of outgrowths of elements which are not homologous – extracolumella in Sauropsida and malleus and incus in Mammalia – certain muscles with the same origin and insertion, but different innervation – stalk of the hypophysial sac in the Myxinoidea and the ductus nasopharyngeus in higher Vertebrata – membrana tympani in lower Tetrapoda and in Mammalia.

152 elements of a spinal column or this column as a whole according to their topography are essential – elements of a branchial skeleton or this skeleton as a whole according to their topography are essential – branchial clefts and branchial sacs in the Marsipobranchia or this region of the head as a whole.

153 processus oticus versus processus ethmoidalis of the palatoquadratum – proximal part of the cornu branchiale I and not its distal part (Pici as contrasted with other Aves) – caudal part of mesonephros in Mammalia and not its rostral part, which may be reduced.

154 neural and costal plates in the carapax of the Testudinides – processus tympanici of different bones in the bulla auditiva – the membrane bones situated on the middle part of the lower jaw in Non-Mammalia.

155 (denial of homology thanks to fundamental or principal dissimilarity in topography of essential parts:) horny scales and bony scales – chordacentrum and arcocentrum – monospondylic and diplospondylic condition – claviculae and furcula – processus pectinealis in Aves and processus pseudopectinealis in Ornithischia – foremost parachordale and polar cartilage – trabeculae cranii in Petromyzontidae, in Myxinoidea and in Gnathostomata – tectum synoticum and tectum occipitale – skeletal wall of the orbita in primary platybasic, tropidobasic and secondary platybasic skulls – laterosphenoid and alisphenoid – splanchnocranium in Cyclostomata, which is primarily agnathous, which is situated lateral to the branchial sacs, branchial musculature and aortic arches; in the exoskeleton of mucous cartilage of which occur medial ridgelike thickenings and which is continuously fused with the primordial neurocranium as contrasted to the splanchnocranium in Gnathostomata, which has a different topography on all these points – part of the muscles of the head in Cyclostomata

and those in Gnathostomata – musculus rectus inferior in Petromyzon and in higher Vertebrata – electrical organs in groups of Pisces which are not systematically allied – epichordal brain vesicles of Branchiostoma and prechordal archencephalon in Vertebrata – reflecting layers in the medial wall of the eye – afferent branchial arteriae in Myxinidae as contrasted with those in Petromyzon and higher Craniota – primordium of the vesica natatoria practically dorsally in the oesophagus (if not, more primitively, more rostrally in the branchial region) and primordia of the lungs laterally or ventrally in the pharynx – larynx and syrinx in Aves – ventral arteriae subclaviae in Loricata, Testudinides and Aves and dorsal arteriae subclaviae in Pisces, Amphibia, Sphenodon, Lacertilia and Mammalia – arteria brachialis s. anterior, lying in front of the nervus medianus in Mammalia and the arteria brachialis, lying behind this nerve, in Homo – pronephros, mesonephros and metanephros according to the opponents of the holonephros theory – pronephros and mesonephros when their areas overlap and when more than one nephridial tubule occurs primarily in this region – copulatory organs in the Squaliformes, in certain Teleostei and in Amniota.

156 luminescent organs in Pisces – special integumental glands in Pisces, showing similarity in shape, build and structure, but divergent topography and thus doubtful homology.

157 horns in the early members of the Titanotheres and in the later evolved members, showing accelerated rate of development, as examples of allometry – skeletal elements of the limbs of gibbon and of sheep – positive allometric growth of some parts and negative allometric growth of other parts of the urogenital organs in the two sexes in Mammalia.

158 (early ontogenetic stages of homologous organs showing a different topography in their primordia:) the gut homologous throughout the Chordata is formed from the roof of the archenteron, from the floor of the archenteron, from both roof and floor of the archenteron, from yolk-cells in the floor of the cleavage-cavity or from the lower layer of the blastoderm.

159 (example of differences between essential and non-essential characters during the course of the ontogenesis:) the little bone and the end-plate with which the tympanicum in Mammalia starts of embryonic life lying against the cartilage of Meckel, as an essential character, whereas the later extension of the tympanicum in the form of the arciform caudal part is not-essential, as its homologue in the angulare of the Non-Mammalia shows.

160 (examples of the phenomenon that the same final stage can be reached along different ways are:) chorda dorsalis with entodermal origin occurs in some Vertebrata and with mesodermal origin in other Vertebrata – straight and oblique abdominal muscles of the ventral trunk musculature have their origin in many Mammalia without a distinct connection with a myotome and in Pisces, Amphibia and Homo with an origin from a myotome – blood vessels with mesodermal origin and blood vessels with partly entodermal and partly mesodermal origin.

161 (in ontogeny considerable differences occur which are not essential in the following cases:) vertebrae, which in the ontogeny of different Vertebrata develop from the combination of different parts of the sclerotomes – basisphenoid which ossifies directly in some Teleostei or from cartilage – muscles of the head in different Vertebrata, which may or may not originate also from mesoderm which stands in no direct relation to the praemandibular, the mandibular, the hyoidean metamere and that of the branchial metameres – muscles of the eye innervated by the nervus trochlearis and the nervus abducens, which in different Vertebrata originate from different metameres – the central nervous system which may arise as a dorsal medullary groove which closes to form a

tube or as a compact strand of cells in which the canalis centralis is developed secondarily – hypophysis developing from the hypophysial depression (Cyclostomata) or as an invagination of the roof of the stomodaeum (Gnathostomata) – hypophysis originating as a hollow invagination or as a solid ingrowth in which a lumen develops subsequently – nasopharyngeal duct which develops by the closing of a groove which originally is situated superficially, or by the ingrowing of a duct and subsequent perforation of the blind end – occurence of sensory cells, goblet cells, serous gland cells, cornifications, teeth in the ectodermal mouth cavity and the entodermal pharynx which may be explained either by ingrowth of cells from the ectoderm, or by induction or by equal potencies of the entoderm) – epithelial part of the teeth, which is furnished by the ectoderm, but sometimes by the entoderm – liver the primordium of which may be paired or single and which possesses ductuli in which the lumen exists primarily or develops secondarily and a bile duct which originally is paired or single and of which the orifice into the intestine is primary or secondary – cloaca which originates from the entoderm in Reptila, from entoderm and ectoderm (urodaeum and proctodaeum) in Aves, from ectoderm in adult Monotremata, which in embryonic condition possess an entodermal cloaca as well – ectobranchiae and entobranchiae, either by ingrowing of the ectoderm into the pharynx or by a displacement of the entobranchiae to the surface of the body – endostyle in Urochordata and Cephalochordata, glandula thyreoides in Cyclostomata and glandula thyreoides in Gnathostomata, which is long or short and in which the lumen is primary or secondary – thymus thoracicus and thymus cervicalis in Mammalia – lung in which in late ontogeny the great lines of division appear and in which an alveolar structure is developed either by centripetal growth of septa or by centrifugal growing of ramifying evaginations and buds – mesodermal nephric ductuli each carrying many solenocytes in Branchiostoma (Amphioxus=) and ectodermal protonephridia in Evertebrata – pronephric ductuli in Vertebrata and either coelomoducts or metanephridia and nephromixia in Evertebrata – pronephros originating from segmental stalks or from undifferentiated mesoderm (Acipenser) – mesonephros at the beginning of its development originating from segmental stalks or from the mesonephrogenic strands (Raja) or from hollow clusters of cells (Dipnoi) – mesonephros in which the secondary ductuli develop by division or budding of already existing ductuli or from remains of the nephrogenic strand – primary urine duct (segmental archinephric duct) arising from a few pronephric nephrotomes or as an independent outgrowth of a tissue strand – vesica urinaria in Amphibia and allantois in Sauropsida – urogenital passage developing by a growing out of the Malpighian capsules (ductuli of the epididymis) or of ampullae or ductuli of the testis – ostium tubae originating either from one or from a few fusing nephrostomes of the pronephros or by an invagination of the coelomic epithelium (peritoneum) – primary oviduct or Müllerian duct originating by longitudinal fission of the primary urine duct (Wolffian, segmental duct) or by lengthening of the blind end of the ostium tubae or from a thickening of the coelomic epithelium – genital funnel in Salmonidae and cavity in the ovarium in the remaining Teleostei, which in the first case remains in open connection with the coelome, in the second case is separated from it.

162 (similarity in non-essential characters in the course of the ontogenesis in shape, topography, etc. in the case of:) the cartilaginous primordium of entotympanicum in Mammalia and of quadratum in Non-Mammalia.

163 (ontogenetical resemblance in non-essential characters which however is seeming; thus no homology; in the following examples:) primordia of hair and epidermal gland – primordia of teeth and of glandulae dentovaginales.

164 (great similarity between essential qualities of phenomena during the ontogene-

sis, that means as well striking likeness in shape, build and structure, as striking likeness in topography during a longer or shorter phase(s), stage(s) or period(s) of in reality connected developmental stages as in the following examples:) cartilaginous primordium of entotympanicum in Mammalia and of quadratum in Non-Mammalia according to some authors – branchial arches and skeleton of the larynx – division of the brain in three, later five vesicles of the brain – membranous labyrinth – metanephric ductuli arising from the primary ductuli and ureter with pelvis and collecting tubuli arising from the caudal part of the Wolffian duct and growing centripetally – cavity of the genital peritoneal funnel in male and female Salmonidae and ovarial cavity in the remaining Teleostei – secondary ductus deferens and secondary oviduct in Teleostei.

165 (fundamental dissimilarity of essential characteristics of ontogeny and thus denial of homology, as in the following examples:) true teat and false or proliferation teat – hairs in Mammalia and "hairs" in Non-Mammalia – bony surrounding of the foramen transversarium and that of the foramen costotransversarium – zonosternum in Selachii and sternum of the Tetrapoda – autostoses and allostoses – procoracoid and os thoracale (clavicula) – operculum in the regio otica and the basal plate of the stapes in Amphibia – skeletal lower jaw in Selachii and Mammalia – the single olfactory pit in Cyclostomata and the paired olfactory grooves in Gnathostomata – the protocoel, which is derived from the blastocoel, and the coelome – glands in the mouth cavity, which develop separately and such glands which develop from an epithelial ridge – dorsal and ventrolateral pancreas – primary truncus brachiocephalicus in Mammalia and secondary truncus brachiocephalicus, which also ontogenetically develops secondarily, in Testudinides and Loricata – arteria subclavia in Amphibia and Lacertilia and secondary arteria subclavia, developing from another branch of the carotid arch in Testudinides and Loricata – pronephros, mesonephros and metanephros according to the opponents of the holonephros-theory, in view of the place and time of development and the way in which the efferent excretory ducts develop–primary urine duct (Wolffian duct) and ureter – rete testis developing as outgrowths of the mesonephric ductuli and rete testis developing as outgrowths of testis tubuli – primary and secondary oviduct in Teleostei.

166 (examples of direct witnesses of phylogeny are:) the skeleton of the extremities of fossil and recent Equidae – the endocranium of fossil and recent representatives of a systematic group – the dermatocranium of fossil and recent representatives of a systematic group.

167 (examples of indirect witnesses of phylogeny are:) the horny scale and feather – tactile spots and hairs – mammary glands and brood spots – organs of sense in general – lagena of the membranous labyrinth – branchial pouch and cavum tympani – coelome arising from entoderm (enterocoel theory) – cutaneous glands round the primary mouth slit and glands of the vestibulum oris.

168 (examples of convergence are:) the skeletal elements of the rostral extremity in Cetacea and in cartilaginous fishes, showing secundary convergence of homologous organs.

169 mimic genes are found in many cases of albinism in animals.

170 (no homology because of origin from other tissue after operation for experimental purposes is found in the following examples:) the lens of the eye in Amphibia after extirpation regenerates from other cell material than in normal ontogeny – the lens of the eye in Amphibia develops from other cell material when the skin over the optic cup is changed for another piece of skin.

171 (examples of distant homology are:) the horny teeth of Anura and the true teeth of Urodela.

172 (a case of different inductors is:) the lens of the eye in Rana esculenta

which is determined in situ via the gradient field co-ordinates of the whole embryo while the lens of the eye in Rana fusca is induced by the optic cup.

173 (some of the criteria allow a positive opinion as to homology, other criteria do not allow an opinion, as *e.g.*:) luminescent organs in Pisces show similarity in shape, build and structure, but show a divergent topography.

174 distinction in the conclusion is dependent on the criterion applied, as *e.g.* the mouth cavity in comparison with the ectodermal stomodaeum and the entodermel part of the mouth cavity.

175 the topographical criterion is more valuable than that of form, build and structure in the case of the homologization of rostral cervical vertebrae in lower Vertebrata and of caudal occipital part of the neurocranium in higher Vertebrata.

176 (cases in which presence is the rule and absence is deviation from the rule; this means in single organs total absence, in paired organs absence of the right and of the left organ:) absence of glandulae sudoriparae and glandulae sebaceae in the Cetacea among the Mammalia – absence of dermal skeleton in the shape of an armour in recent Amphibia, Aves and most Mammalia among the Vertebrata – local absence of horny scales in Aves and Mammalia among the Amniota – absence of feathers among the Aves – absence of hairs among the Mammalia – absence of claws on the forelimbs in Aves among the Amniota – absence of ossifications in the cartilaginous skeleton among the Vertebrata (except the lowest ones) – absence of centra in the vertebrae in the recent Marsipobranchii among the Vertebrata – absence of the caudal vertebrae in the Gymnophiona among the Vertebrata – absence of costae among the Vertebrata – absence of the skeleton of paired fins in recent Marsipobranchii among the Vertebrata (except the lowest ones) – absence of the skeleton of the fore legs in Gymnophiona, Anguis and Serpentes among the Tetrapoda – absence of the secondary pectoral girdle in Urodela among the Vertebrata (except the lowest ones) – absence of cleithralia in Sauropsida and Mammalia among the Vertebrata (except the lowest ones) – absence of the os thoracale (clavicula) in certain Mammalia among the Vertebrata (except the lowest ones) – absence of the carina sterni among the Aves – absence of the phalanges of one or more digits in Aves and Cetacea among the Tetrapoda – absence of ilium and ischium in Cetacea among the Tetrapoda – absence of ossified basioccipitale, supraoccipitale, besisphenoid and ethmoidalia in Anura among the Vertebrata (except the lowest ones) – absence of the mediobasal, basicranial connection among the Tetrapoda – absence of the processus ethmoidalis of the palatoquadratum among the Vertebrata – absence of the dermatocranium in recent Marsipobranchii and Selachii among the Vertebrata – absence of the long median leg of the parasphenoid in Mammalia among the Vertebrata (except the lowest ones) – absence of some of the allostoses of the lower jaw among the Teleostomi, Amphibia and Sauropsida – absence of the extracolumella in Mammalia among the Amniota – absence of one or more branchial arches among the Pisces – absence of the musculus constrictor dorsalis in Dipnoi, Holocephali and Tetrapoda among the Vertebrata (except the lowest ones) in relation with their akinetic skulls – absence of the muscles of the eye in Myxinoidae among the Vertebrata – absence of the cerebellum in Myxinoidae and Bdellostomidae among the Vertebrata – absence of the glandula pinealis in Xenarthra among the Mammalia – absence of the velum transversum between diencephalon and telencephalon in Marsipobranchii among the Vertebrata – absence of the nervus terminalis s. nervus Jacobsoni in several Pisces, etc. – absence of the nervus opticus in Myxinoidae among the Vertebrata – absence of the lateralis system, which innervates the neuromasts, among Pisces and Amphibia – absence of papillae foliatae in some Mammalia – absence of nervi olfactorii in adult Odontoceti among the Mammalia – absence of the vestibular part of the olfactory organ among the Amniota

–absence of Jacobson's organ among the Tetrapoda – absence of the passage between Jacobson's organ and the mouth cavity in a few Mammalia – absence of the passage between Jacobson's organ and the nasal cavity in many Reptilia – absence of the ductus endolymphaticus among the Vertebrata – absence of the cavum tympani in Urodela, Gymnophiona and Serpentes among the Tetrapoda – absence of the external auditory meatus among the Amniota – absence of the external ear among the Mammalia – absence of eyes in Myxinoidae among the Vertebrata – absence of the membrana nictitans in a number of Selachii, a few Sauropsida and a few Mammalia among the Vertebrata – absence of Harder's gland in species with a reduced membrana nictitans among the Mammalia – absence of lips, which are either movable or not, in Loricata, Testudinides except the Trionychidae, Aves and Monotremata – absence of teeth in a few Anura, in Testudinides and Aves among the Vertebrata (except the lowest ones) – absence of glandulae dentovaginales in adult Mammalia among the Tetrapoda – absence of the tongue in Cephalochordata among the Chordata – absence of the muscular part of the tongue in Pisces and a few Tetrapoda among the Vertebrata – absence of smooth muscle fibres in the oesophagus in Mammalia except the Monotremata, among the Vertebrata – absence of appendices pyloricae among the Teleostei – absence of the coecum in the Lipotyphla, Ursidae, Bradypodidae and Hippopotamus among the Mammalia – absence of the taeniae in the colon in Carnivora and many Ruminantia among the Mammalia – absence of the cystis fellea (gall bladder) in Aves and a few Mammalia among the Vertebrata – absence of the spiraculum in most of the Teleostei among the Pisces – absence of the glandula thymus in the Marsipobranchii among the Vertebrata – absence of the vesica natatoria among the Cyclostomata and Pisces in Cyclostomata, in Selachii and in part of the Teleostei, even in part of the species of one and the same genus, *e.g.* Scomber – absence of the ductus pneumaticus in part of the Pisces possessing a vesica natatoria – absence of both lungs in lungless Salamandridae – absence of larynx, trachea and bronchi in the lungs of the Brachiopterygii and Dipnoi – absence of ligamenta vocalia bordering the rima glottis in Aves among the Tetrapoda – absence of the fourth arcus branchialis in terrestrial Tetrapoda among the Vertebrata – absence of the sinus venosus in Tetrapoda among the Vertebrata – absence of the conus arteriosus s. bulbus cordis in Cyclostomata, Sauropsida and Mammalia among the Vertebrata – absence of the membranous valve in the right ostium atrio-ventriculare in Aves among the Sauropsida – absence of the bulbus arteriosus in the Cyclostomata, Selachii, Polypterus and Lepisosteus among the Cyclostomata and the Pisces – absence of the ductus caroticus in Testudinides, in a number of Lacertilia, in Serpentes, Aves and Mammalia among the Tetrapoda – absence of the ductus arteriosus Botalli in many Lacertilia, in Aves and most adult Mammalia among the Tetrapoda – absence of the cranial parts of the vena cardinalis posterior in Anura and Sauropsida – absence of the vena abdominalis in Aves and Mammalia – absence of the mesonephros in the Myxinoidea among the Marsipobranchii – absence of the glomeruli in parts of the kidney – efferent urine duct, running via the ductus urogenitalis to the cloaca in Monotremata, absent in Marsupialia – absence of the vesica urinaria in adult Serpentes and Aves, except Struthio – absence of pori abdominales in a number of Pisces and Reptilia and in the higher Vertebrata – absence of Müller's duct in Marsipobranchii, Lepisosteus and Teleostei among the female Vertebrata – total absence of Müller's duct in many adult male Anura – absence of the penis in Anura, Sphenodon and most Aves (except "Ratitae", Crypturi, Anseres, Cracidae) among the terrestrial Tetrapoda – absence of the glans penis with praeputium or praeputial sac in a few species among the Monodelphia.

177 (examples of "secondary" absence, either on the right or on the left side:) absence of the left lung in a number of Serpentes and serpentlike Lacertilia – absence of the left series of gonads in Asymmetron among the Acrania, of the left ovarium in Myxine and Bdellostoma among the Marsipobranchii – absence of one of the ovaria in some Selachii, of the right ovarium in Trygon bleekeri and in most Aves among the Vertebrata – absence of the right oviduct in the female Trygon bleekeri and in most adult Aves among the Vertebrata.

178 (examples of absence as a rule, presence being divergence from the rule:) patagium – horns – antlers – tapetum behind the retina – condyli occipitales in the Rajiformes among the Pisces – processus paroticus in Reptilia among the Amniota – autostylic as well as hyostylic suspension of the upper jaw in Notidanidae among the Vertebrata – Versluys' intercalare in a single Reptile among the "autostylic" Amniota – processus oticus of the quadratum in certain lower Vertebrata – processus ascendens in certain recent Teleostomi and certain Reptilia among the Vertebrata – nuchalia, rostralia and operculum in Teleostomi among the Vertebrata – supraorbitalia, infraorbitalia and certain temporal membrane bones in Pisces among the Vertebrata – os nariale s. septomaxillare – praevomeres in certain Mammalia – secondary bony palate – processus retroarticularis among the Vertebrata (except the lowest ones) – retroarticulare – mentomandibulare – tentorium osseum in the cavum cranii (cavity of the skull for the brain) – separate muscle in some cases in contrast to the bifid or single muscles in other Vertebrata – saccus vasculosus in Pisces – secondary soft palate – uvula in Homo and some other Primates among the Vertebrata – appendices pyloricae in Laemargus, Polypterus, Chondrostei and Lepisosteus in Pisces which do not belong to the Teleostei – intestine with a spiral valve in Petromyzontidae, Selachii, Dipnoi, Polypterus, Holostei and Chondrostei among the Vertebrata – processus vermiformis – gills in Perennibranchiata among the adult Amphibia – postbranchial corpuscles in Pisces among the Vertebrata – suprapericardial corpuscle in Tetrapoda among the Vertebrata – epithelial corpuscles in Tetrapoda among the Vertebrata – muscular valve in the heart in the right ostium atrio-ventriculare in Loricata, Aves and Monotremata – lymph hearts in some Aves – valves in the lymph vessels in Aves and Mammalia – pronephros as functionating kidney in Myxinoidea among adult Vertebrata – nephrostomes in many adult Euselachii among the Pisces – metanephros in some Teleostei among the Pisces – os penis s. os priapi in Insectivora, Rodentia, Carnivora, Cetacea and lower Primates – hymen s. valvula vaginalis in Ungulata, Rodentia and Primates.

179 (examples of "seeming absence" of an organ, because the primordium disappears before birth:) the bony scales on the ventral surface in Dasypodidae – horny scales in most Mammalia – hairs in Cetacea – most caudal vertebrae in Homo (nos 35–37) – ductus endolymphaticus in certain higher Vertebrata – coelome of the head in Craniota as a rule – teeth in certain Edentata and in Mystacoceti – milk dentition in Chiroptera – glandulae dentovaginales in a few Mammalia – cloaca in Teleostei – spiraculum in most Teleostei – certain branchial apertures (gill slits) in Tetrapoda – vesica natatoria in bottom dwelling Teleostei – ductus pneumaticus in physoclistous Teleostei – left lung in Neoceratodus – sinus venosus and conus arteriosus in Tetrapoda – ductus arteriosus Botalli in most Mammalia – lymph hearts in a few Aves – cranial part of the mesonephros in male Mammalia – Müller's duct in male Vertebrata – right ovarium in Aves – urogenital connection in female Vertebrata – right oviduct in Aves.

180 ("seeming absence" of an organ disappearing in the larval stage or with metamorphosis occurs in the case:) the processus ascendens of the palatoquadratum

in those Amphibia, in which it is well developed in larval condition but wanting after metamorphosis.

181 ("seeming absence" of an organ through fission or division during ontogeny occurs in the case of:) the cloaca and the cloacal aperture in higher Mammalia.

182 ("seeming absence" occurs through coalescence with primordia of neighbouring organs during ontogeny in the case of:) the sacrum – the os coxae – the os centrale carpi coalescing with the naviculare in Homo – os occipitale – os sphenoideum – os temporale – os incisivum fusing with os maxillare in Homo – malleus fusing with processus folianus – electric organs originating from the fusion of four eye muscles in Astroscopus – ganglion Gasseri – conus arteriosus fused with the left ventriculus in Aves, so consequently in Aves the corresponding heart valves are situated at the entrance to the right arcus aortae – the part of the primary urinary duct situated distally of the point where the ureter branches off, is incorporated into the wall of the vesica urinaria in Mammalia.

183 ("seeming absence" because the presence is only internally and not externally discernible in the case of:) the chiasma nervorum opticorum in many Pisces.

184 ("seeming absence" because of a very slight development, is in the case of:) the ductus urogenitalis in female Homo (vestibulum vaginae).

185 (absence of adult characters, due to neoteny in a broad sense, that means neoteny in all organs of the body except in the sexual organs in the case of:) perennibranchiate Urodela in contrast to adult caducibranchiate ancestors.

186 (absence of adult characters, due to neoteny in a narrow sense, that means neoteny in a few organs of the body except in the sexual organs in the case of:) some neotenic Salamandridae with absence of lungs and larynx, but with the presence of gills, gill slits and branchial arches.

187 (real absence of adult characters of an organ, due to partial neoteny, *i.e.* neoteny in relation to that organ in the case of:) absence or coalescence of the centrale and the five distal carpalia which persist in the hand of Cetacea – absence of an ossified pectoral girdle in Urodela – absence of ossification in the cartilaginous sternum in recent Equus – absence of an ossified skull in recent Marsipobranchii and Selachii –absence of the permanent dentition in Odonceti – absence of roots in the molars (cheek teeth) in Ungulata.

188 (examples of presence or absence either as a primary or as a secondary character in the following cases:) presence of an unpaired organ and absence of a paired organ in the case of the nasal organ and of the parietal organ is a primary character in the Marsipobranchii – absence of the skeletal jaws (agnathy) is a primary character in Marsipobranchii.

189 (examples of a high number as the rule, a small number is derived and secondary, are:) the number of skeletal fingers among the Tetrapoda (hyperdactyly is as well derived) – mammary glands among the Mammalia – dermal ossifications among the Vertebrata (according to Gegenbaur) – bony plates in the carapax and the plastron among the Testudinides – horny scales among the Tetrapoda – plantar tuberculi (foot pads) among the Tetrapoda – abdominal ribs among the Tetrapoda – branchial bars among the Vertebrata (except the lowest ones) – membrane bones of the skull among the Vertebrata (except the lowest ones) (according to Gegenbaur) – myomeres (metameres of the muscles) in the branchial region among the Vertebrata – number of nerves in the plexus lumbosacralis – rami posttrematici nervi vagi – ganglia of the nervus vagus – teeth on an extensive area of the mouth cavity among the Vertebrata – teeth and molars in the numbers 5, 1, 4, 4, on the edges of each halve of each jaw among the Marsupialia – teeth and molars in the numbers 3, 1, 4, 3, on the edges of each halve of each jaw among the Monodelphia (the higher number in Odontoceti is derived and tertiary or secondary) – number of branchial aper-

tures (gill slits) and visceral pouches (branchial sacs) among the Cyclostomata – number of branchial apertures (gill slits) in Gnathostomata (the higher number in the Notidanidae is probably secondarily derived) – number of holobranchiae and hemibranchiae in Pisces – number of pronephric ductuli and mesonephric ductuli – number of glomeruli in pronephros, mesonephros and metanephros – ureters among the Tetrapoda – number of ductuli efferentes.

190 (examples of small number as the rule, a higher number is divergence from the rule, a lower number can occur as a tertiary condition, are:) sutureless dermal skeleton, secondarily more and more separate dermal ossifications, tertiarily containing few dermal ossifications, among the Vertebrata – one-headedness of the ribs, secondarily two-headed, tertiarily one-headed again, among the Vertebrata (except the lowest ones) – sutureless exocranium and endocranium, showing secondarily an increase and tertiarily a decrease of the number of elements – continuous uninterrupted skeleton of the median fin, secondarily discontinuous interrupted, split up into a higher number of smaller fins, tertiarily continuous uninterrupted again among the Vertebrata – number of arci branchiales and of the gill slits five; a higher number occurs in the Protocraniota and the Marsipobranchii and is due to a still more rostral arcus and gill slit – single, undivided mass of muscles in the trunk and tail among the Vertebrata – number of digiti and of phalanges in the archetype of the Reptilia: 2, 3, 4, 5, 3 (number of digiti and phalanges in Ichthyosauria much larger) – only one testis on the right and the left side among the Vertebrata (in Gymnophiona and a few Urodela multiple).

191 (examples of a secondary absence of one of the paired organs, either on the right side or on the left side, are:) absence of the left lung in a number of Serpentes and serpentlike Lacertilia – absence of left series of gonads in Asymmetron among the Acrania, of the left ovarium in Myxine and Bdellostoma among the Marsipobranchii – absence of one of the ovaria in some Selachii, of the right ovarium in Trygon bleekeri and most Aves among the Vertebrata – absence of the right oviduct in the female Trygon bleekeri and most adult Aves among the Vertebrata.

192 ("seeming small" number, because of disappearance during ontogeny occurs with:) mammary glands in many Mammalia – bony scales in Dasypodidae – horny scales in certain Mammalia and in Aves – hairs in Cetacea – teeth in certain Edentata – branchial apertures (gill slits) in Tetrapoda – aortic arches in Tetrapoda (except in many Urodela).

193 ("seeming small" number, because of long time intervals during consecutive appearance, occurs with:) molars of recent Proboscidea – praemolars if the hindmost cheek-teeth, which are not deciduous, are considered as praemolars.

194 ("seeming higher" number, because of fission during ontogeny, occurs with:) hyperphalangy – two or three membranous valves in the left ostium atrioventriculare in Aves among the Sauropsida.

195 ("seeming higher" number, because organs draw away from each other, occurs with:) condylus occipitalis becoming a condylus tripartitus – ganglion nervi glossopharyngei in lower Vertebrata becomes ganglion superius and ganglion petrosum in Amniota – nervus accessorius is split off from the nervus vagus – the ringshaped eye lid occurring in Pisces and Chamaeleontidae is divided into an upper and a lower eye lid.

196 ("seeming small" number because of coalescence early during ontogeny, occurs in the cases of:) dermal ossifications – ossa composita – radius with ulna and tibia with fibula in Rana – eye lids in some Reptilia – primordia of a molar or praemolar according to Bolk's dimere theory – valves in the conus arteriosus of Monopneumones, the caudal ones being coalesced to form a longitudinal fold – valves fusing to form a second longitudinal fold in the cranial part of the

conus arteriosus in Dipneumones – valves fused to form a longitudinal spiral valve in the conus arteriosus of Amphibia – lateral valves fused to form the valvula bicuspidalis in the left ostium atrio-ventriculare in Marsupialia and Monodelphia – glomeruli of the hindmost pronephros ductuli fused to form one glomus in Myxinoidea – external glomeruli fused to form one glomus in Megalobatrachus – glomeruli of the pronephros fused to form one glomus in Chrysemys – glomeruli of the mesonephros fused to form one glomus in Petromyzontidae.

197 (examples of a "seeming small" number, because the organs draw closely together during ontogeny, occurs in the cases of:) the localisation of unicellular glands – foot pads – dorsal and ventral radices (roots) of spinal nerves in Gnathostomata – primarily segmental structure of the adrenal gland – localisation of sensory cells in the skin – right and left olfactory sac – right and left half of the scrotum.

198 number of organs, dependent on the presence and the stage of development in cases of neoteny in the case of branchial apertures (gill slits) in Derotremata.

199 (similarity and non-similarity in size of the right side and of the left side:) the two halves of head and body of Plectognathi.

200 (small size is the rule, increase in size is secondary, reduced size is tertiary:) epidermis among the Vertebrata: secondarily a large number of strata (layers), tertiarily less strata – pterylae of contour feathers among Aves: secondarily extensive – row of cervical vertebrae in Tetrapoda : secondarily long in Aves and Mammalia – sacrum among Tetrapoda – ribs among Vertebrata (except the lowest ones): secondarily long, reaching as far as the sternum, tertiarily short in Syngnathidae and Anura – pectoral girdle among Vertebrata (except the lowest ones): secondarily large in Rajiformes, Pterosauria and Plesiosauria – pelvis among Vertebrata (except the lowest ones): secondarily large in Tetrapoda, tertiarily short in Ornithischia, Ichthyosauria, Serpentes, Aves and Cetacea – skeleton of paired fins among Vertebrata (except the lowest ones): secondarily large in flying Pisces – os occipitale among Gnathostomata: secondarily large in Homo – skeleton of the rostral part of the temporal region in kinetic skulls only partially ossified: secondarily ossified over larger areas in akinetic skulls – skeletal elements in the temporal region among Gnathostomata: secondarily extensive in the secondary stegocrotaphic condition – processus ascendens of the palatoquadratum: secondarily reaching as far as the ventral border of the secondary roof of the skull – skeletal elements surrounding the cavum tympani: secondarily extending into the wall of the cavum tympani in certain Mammalia – secondary bony palate among the Reptilia: secondarily lengthened in Loricata – dentale among Gnathostomata: secondarily large in Mammalia – intumescentia cervicalis of the spinal cord: secondarily strong in Chiroptera – intumescentia lumbalis of the spinal cord: secondarily strong in Macropodidae – brain short in Acrania, secondarily extended rostralwards in Vertebrata – cerebellum slightly developed in Petromyzontidae, secondarily large – corpora mammillaria: secondarily large in Mammalia – hippocampus formation: secondarily large in Mammalia – telencephalon among Vertebrata: secondarily large in Mammalia – nervus trigeminus: innervation of the skin of the head secondarily extended over an increased area in higher Vertebrata – pinna (external ear) among Mammalia: secondarily large in Elephas, tertiarily small in Homo, in burrowing and in swimming Mammalia – teeth in Gnathostomata: secondarily large tusks or fangs – oesophagus in Tetrapoda: secondarily very long in a few Aves, in Giraffa, etc. – part of the pharynx in which striated muscle fibres occur in Tetrapoda: secondarily extended into the oesophagus in Mammalia systematically higher than the Monotremata – coecum: secondarily a voluminous coecum amplius in herbivorous and omnivorous Mammalia the

food of which is rich in cellulose – liver among Mammalia: secondarily larger in carnivores and omnivores – pseudobranchia of the spiracular small in many adult Selachii, well developed in Acipenser and Polyodon – bulbus arteriosus in Pisces: secondarily very long in Teleostei – kidney in Tetrapoda: secondarily very long in Teleostei – kidney in Tetrapoda: secondarily extended along the full length of the splanchnocoel in Gymnophiona – testis in Vertebrata: secondarily extended along the full length of the splanchnocoel in Notidanidae – ovarium in Mammalia: secondarily large in Monotremata.

201 (considerable size is the rule, decrease in size is secondary, tertiarily the size may increase again:) chorda dorsalis (notochord): secondarily rostrally shortened in Vertebrata – exocranium in fossil Ostracodermi: secondarily reduced to a few patches in recent adult Marsipobranchii – exocranium sutureless and complete: secondarily locally remaining unossified cartilaginous – endocranium among Vertebrata: secondarily without a roof – longitudinal stem of the parasphenoid: secondarily short in the fossil ancestors of Mammalia – quadratum and articulare among Gnathostomata: secondarily small as incus and malleus (in Mammalia) – pars palatina of the palatoquadratum – entopterygoid in Non-Mammalia reaching as far as the quadratum: secondarily in Mammalia remaining separated from it – branchial skeleton in the form of a "Kiemengitter" in Petromyzon and in the ancestors of the Myxinoidae: secondarily with strongly reduced postauditive region in Myxinoidae and Bdellostomidae – foremost arcus branchialis: secondarily short in higher Vertebrata – hindmost arcus branchialis primarily long: secondarily short in Teleostomi in which the pectoral girdle is not suspended from it – cornu hyale: secondarily short and partly ligamentous – cornua branchialia 1, 2 and 3: secondarily short (except in Picidae, woodpeckers) – row of caudal vertebrae among Vertebrata – proximal parts of the skeleton of the extremities among Tetrapoda – spinal column in the tail among Vertebrata – cavity in the mesencephalon: secondarily very narrow as the aquaeductus mesencephali Sylvii – rami dorsales of most caudal branchial nerves: secondarily reduced in higher Vertebrata – organs of the lateral line system: secondarily reduced in terrestrial Vertebrata – nervus olfactorius: secondarily very small in Mystacoceti – eye among Vertebrata: secondarily small in part of animals active in darkness or twilight – membrana nictitans among Gnathostomata: secondarily small in Cetacea and Homo – splanchocoel: in Serpentes secondarily restricted to the caudal part by coalescence of the medial and lateral walls – mouth slit among Gnathostomata: secondarily reduced in length in Mammalia – intestine: secondarily shortened in carnivorous Vertebrata – lungs: secondarily very small in Desmognathus – larynx in Tetrapoda: secondarily slightly developed in Aves – conus arteriosus in Pisces: secondarily very short in Teleostei – ductus arteriosus Botalli: secondarily reduced in many Tetrapoda – arteria and vena caudalis: secondarily short in many terrestrial Tetrapoda with a reduced tail – oviduct in Vertebrata: secondarily short in many Ganoidae and many Tetrapoda.

202 (considerable size is the rule; decrease in size through rudimentation:) placoid scales in Selachii and rudimentary placoid scales in Rajidae – skeleton of the extremities in Lacertilia and rudimentary skeleton of the extremities in serpent-like Lacertilia and in Serpentes – skeleton of the hind leg in Mammalia and rudimentary skeleton of the hind leg in Cetacea – skeleton of the digits in Carnivora and skeleton of the rudimentary digits in Ungulata – eyes of Vertebrata and rudimentary eyes in deep-sea living Pisces and in cave-dwelling Gymnophiona, Reptilia and Mammalia.

203 (considerable size is the rule; decrease in size through aphanisy is a secondary total reduction:) disappearance of the skeleton of the tail in larvae of Anura –

disappearance of the dorsal musculature in Testudinides – disappearance of teeth in Acipenser.

204 (relation of size of organs and size of body in related races, etc. with larger body size:) hairs shorter – skeleton more voluminous and more heavily built – skull smaller – brains smaller – eye ball, lens of the eye and cornea smaller – intestine longer – liver smaller – heart smaller – kidney smaller.

205 (maximal size of certain organs in the smallest animals:) diameter of the lens of the eye and distance between the lens and the retina.

206 (certain organs absent in the smallest animals:) absence of lungs in the smallest Urodela.

207 (seemingly "large" size because of coalescence:) certain elements of the carpus and tarsus – cannon bone – squama occipitis of the os occipitale coalesced with rudiments of tabularia and postparietalia.

208 (seemingly "small" size because of the disappearance of certain parts when still in a rudimentary state:) rudimentary skeleton of the extremities.

209 (shape and structure primarily simple, secondarily complicated, tertiarily simplified:) epidermis among Vertebrata: secondarily stratified – horny scale among Tetrapoda: secondarily evolved to a feather – rib among Vertebrata (except the lowest ones): primarily undivided, secondarily tripartite, tertiarily undivided – skeleton of the larynx among Tetrapoda: secondarily with cartilago thyreoides – a number of muscles in Vertebrata: secondarily branched or bifurcate and nearly or completely divided – pars striatalis or corpus striatum in Vertebrata: secondarily more than the palaeostriatum alone – telencephalon among Vertebrata: secondarily developing the pallium– metencephalon among Vertebrata: secondarily with pons Varolii and pyramids – meninx among Vertebrata – papilla basilaris among the Tetrapoda – first primordium of the tooth: primary is the placoid type, secondary the bell shape with or without a stem – tooth among Gnathostomata: secondarily molar (cheek tooth) – tongue among Vertebrata: secondarily developing a muscular part–intestine: primarily without distinct divisions in Acrania and at least without a differentiated oesophagus and stomach in Marsipobranchii, Holocephali, Dipnoi and Cyprinidae – pharynx in Marsipobranchii and Pisces primarily undifferentiated, secondarily differentiated into a nutritive and a respiratory part, lying rostral to respectively caudal to each other in Myxinidae and dorsal to respectively ventral to each other in the Petromyzontidae – stomach in Vertebrata: primarily a straight tube, secondarily curved in a U-shape in part of the Pisces, in Amphibia, etc. – stomach in Tetrapoda: primarily having the same structure over its full length, secondarily locally differentiated *e.g.* into a glandular proventriculus and a gizzard in Aves, with hollow outpushings in several Mammalia – midgut and rectum: primarily straight in Acrania and Marsipobranchii and part of the Selachii, secondarily coiled – intestinum tenue: primarily undifferentiated, secondarily differentiated into duodenum and remaining part and in Homo into duodenum, jejunum and ileum – intestinum crassum: primarily not or hardly differentiated, secondarily differentiated into coecum, colon and rectum, and the colon even into colon ascendens, flexura coli and colon descendens – cloaca in Non-Mammalia: primarily undifferentiated in Selachii and Dipnoi, secondarily differentiated into urodaeum and proctodaeum in Amphibia, Loricata and Aves – lung in Pisces and Tetrapoda: primarily a simple sac with a smooth wall, secondarily a sac with septa and alveoli, tertiarily simplified in Amphibia (compared to Dipnoi) – heart among Vertebrata: secondarily with septum – nephric ductuli: primarily simple ductuli, secondarily secondary and tertiary, etc. ductuli – penis among Tetrapoda – oviduct in nearly all female Vertebrata: primarily a simple tube, secondarily differen-

tiated into divergent parts in viviparous Selachii and Rajiformes and in Tetrapoda.

210 (shape and structure primarily complicated, secondarily simplified:) primordial neurocranium among Vertebrata: secondarily reduced in Marsipobranchii – pectoral girdle among Tetrapoda: secondarily reduced in Urodela – pelvic girdle among Tetrapoda: secondarily reduced in Urodela, Anura, Cetacea – skeleton of the extremities among the Tetrapoda: secondarily fin-shaped skeleton in Cetacea – lobus olfactorius in Sauropsida: secondarily without pedunculus olfactorius – nervus glossopharyngeus among Vertebrata – nervus vagus among Vertebrata – teeth and molars (cheek teeth) in Mammalia: secondarily with a wide basal end (and consequently a prolonged growth) and little or no enamel – mesonephros in nearly all male Vertebrata: primarily containing excretory ductuli and ductuli carrying sperm, secondarily containing only ductuli carrying sperm in male Selachii and Rajiformes and male Amniota.

211 (seemingly complicated because an adjacent part has (adjacent parts have) been incorporated:) stomach without and with an oesophageal (cardiac) part.

212 (seemingly simple because a part has (parts have) been separated:) cloaca into rectum and sinus urogenitalis – haemolymph system into vascular and lymphatic system.

213 (morphological adaptativeness of the properties is obvious:) patagium as to its shape and situation – adipose layer in the skin of foetal Mammalia as to its situation – adipose layer in the skin of Cetacea as to its thickness – mammary glands as to their structure – luminescent organs as to the shape of the lens, structure of the tapetum, etc. – bony dermal armour and coat of bony scales as to their consistency and situation as a covering layer – stratum corneum (horny layer) as to its situation as a covering layer – coat of horny scales as to its consistency and situation as a covering layer – coat of feathers and of hairs as to their situation as a covering layer – row of remiges in Aves as to their shape – claws, hoofs and nails as to their shape and situation – antlers as to their solidity, shape and situation – horns as to their solidity, shape and situation –processes of skeletal elements serving the attachment of muscles as to their shape and situation – row of cervical vertebrae as to its length and flexibility – row of caudal vertebrae as to its shape and movability – vertebral centrum as to its shape – joints in the vertebral column as to their shape – pectoral girdle as to its size, shape and structure in the ventral median – carina sterni as to its shape and situation – skeleton of the paired fins in Pisces as to their stiffness, shape and size – skeleton of the limbs of Tetrapoda as to their internal movability – skeleton of the fin shaped fore limb of Cetacea as to its stiffness, shape and size – condyli occipitales as to their shape and situation – malleus and incus as to their shape and situation – cerebellum and mesencephalon as to their size and shape – rhinencephalon as to its size – telescope eyes in certain deep-sea Pisces – eye as to the shape of its lens and the development of the tapetum – ear as to the structure of the apparatus transmitting the sound waves – molars as to the properties of the free surface – tongue as to its shape and size – stomach as to its size and shape – intestinum as to its length – gills as to their shape – lung as to its form – ductus arteriosus Botalli as to its width – copulatory organs as to their shape and size.

214 (adaptativeness is so extreme, that it makes life in a different medium impossible:) remiges and rectrices in Aves – patagium – adipose layer in Cetacea – hoof in Ungulata – skeleton of the fore limb in Cetacea.

215 (adaptation within a bigger systematic group in one special sense or to one special environment:) absence of cervical vertebrae in Pisces – skeleton of fin shaped extremities in Pisces – internal gills in Pisces – penis in Tetrapoda.

216 (diverse adaptations within a bigger systematic group to functions and envi ronment:) skeleton of hand and foot in Mammalia – mammary glands in Mammalia – ethmoturbinalia in Mammalia – rhinencephalon in Mammalia – Jacobson's organ in Reptilia and Mammalia – molars in Mammalia – syrinx in Aves – metanephros – placenta in Mammalia.

217 (adaptations are specific variations on a conservative structural scheme:) legs, wings and also the "fins" of Cetacea as to a number of their component parts – vertebrae as to a number of component parts – pectoral girdle as to a number of component parts.

218 (conservative properties obvious:) cervical vertebrae in Mammalia as to their number – ribs as to their presence and situation – bones of the skull as to their presence and situation – hyoid skeleton as to its component parts.

219 (new formations with adaptative properties only:) luminescent organs in certain not nearly related species of Pisces – patagium in certain not nearly related species of Mammalia.

220 (characters of the ancestor deduced from those of recent descendants:) characters of the ancestral Acrania deduced from those of the recent Branchiostoma (Amphioxus =) – characters of the ancestral Mammalia deduced from those of recent primitive Mammalia.

221 (characters of the ancestor deduced from those of allied forms, recent or fossil, in "older" groups:) epidermis of a single layer from that in the Acrania – position of the rostral end of the notochord from that in Acrania – absence of prochordal brain from that in Acrania – characters of the ancestor of primitive Vertebrata from those of Acrania – characters of the skull in primitive Tetrapoda from those in Dipnoi.

222 (characters of the ancestor deduced from those in ontogeny:) segmental metameric rows of many organs in Pisces.

223 (conclusions from ontogeny may be dangerous because simplicity does not mean anything:) epidermis originating as a single layer.

224 (recent descendant furnishes a negative information about the ancestor:) organs of locomotion and of sight in contrast to intestine, organs of chemical sense, organs of reproduction.

225 ("rudiment" is not a precursory stage of an organ in evolution:) eyes of cave-dwelling Vertebrata and of bathypelagic Vertebrata.

226 (archallaxis:) certain carpal and tarsal elements – first stages in the ontogeny of a molar (back tooth) after the dimere-theory.

227 (actually new formations are inconceivable, as they are already present in the archetype or in the ancestor-type:) all cartilage must be traced back to cartilage present in the Selachii.

228 (seemingly new formations due to increase in one or two of the dimensions, dilatation, folding and overvaulting:) patagium – marsupium – webs – paniculus adiposus (fat layer of the integument or skin in Cetacea) – crista on the surface of a bony scale – semilunar groove on the surface of a bony scale – tube-shaped canal on the surface of a bony scale – carapax and plastron in Testudinides – feathers in Aves – horns – antlers – processus on the skeleton – shape of the articular surfaces – shape of the rostral and caudal surfaces of the centrum of a vertebra – modification of shape of the sacral vertebrae – elongation of the spinal column in the tail – condyli occipitales – supra-occipitale in Homo – alisphenoideum – secondary skull – secondary palate – dentale in Mammalia – skeleton of the larynx – pallium – division of the opening to the nasal groove in Pisces into two external nasal openings (nares anteriores and posteriores) – external nose – ethmoturbinalia – ventral wall of the cavum tympani – pinna (external ear) – eyelids in the Tetrapoda – diaphragma – tusk – sharp cusps and tubercles of a molar – branches of the complex liver in Vertebrata instead of the

single tube-like liver in Branchiostoma – operculum of the branchial apparatus – internal surface of the lung – septum in the heart – arteria pulmonalis – ureter – scrotum.

229 (seemingly new formations due to invagination, depression:) vestibulum of the olfactory organ – external auditory meatus.

230 (seemingly new formations due to division, fission, splitting off:) stratified epithelium of the epidermis – pharyngobranchiale, epibranchiale, ceratobranchiale and hypobranchiale of Gnathostomata in stead of the undivided skeletal arcus branchialis – hyperphalangy – hyperdactyly of the skeleton – division of the undivided mass of muscle in separate muscles – dermal muscles – muscles of the tongue – nervus accessorius – septum in the heart – rectum beside the sinus urogenitalis.

231 (seemingly new formations due to constriction and fission:) lens of luminous organs – cartilage in the joint of the jaws in Mammalia.

232 (seemingly new formations in higher forms which occur also separately in lower forms:) carina sterni in Chiroptera and in Aves – condyli occipitales in Mammalia and in Rajiformes – secondary palate in Mammalia and in some Reptilia – external ear in Mammalia and in Loricata and in some Aves.

233 (seemingly new formations are adaptations to function and environment:) patagium – webs – carina sterni – tusk.

234 (seemingly new formations which appear to fit into the general organisation scheme of a larger group:) carina sterni in carinate Aves.

235 (differentiations which are locally differently developed:) stratum corneum on the lips and on the sole of the foot – horny scales and the stratum corneum between them – claw, hoof and nail and the rest of the stratum corneum – horn and the rest of the stratum corneum.

236 (differentiations which are locally separated:) multicellular glands and diffusely scattered gland-cells – stomach of the Ruminantia.

237 (differentiation by means of local alterations of the tissues:) epithelial cells become gland-cells in the epidermis – cartilage is replaced by endochondral bone in the skull, in the composite rib, etc. – connective tissue becomes cartilage in the heart of Bos – meninx primitiva becomes two or more meninges – connective tissue becomes the tapetum behind the retina.

238 (local differentiations in the tissues common in higher groups scattered among the lower Vertebrata:) cornified spots on the skin in Pisces.

239 (differentiations are adaptations to function and environment:) gland-cells, respectively indifferent epithelial cells – tapetum behind the retina or undifferentiated connective tissue.

240 (differentiations incorporated into the organisation scheme of the group:) complex stomach of the Ruminantia.

241 (seemingly new formations through combination:) horn – antlers – fin rays with placoid scales in the median fins – pelvis with sacrum – combination of the first cervical vertebrae to the occipital region of the neurocranium – coalescence of ulna and radius in the recent Equus – ganglion Gasseri – dorsal and ventral nerves of the medullar spine lying close together in Cyclostomata and being mixed up in Pisces – teeth plates in Dipneusta – tongue – stomach with an oesophageal part – larynx – opisthonephros – penis.

242 (non-essential new formations caused by mechanical factors:) cartilages within tendons and sesamoid bones.

243 (non-essential new formations, occurring in a single species:) certain extra elements in the carpus and tarsus.

244 (detailed components of a structural element:) horny scale as component of a structural element of the skin – vertebra as component of a region of the spinal column after the nonius-theory – mesonephros as component of the holonephros.

245 (seemingly new formations which, however, allow a hypothetical deduction from organs of lower Vertebrata:) paired fins from fold of the skin – skeleton of legs from that of paired fins – deeply situated ossifications from placoid scales – hairs from certain epidermal sensory organs – lungs from vesica natatoria (air-bladder).

246 (really non-deducible new formations:) epidermal glands in Mammalia – secondary dermal ossifications in Dasypodidae – secondary covering with horny scales in Pholidota – parasternalia – epipubis – secondary cartilage in the jaw joint in Mammalia – entotympanicum – pons (Varolii) and pyramid tract in the metencephalon – Corti organ – vena pulmonalis – ureter.

247 (organs limited to small systematic groups:) patagium – antlers – carina sterni in Mammalia.

248 (subjectively conceived series, which can be read in either direction:) antlers and horns – number of skeletal digits – sculptures on the internal surface of the intestine – several forms of the uterus in Mammalia.

249 (qualitative subjectively conceived series:) claws, hoofs and nails – antlers and horns – sculpture on the surface of the molars in Placentalia – sculptures on the internal surface of the intestine – several forms of the uterus.

250 (quantitative subjectively conceived series:) number of skeletal digits.

251 (unbranched rectilinear subjectively conceived series:) number of skeletal digits – antlers and horns – structures of the olfactory organ in Vertebrata – forms of the uterus.

252 (branched subjectively conceived series:) claws, hoofs and nails in Mammalia – sculptures on the surface of the molars in Placentalia – sculptures of the internal surface of the intestine – arches of the aorta in Vertebrata.

253 (principle of praecedency:) structure of the skeletal tail of Archaeopteryx precedes that of the recent Aves according to the systematic, ontogenetic and palaeontological-stratigraphic praecedency.

254 (from primitive prototype to progressive derived forms in an idealistic-morphological series:) number of skeletal digits – from the primitive skeleton of the fins via the skeleton of the eurybasal fin to the skeleton of the stenobasal fin – from ichthyopterygium to cheiropterygium – from vesica natatoria (air-bladder) to lung.

255 (regressive series from highly developed type to reduced forms in an idealistic-morphological series:) all series concluding with a rudimentary organ.

256 (hyperprogressive forms:) excessive development of ornamental feathers in some Aves – excessive development of antlers – excessive development of fangs or tusks in Ungulata, perforating the upper lip – tusks of the mammoth – canini of Smilodon.

257 (sudden, discontinuous and continuous transitions during the idealistic-morphological metamorphosis of one group to the other:) mesencephalon - metencephalon.

258 (qualitative idealistic-morphological series:) claws, hoofs and nails – sculpture of the surface of molars in the Placentalia.

259 (quantitative idealistic-morphological series:) number of skeletal digits.

260 (unbranched or branched idealistic-morphological series:) number of skeletal digits – claws, hoofs and nails in Mammalia – sculpture of the surface of the molars in Placentalia – aortic arches in Vertebrata.

261 (primitive and specialised on a phylogenetic series:) heart of Reptilia in relation to that of Mammalia, resp. to that of Pisces.

262 (trends of morphological specialization towards extreme modes of life in phylogeny:) phylogeny of the recent ectoparasitical Marsipobranchii – phylogeny from terrestrial Mammalia to Cetacea – phylogeny of Vertebrata, living in dark caves – phylogeny of the underground digging Gymnophiona – phylogeny

of those Reptilia that climb against vertical walls – phylogeny of Chamaeleo walking on tree-branches – phylogeny of the scale pattern of Pisces lying with one lateral body side on the bottom of the sea – phylogeny of the shoulder girdle with its broad attachment to the vertebral column in Rajiformes – phylogeny of the construction of the flesh-cutting shears ("Brechscherengebiss").

263 (specialization towards a parasitical mode of life:) the sucker-shaped mouth and the build of the eye in Myxinoidea, as adaptations to ectoparasitic life, are either a rudimentary, reduced condition or a primitive condition – the parietal eye and the kidney in Petromyzon are probably in a rudimentary, reduced condition; the horny teeth, as adaptations to ectoparasitic life, are no doubt new formations.

264 (trends of morphological specialization towards extreme modes of life in phylogeny:) phylogeny from terrestrial Mammalia to Cetacea – phylogeny of the recent ectoparasitical Marsipobranchii – phylogeny to the construction of the flesh-cutting shears ("Brechscherengebiss").

265 (evolution of different organs and organ-systems do not run parallel:) olfactory pits versus skeleton – uterus versus skeleton – several organs in the evolution of a race with a larger or a smaller body-volume than the ancestral race – the series from the Protocyclostomata to the Petromyzontidae shows progression in the build of the mouth ring and the cirri, in the spinal column, in the brain, in the auditory organ and the number of gill slits, etc., but regression in the reduction of the branchial skeleton ("Kiemengitter") – the series from Amia to Teleostei shows progression in the skeleton, and regression in the absence of ganoin – the series from the lizard-like ancestor of the Chamaeleon to this Chamaeleon shows progression in the extremities, but regression in the rudimentary organ of smell and in the rhinencephalon – the series from the reptile-like ancestor of the Aves to the Aves shows progression in many respects, but regression in the reduction of the skeleton of the rostral extremities and of the left arcus aortae.

266 (phylogenetic "seeming"-series:) molars of fossil Proboscidea.

267 (discontinuous transitions in large systematic groups:) from placoid scales to deeply situated allostoses (dermal bones).

268 (qualitative phylogenetic series:) olfactory pits – holonephros.

269 (quantitative phylogenetic series:) skeleton of the limb in Equidae – condyli occipitales – disappearance of two incisivi in most Rodentia – skeleton of the autopodium of the extremities of the ancestors of Quadrupeda among the Crossopterygii with seven fingers or toes – skeleton of the autopodium of Equidae – condyli occipitales – size of the eye and of the pupil of the eye in blind Vertebrata and in Vertebrata living in twilight – disappearance of two incisivi in most Rodentia – number of functioning gill slits in Marsipobranchii and in Gnathostomata and in Bdellostoma stouti and in other Marsipobranchii.

270 (progressive series of organs in phylogeny:) coalescence of scales to one undivided dermal armour in many Ostracodermi – primitive skeleton of the paired fins to eurybasal and stenobasal fin-skeleton – ichthyopterygium and cheiropterygium – condyli occipitales – from primary agnathous condition in Ostracodermata to Pisces with skeletal jaws – lower jaws – olfactory pits – glands of the mouth cavity in several classes of the Vertebrata – consecutive occurrence of an increasing number of enamel folds on the molars in Equidae and Proboscidea – condition of the aortic arches in several large groups of Vertebrata.

271 (regressive and degenerative series of organs in phylogeny:) all series ending with a rudimentary organ – reduction of the undivided armour of bone and dentin of the type of Cephalaspidae and Pteraspidae through degeneration and decay ("Zerfall") into a dermal skeleton, consisting of placoid scales in later

groups – reduction of the osseous skeleton of the ancestors of the Gnathostomata to a cartilaginous skeleton in some recent Gnathostomata – reduced condition of the skull of the Acipenseridae – reduction of the cartilaginous rostrum – reduction of the symphysis palatoquadrati – reduction of a limb with the skeleton of four digits to one with only that of one digit in steppe-dwelling animals – reduction of the pelvic bones in Sirenia – coalescence of ulna and radius, still separated in the fossil Eohippus, in Parahippus and in the recent Equus – reduction of the canini in Equidae and Proboscidea.

272 (orthogenesis in a descriptive sense:) absence or presence of horns and the length of the horns in the series of Titanotheres – development of the hair-coat on the head and on the rest of the body in monkeys, gibbon, gorilla and Homo.