sidered as directing the course of evolution through organic selection.

8. *Tradition* (Lloyd Morgan): the handing on from generation to generation (independently of physical heredity) of acquired habits.

9. *Social Heredity* (Baldwin): the process by which the individuals of each generation acquire the matter of tradition and grow into the habits and usages of their kind.*

J. Mark Baldwin.

Princeton University,
March 13, 1897.

WHAT IS A TYPE IN NATURAL HISTORY?

All naturalists concede that type specimens constitute the most important material in a museum of natural history. The true appreciation of this fact, however, is of recent date, and is shown in the numerous lately published catalogues of types possessed by different museums. The greater number of these publications have appeared in England and America. This just valuation of type material in recent years has come about through the work of specialists in their efforts to monograph groups of organisms. In those branches of natural history where original descriptions are usually accompanied by figures, the value of type material is not so apparent as where no figures are given, but in all branches of this science except bacteriology, it is upon the type material that the entities of natural history and its taxonomy rest. It is therefore of the greatest importance to learn the whereabouts of types. The object of this article, however, is not to point out the great scientific value of type specimens, but to determine what constitutes a type and what kinds of types exist.

There is considerable diversity of opinion as to what is meant by a type. One writer states that "By a type is meant the original specimen to which any generic or specific name was first assigned."*

The late Dr. G. Brown Goode writes that

> By a type is meant a specimen which has been used by the author of a systematic paper as the basis of detailed study, and as the foundation of a specific name. In cases where a considerable number of specimens has been used, it is desirable to separate one or more as being the *primary types*, while the other specimens, which may have been used in the same study for the purpose of comparison, may be regarded as *collateral types*.†

A mammalogist further states that "The word 'type' itself, when first introduced, was meant to refer to the particular specimen (in the singular) originally described, but it was soon naturally applied to any individual of the original series, if more than one specimen was examined by the describer."‡

These citations clearly show that a type is not always restricted to a single specimen selected by an author, but also applies to several, or even to all the specimens contained in the original lot. Moreover, the word type has been applied to specimens sent out by the author of a species, but not

* Professor Lloyd Morgan thinks this term unnecessary. It has the advantage, however, of falling in with the popular use of the phrases 'social heritage' and 'social inheritance.' On the other hand, 'tradition' seems quite inadequate; as generally used it signifies that which is handed on, the material; while in the case of animals we have to deal mainly with the process of acquisition. 'Social heredity' also calls attention to the linking of one generation to another. However, I think there is room for both terms. For further justification of the terms 'Social Heredity' and 'Organic Selection,' I may refer to the *American Naturalist*, July, 1896, pp. 552 ff.

*T. McKenny Hughes, Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge, 1891; prepared by Henry Woods.

†Circular letter of July 1st, 1893, to Curators in the U. S. National Museum.

‡Suggestions for the more definite use of the word 'type' and its compounds, as denoting specimens of a greater or less degree of authenticity, by Oldfield Thomas. Proc. Zool. Soc. London, 1893, pp. 241–2.

described in the original paper. Students of parasitic insects often rear numerous individuals from a single mother of a new species, any one of which is naturally as much like the type as those selected by the author. Some of the individuals of such broods are distributed to other workers and museums as types. For a clear description of a new species a paleobotanist may require as many individuals as there are specimens selected for study, all of which are regarded as types. Because of the general imperfection of fossils, much of the original material is usually accepted by paleontologists as types, but when specimens are figured, as is the general custom, it is good practice to regard these alone as types. The writer is not aware that any invertebrate paleontologist in America ever considers a species to be based upon a single specimen, if others are present at the time of original publication. It is doubtful if many species, living or extinct, can be defined from a single individual; hence the multiplicity of types is generally a necessity. In birds and mammals, where the sexes usually exhibit marked differences, there are seasonal modifications, a bony skeleton, geographical and individual variation, and stages of growth, and all these parts and variations require material for the proper and final interpretation of species. The practice of selecting a single example as the type, however, has its advantages, since all doubt is thus removed when a new species is later found to contain diverse elements.

The writer believes that it is possible to harmonize all these different conceptions as to what constitutes a type. The following is, therefore, offered as an expression of individual opinion, in the hope that biologists will, when necessary, emend the different definitions here given or offer new ones, so that a proper terminology in regard to types may come into general use.

KINDS OF TYPES.

Type Material.—This includes all specimens which have served as the basis for published primary and supplementary descriptions and figures. Mere lists of names should not be regarded as based upon 'type material;' neither should typical undescribed specimens of the original series identified by the author of a new species, nor the reared original duplicates of a series out of which the type material was selected, be sent out to collectors and museums as types. There are, therefore, two great groups of type material: primary and supplementary types. These may be defined as follows:

Primary Types.—These are the described or figured specimens of any new species. There are three kinds of primary types: holotype, cotype and paratype. To these may be added a fourth, plastotype, including all artificial reproductions moulded directly from some primary type.

Supplementary Types.—These consist of the described or figured specimens used in publication in extending or correcting knowledge of a previously defined species. For such type material the term hypotype (*hypo*=under or sub, and *typos*=type) may be used. For artificial reproductions moulded directly from a supplementary type, *hypoplastotype* may be useful.

The collective term, 'type material,' therefore includes all specimens used in publications and upon which the entities of natural science are founded. 'Primary types' include only the material of a new species, while 'supplementary' or 'hypotypes' are those specimens supplementing knowledge of a previously defined species. The various kinds of primary types may be defined as follows:

Holotype (*holos*=whole or entire, and *typos*=type).—A holotype in natural history is a particular individual deliberately selected by the author of a species, or it

may be the only example of a species known at the time of original publication. A holotype, therefore, is always a single individual, but may embrace one or more parts, as the skin, skeleton or other portions. When a holotype is selected, but other specimens are also described, the latter must be known as paratypes. When no holotype is selected, and more than one specimen is described, all become cotypes. Therefore, the original material of any species cannot include a holotype and cotypes, but may include a holotype and paratypes, or all may be cotypes.

In cases where a holotype is selected, but no description or designation is given to distinguish it from the associated material, the holotype practically does not exist.

In cases where a holotype has been selected, but the diagnosis is found to contain more than one species, the remaining material will always constitute the paratypes. These will not necessarily remain as such under another name, but will always be the paratypes of the new species as interpreted by its author.

The author of a new species having failed to select a holotype, no subsequent author can do this for him. No just law is retroactive. However, there are two exceptions which appear not to violate this law: first, when the original definition includes two or more species; and second, when no holotype is selected and but a single example is figured. Further remarks on these exceptions follow:

In cases where a single individual is originally figured, no holotype being selected, and the original diagnosis is known to be based upon several examples, it is recommended that the figured one be regarded as the holotype by subsequent authors. The remaining material described will, therefore, be changed from cotypes to paratypes, since out of the original series the holotype has been selected. (See definition of cotype.)

Where the original diagnosis is without illustrations and contains more than one species based upon cotypes the first subsequent author is at liberty to select from these a holotype for the old species, adhering as far as can be ascertained to the intention of the original author. For the other new species, if any, he may select from the remaining cotypes, or from other material in his possession, the holotypes or cotypes of his new species.

In cases where a new species is not directly based upon material, but upon the published description of an earlier author, the specimens of the latter become the type material of the new species. The kind of type then present will depend on whether in the original description a holotype had been selected.

A species described or new and proving to be a synonym does not affect the type material of the species with which it is synonymous. All such synonymous material, however, should be carefully preserved and marked as holotype or cotype under the original name as well as under the one of which it is known to be a synonym.

Cotype (or associate type).—Cotype was introduced by Waterhouse, and is defined by Oldfield Thomas as follows: "A cotype is one of two or more specimens together forming the basis of a species, no type [holotype] having been selected. No species would have both [holotype] and cotype, but either the former [or holotype and paratype], or two or more of the latter." In cases where the cotypes are unmarked and cannot be distinguished from the balance of the original series the only safe plan to follow will be to regard all the original material of a new species as cotypes. If such specimens are sent out to collectors and museums they should be marked as cotypes.

Paratype (*para*=beside, and *typos*=type).—"A paratype is a specimen belonging to the original series, but not the type [holotype], in cases where the author has himself selected a [holotype]. It should, however, be one of the specimens * * * [described] in the original description." The present writer has removed from this definition of Thomas, the words 'mentioned or enumerated' and substituted 'described.' Specimens merely mentioned or enumerated add no characters to the description of a species. Lists of specimens giving measurements, however, do add to the knowledge of a species, and are to be regarded as type material, either as paratype, cotype or hypotype, as the case may be.

A paratype may be subsequently selected as a holotype when it proves to be a new species and is not the species to which it was originally referred.

Plastotype (*plastos* = formed or moulded, and *typos* = type).—Any artificial specimen moulded directly from a primary type. There are many specimens of this kind in existence, cast directly from fossils, and these are often quite as good as the originals. No models, however, can be included, since they are not cast from type material. Artificial casts made from supplementary material will become plastotypes if a specimen from which the reproduction was made is subsequently used for the founding of a new species.

In this connection it may be well to give a name to artificial casts made from supplementary types, since some have a very decided value. For instance, many artificial casts are in museums of one of the supplementary types of the trilobite Isotelus gigas, the only one preserving the ventral limbs. For such the term *hypoplastotype* may be useful.

In paleontology fossils are sometimes described and illustrated from artificial casts or squeezes made from natural rock cavities from which the fossils have been leached. Such plastotypes are not to be regarded as type material. The natural moulds from which they are made, however, should always be so considered.

TYPICAL MATERIAL.

Mr. Thomas has also proposed the terms 'topotype' and 'metatype.' The material to which these terms are applied has not served in publication, but simply refers to typical material, either derived from the type locality (topotype) or derived from the type locality and identified by the author of a new species (metatype).

These were defined as follows: *Topotype.*—'A specimen simply collected at the exact locality where the original type was obtained.' *Metatype.*—'A specimen received from the original locality after the description has been published, but determined as belonging to his own species by the original describer himself.'

Genotype (*genos* = race, and *typos* = type).—Genotype applies to any typical material of the type species of a genus. The material, however, should be, if possible, from the original locality of the species, or a genotype should also be a topotype or metatype. Therefore there may be as many genotypes of Lingula as there are museums having characteristic specimens of Lingula anatina.

MARKING OF TYPE MATERIAL.

All type material should be plainly and permanently marked to distinguish it from other specimens. If this is carefully done, much doubt will be removed for subsequent students. When such material is large, as birds and mammals, a small highly colored card or a piece of plain zinc may be attached, upon which should be printed or stamped the proper term indicating the kind of type and the museum catalogue number. In paleontology it is the custom to glue small colored tickets upon the type

material in addition to the catalogue number, when sufficiently large to permit of this without covering too much of the specimen. The small specimens are placed in numbered vials or boxes. In the Woodwardian Museum (Cambridge) type fossils are mounted on blue tablets. This arrangement, however, has the disadvantage of giving the exhibition series a checkered appearance, and should the specimens become loosened and displaced there is danger of the types being overlooked.

CHARLES SCHUCHERT.

THE FAUNA OF CENTRAL BORNEO.

IN 1893 the Netherlands Commission, established for the purpose of promoting research into the natural resources of the Dutch colonies, united with a similar society formed in Batavia composed of merchants, financiers and government officers in organizing an expedition of scientists to central Borneo, a hitherto scientifically unexplored region.

Herr Büttikofer was the zoologist of the expedition and presented an account of its results to the third International Zoological Congress, held last year at Leyden, and his report has since been printed in the *Compte-rendu* of the Congress.

To zoologists it is hardly necessary to say that Herr Büttikofer is the distinguished curator of the Zoologischen Reichs Museum in Leyden, and the author of 'Reisebilder aus Liberia' (Leyden, E. T. Brill, 1890), the best zoological and sociological study of that country which has been made, and which in its minute descriptions of animal life is superior to any work upon any part of the African continent with which we are acquainted.

The work of the expedition was divided into six departments: Geology, Mineralogy, Botany, Zoology, Anthropology and Ethnography. Of these geology and mineralogy were assigned to Professor Molengraaff, of Amsterdam; Botany, to Dr. Hallier, of Buitenzorg (Java); anthropology and ethnography to Dr. Nieuwenhuis, who was also medical officer; and zoology to Dr. Büttikofer, as before stated. Each had perfect control of his own department as to the field of research and the time to be spent. In anthropology and ethnography not much could be expected, as they require a much longer residence and acquaintance with the native populations than such expeditions usually afford.

"In my own department," says Herr Büttikofer, "I had the valuable assistance of a black man, Max Moret, a soldier in the Dutch army who had before accompanied Professor Selenka in his Borneo journey." "The natives became interested in my department and willingly lent me a helping hand."

Herr Büttikofer reached Batavia, November 1, 1893, and during his three weeks' stay in Java made an excursion to the Preanger regencies, and to the lofty mountains Gedeh and Pangerango, where he obtained among other specimens the very rare *Merula javanica*. Leaving Java on November 17th, he landed at Pontianak, on the west coast of Borneo, and ascending the mighty river, Kapuas, established a central station at Smitau. The river being in flood, the hunting was confined to birds and other tree-living animals, and many new specimens were obtained.

In December they moved on to Mt. Kenepai (1200 metres), near the borders of Sarawak, where on higher ground a better field was found. Ascending the mountains, they pitched their tents half way to the summit and found the life most romantic. "In the early dawn we were awakened by the loud jodelling of gibbons and the ear-splitting shriek of the Rhinoceros birds, after which, as the morning advanced, the other members of the winged orchestra joined in the chorus."