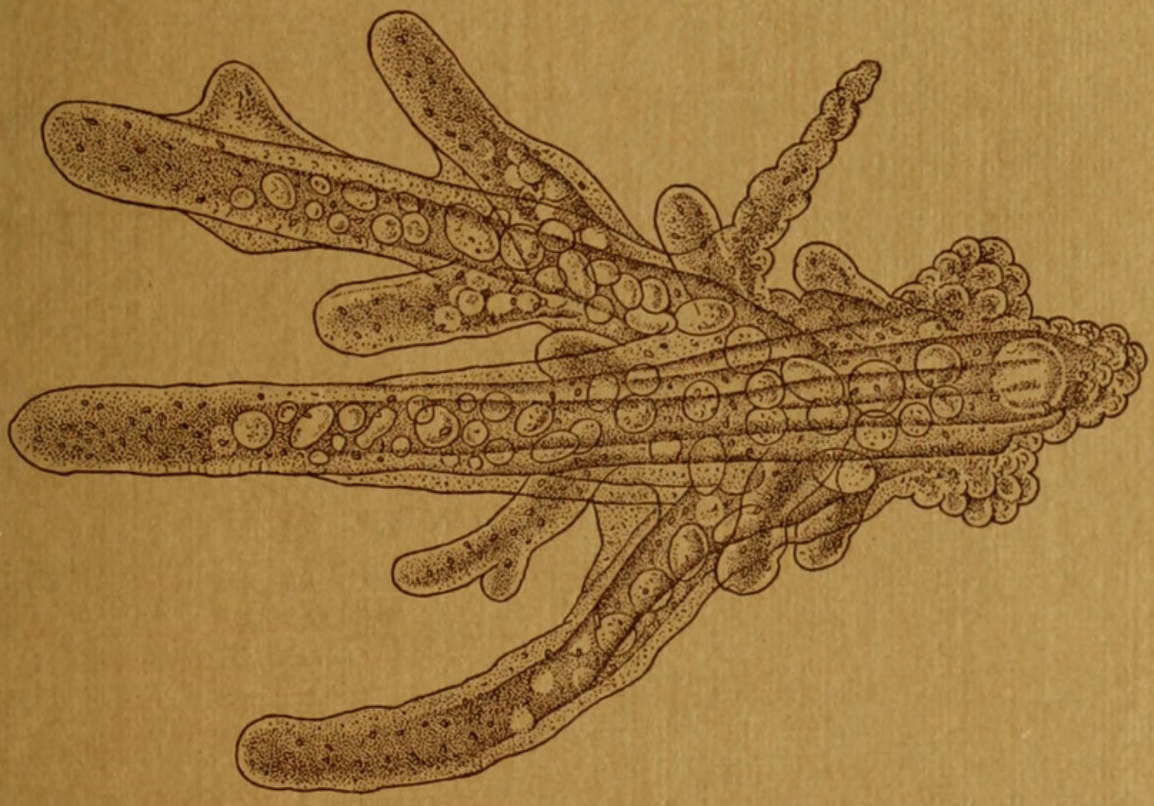
AMERICAN MUSEUM OF NATURAL HISTORY

A FIRST CHAPTER IN NATURAL HISTORY

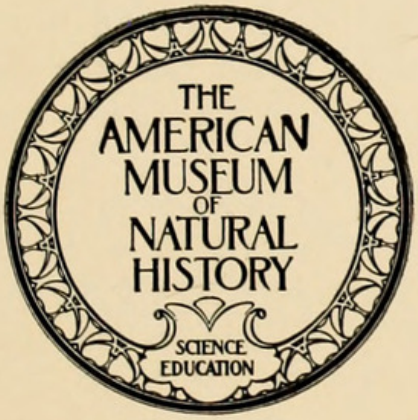


By FREDERIC A. LUCAS

GUIDE LEAFLET No. 51
EDITION OF 1925

A FIRST CHAPTER IN NATURAL HISTORY

BEING THE INTRODUCTION TO CHAMPLIN'S YOUNG FOLKS' CYCLOPÆDIA OF NATURAL HISTORY



By
FREDERIC A. LUCAS

Published by permission
GUIDE LEAFLET No. 51
Third Printing
February, 1925

Where you may find illustrations or examples of some of the subjects noted in this leaflet

THE DARWIN HALL OF INVERTEBRATES

The exhibits in this hall, on the first floor, give a complete synopsis of the Animal Kingdom, all groups from Protozoa to Vertebrates being represented. Here too are groups illustrating relation to environment, the **Struggle for Existence, Survival of the Fittest, Geographical Distribution and Variation in Nature** and **under Domestication.**

THE SYNOPTIC SERIES OF MAMMALS

The attention of teachers of biology in our schools is called to the Synoptic Series of Mammals in The American Museum of Natural History, on the third floor, which has been developed with a special view of making it instructive to the student while at the same time of interest to the general visitor.

It not only comprises examples of every family of existing mammals, illustrating in many cases their structure, and origin in point of time, but includes exhibits showing various points in the evolution of mammals, sundry principles of classification, and interesting or peculiar habits. The specimens are, or are to be, accompanied by detailed descriptive labels giving the characters and more important information in regard to the various orders and families of mammals, the series being an example of Doctor Goode's definition of a (university) museum, "a collection of labels illustrated by specimens."

Among the subjects illustrated are albinos and melanos, modifications of the limbs for locomotion, structure and modifications of teeth, variations in the character of the brain, influence of environment and adaptation of mammals to their surroundings. What may be called an introductory chapter gives the distinctive characters of mammals, and a family tree, showing the probable lines of evolution of the animal kingdom and the relation of *Mammals* to the other great groups or *phyla*, see Guide to the Hall of Mammals.

THE HALL OF INSECT LIFE

In the next hall is the collection of Insects so arranged as to illustrate their relationships to each other and to other animals (**Classification**), their importance, and such topics as **Protective Coloration, Mimicry**, and **Evolution.**

A First Chapter in Natural History

Natural History is the story of all natural objects, plants and minerals, as well as animals, though in popular usage it is often confined to the last. And while the term animal is very commonly thought to refer to mammals only, it being a mistake of frequent occurrence to speak of birds and animals when birds and mammals is meant, the name animal properly applies to every living or animate creature, from the tiny being that can be seen only with the aid of a microscope up to a whale, the mightiest creature that has ever lived.

Broadly speaking, animals are distinguished from plants by their ability to feel, move, and digest organic substances such as plants and other animals. Plants on the other hand do not feel, have no power of voluntary movement, and are nourished by inorganic substances absorbed through their roots. The boundary line between animals and plants is, however, not sharply defined, especially between the lower, or simpler, forms. Some plants move and some animals are rooted to one place, and a few plants even have the power to digest animal substances, but with all these exceptions the power of voluntary movement remains the most evident distinction between animals and plants.

EVOLUTION

The smallest and simplest animals consist of an extremely minute quantity of a jelly-like substance, termed protoplasm, surrounding a central speck of firmer material known as the nucleus. This constitutes a cell, and the smallest, simplest animals are formed of a single cell and are called unicellular or single-celled animals. The largest of creatures is merely a vast assemblage of very similar cells, grouped into structures of different kinds and serving different purposes; and a few naturalists have argued that even the very highest animals are really compound beings made up of combinations of simple animals. We may, however, dismiss this theory as fanciful, while noting that plants, as well as animals, are composed of combinations of cells, the cell being the unit of life.

All life is believed to have begun with simple, one-celled beings, because the animals we find entombed in the rocks become simpler and simpler in structure as we go down, the higher groups of mammals, birds, reptiles, etc., disappearing one after the other as we go backwards

in time. For the reason that the simpler forms of life appeared first, it is thought that plants preceded animals, and as the lowest forms of each are almost indistinguishable from one another, both may have been derived from the same simple organism. While this belief is entirely probable, it may never be actually proved: because the small, soft, simple animals and plants could leave no trace of their former presence in the shape of fossils; and the only animals found are those high enough in the scale of life to possess hard parts that could be preserved as fossils.

As living things increased in the world, they were influenced by their surroundings, and affected by the amount of light and heat, of rest or movement, to which they were subjected. In places favorable to their growth and increase, they multiplied to such an extent that they began to crowd one another, and localities suitable for the support of a limited number were even overpopulated, and it became a question as to which should survive. Thus, almost at the outset arose the **Struggle for Existence**, but it must be borne in mind that this was not an active struggle, but usually a mere passive effort to endure—such animals as by their strength, powers of endurance, and ability to withstand changes of climate and to resist heat or cold, being those that survived, while the weaker or less fit were swept out of existence. This is the very simplest form of the **Survival of the Fittest**; among higher animals the process is vastly more complicated, and the means by which it is accomplished so varied as to be almost infinite. It is nevertheless purely passive on the part of the animals, not being brought about by any thought or conscious effort on their part. Animals think to a certain extent, but the reader is cautioned to beware of ascribing to other animals the thoughts and feelings of man; this is the more important, as so many books have been written in which animals are made to feel, and think, and act like human beings, the height of absurdity being reached when these thoughts and feelings are ascribed to plants. The care of birds for their young is often cited as a beautiful example of parental tenderness; but while birds, it is true, care a great deal for their young, it is not much in the manner in which human parents care for their children. The bird that will do all in her power one season to preserve her offspring, will transfer her affections the very next year to a new brood, and treat last year's family as strangers, or even enemies.

Bats furnish a good example of what may be called passive resistance. These active little animals are for the most part insectivorous—insect eaters, and dependent entirely on the presence of insects for their

livelihood. Insects in turn are directly or indirectly dependent on flowers, and when in northern regions the approach of winter puts an end to the flowers, insects begin to disappear. With the withdrawal of their food supply, bats must either migrate, die, or in some manner survive without food. To a limited extent bats do migrate; but the majority exist without eating by hibernating during the winter—the same cold which puts an end to flowers and insects checking the circulation of blood, and permitting the bats to exist for a long time with very little bodily waste. This very curious condition has not been brought about by any direct effort on the part of the bats, but, it is believed, simply by the weeding out of those that were unable to lie torpid, and the survival of those in which the bodily functions and waste of flesh were checked without destroying life.

It must always be borne in mind that the survival of the fittest is by no means the survival of the strongest: for while size and strength count for much in the struggle between animals of the same kind, they count for little in combating nature, a fact which we see over and over again in studying the history of the past. Those great reptiles, the Dinosaurs, mightiest of all land animals, were swept out of existence while the smaller and weaker mammals survived. And, after these had attained to supremacy, the lumbering Titanotheres succumbed in their turn, and other types, smaller and weaker but better adapted to the changes that were taking place, succeeded them. Small animals, as a rule, have certain advantages over their larger relatives in the struggle for existence; they breed more rapidly, reach maturity sooner, are more readily concealed, and require less food: so that they are able to subsist through periods of drouth and cold which cut off the supply of food of the large animals and cause them to perish of starvation. As a result of the weeding out process, the influence of their surroundings, and what seems an inborn tendency to vary,[1] animals changed more or less in form and habits, becoming adapted to the changing conditions under which they lived, resulting in the **Evolution** of new kinds of animals. In this manner very wonderful modifications have been brought about: for we see some animals dwelling in the heat of the tropics, and others equally at home amid the snow and ice of arctic regions; some passing their lives high on the mountain tops, some dwelling a mile or more in the depths

[1]There are two very different views in regard to this point, one that change in the surroundings *causes* the changes in the animals, the other that it simply allows the tendency to vary to assert itself. Both are probably true, as is the case with both sides in many quarrels—perhaps in most.

of the ocean where the temperature is but little above freezing, and some quite at home in springs whose waters almost reach the boiling point.

Among the many changes that have been brought about in the process of evolution, is the matter of **Protective Coloration**—the resemblance of animals to their surroundings, or, in some instances, to one another, by which they are enabled to escape their enemies. Birds, like snipe, meadow larks, and quail, and mammals, such as the common gray rabbit, so harmonize with the dried grass, leaves, and brush amid which they live that it is a difficult matter to see them when at rest. Desert-haunting animals, many mice, or on a large scale, some of the African antelopes, also blend with their surroundings, and so do the spotted young of many shore birds that are brought up on pebbly beaches. On the other hand parrots and fruit pigeons are largely green, and thus elude observation among the trees in which they live. Then there are some very interesting cases of animals that are doubly protected, changing their raiment with the season, harmonizing with leaves and grass in summer and with the snows of winter. Such are the weasels, hares, and ptarmigans, and it is a curious fact that those which have an extensive north and south range, reaching regions where there is little or no snowfall, do not turn white in their southern homes. The white color of northern animals may not be entirely for their protection, but for their warmth as well, since white does not give out heat so rapidly as dark colors.

A most remarkable mode of protection exists in some marine animals which are almost as transparent as glass, the very blood being transformed to a colorless fluid, so that they can scarcely be distinguished from the water in which they dwell.

Still another method of protective coloration is shown by many edible species of animals that bear a strong resemblance in form and color to those that are presumably disagreeable on account of peculiarities in taste or odor. The term presumably disagreeable is used: for it by no means follows that because a given flavor is offensive to us, it is equally unpleasant to birds and other animals. We know from the few careful experiments which have been made, that insects repugnant to us are eaten by various animals. Also it is very evident that although the vast majority of animals are good to eat they nevertheless are not eaten out of existence.

In some cases colors that at first sight seem conspicuous are really protective, as are the stripes of the tiger and the spots of the leopard and jaguar, which so suggest patches of light and shade that the animals

crouch unseen in the jungle. In these particular instances color is not necessary for protection, but is of service while the animals are stalking their prey.

For protective coloration is by no means a one-sided matter or else many animals would go hungry, but while it helps some to elude their enemies it is also of service to predatory beasts in stealing upon their quarry. The dun color of many African antelopes is undoubtedly a protection, but the dun color of the lion blends with that of the desert sand and enables him to steal unseen upon the protected antelope. There is, to add a word of warning, much reason to think that entirely too much importance has been ascribed to protective coloration and that it is by no means so effective as its more ardent advocates would have us believe, since it is to a great extent offset by keenness of sight, acuteness of smell and sharpness of hearing on the part of both the hunter and the hunted.

Given a tendency among animals to vary, it is easy to see how protective coloration might have been brought about by Natural Selection. Any animals that chanced to resemble their surroundings in color so as not to be readily seen on the sand, or among the leaves or grass as the case might be, would have a little better chance of being overlooked by hungry enemies than those that were conspicuous, the result being the killing off of the conspicuous animals and the gradual establishment of a race of animals protectively colored.

In regard to these various questions of natural selection, survival of the fittest, and evolution of animals, it may be said that while we do not, and never can, actually *know* that these things have taken place as described, careful study of the facts renders it probable that such has been the case. One of the oft remarked characteristics of mankind is a desire to know the causes of things, and if man can not ascertain all the facts he will frame some theory to explain those that are available.

If animals are affected by their surroundings, we would expect to find that those which dwell where the conditions vary least, have changed the least; we would also expect that the simplest animals, those that have the fewest parts to change, bear the strongest resemblances to those that lived in the earlier days of the world. And this is exactly what is shown by the study of the past, the differences between living and extinct animals bearing a direct relation to these two things. Among the highly organized mammals, not a living species is directly related to those of that early period of the earth's history we call Eocene, while very few go back beyond the (geologically) recent period known as Pliocene. By the

aid of fossils we are able to trace some, notably the horse, back through the various changes they have undergone; but when this is done the early species are found to be so different from their living descendants that without the aid of the intermediate forms the relationship between the two would not be suspected. The direct relatives of many reptiles are found much further back than are those of mammals, while some living fishes belong to the same family and even the same genus as those that existed so long ago as the Cretaceous Period. As for invertebrates, and especially some shellfish, a few go back unchanged for periods of time representing millions of years; down in the depths of the sea, in uniform quiet, cold and darkness, they have lived an unvarying existence for æons of time, while what we term the eternal hills have been washed away, and others upheaved to take their places.

Thus evolution, or change among animals, has gone on more and more rapidly as higher forms came into existence.

Knowing the great changes that have taken place among animals since they first appeared in the world, we are able to account for existing differences we find between them. Some groups have steadily progressed, a few have degenerated; some have diminished in numbers and many have disappeared.

If we open a fan, and imagine that the sticks represent various divisions of animals, we shall have a rough illustration of what might have taken place had their development been uniform; all have a common point of origin, but the farther we go from this point, the more widely are they separated, although the relationship of one to another may easily be seen. If now we break some of the sticks at different places and whittle down some of the ends, we shall have gaps of varying widths at various places, and the ends will be of unequal size and at irregular distances from one another, as are the groups of living animals.

For example, while there are but two living species of elephants, one in Asia, and another in Africa, fossil remains indicate that there were formerly a large number of species inhabiting all the continents save Australia. And, as the history of the elephants is followed backwards, we find, even with the small amount of material now at our disposal, that their characters gradually change, and that they may be traced to much smaller animals not unlike tapirs. In this instance, not only are the sticks of the fan broken, but the one representing the elephants is whittled down to two species. The horse is probably the best example we have of an unbroken line of descent, and most educated people are aware that its pedigree may be traced to a race of animals no larger than

a collie dog which also gave rise to other and very different groups of animals. The stick representing the horse family is entire, but not so large as it was.

Owing to the various facts just mentioned it is impossible to arrange animals in a straight line from lowest to highest; each animal is not only related to those before and behind, but to those on either side of it, and if one group of animals is compared with another it will be found that the lower members of one will be decidedly lower or simpler in structure than the highest members of the preceding group. The relations of animals to each other are often expressed in the form of a tree. The trunk represents the common origin of animals, the branches the great groups (see Classification), and the tips of the twigs individuals. Only it must be remembered that in the tree of life as we now see it many of the branches are lacking.

The questions of evolution and of the animals that formerly existed are directly connected with the problem of distribution.

GEOGRAPHICAL DISTRIBUTION

Animals are not spread indiscriminately over the earth, but certain kinds or species are found in particular regions, some being confined to comparatively small areas, while others are widely distributed. Llamas are found only in South America; one kind of elephant occurs in Africa, another in parts of Asia; the moose, represented by three closely related species, circles the entire northern hemisphere, while the orang-utan is restricted to a small part of Borneo, a second species being limited to a still smaller portion of Sumatra. This distribution is termed **Geographical Distribution**, and the branch of geography devoted to it—zoological, or more briefly zoögeography, the corresponding study of plant distribution being phytogeography. The problems of zoögeography are very complicated; for many causes have brought about the dispersal of animals, or caused their restriction to certain regions.

The means by which animals that walk, swim, or fly have been distributed are apparent, while those less able to get about in the world are subject to winds, rivers, currents, floods, and accidental transportation by other animals. The distribution of some takes place while they are still in the egg, or very small: for many animals, like the oyster, which are rooted to one spot when old, are free to wander while young. This may bring about results that at first sight seem contradictory creatures whose powers of locomotion are small having a wider range than some well able to travel about. Such cases may sometimes be explained

by the fact that the more active animals are less subject than the others to accidental dispersion, and are not swept away from places where food is abundant and enemies few. There are, however, many instances where the reasons for the restriction of animals to certain places are by no means evident. Great bodies of water are most effectual barriers to the spread of many animals, some are hemmed in by mountain ranges, others by deserts, but back of such obvious causes lies the all-important question of food, and this, so far as land animals are concerned, depends on temperature, which determines the distribution of plants and of the animals directly or indirectly dependent on them for subsistence.

New Zealand and Australia are the most striking examples of the effect of wide stretches of water on the distribution of animals: for, save two species of bats, not a single mammal is found in New Zealand, while the mammalian fauna[1] of Australia consists almost entirely of marsupials, the only other land animals being the dingo, or wild dog, supposed to have been introduced by man, and a few little rodents. In the first case it is inferred that if New Zealand has ever been connected with any other land, it was before the appearance of mammals on earth; in the latter instance, the deduction is that Australia has been isolated since the Cretaceous Period, when the lower types of mammals had appeared, and that its peculiar assemblage of animals is the result of evolution within its own boundaries.

A very important point that must be taken into account in dealing with the distribution of existing animals is the distribution of extinct animals: for this often accounts for the presence of related species in widely separated parts of the world. Tapirs are examples of this discontinuous distribution, one species being found in Malaysia, while the others dwell in the warmer parts of America. These places are widely separated, and by no possibility could these animals now pass from one locality to the other; but remains of fossil tapirs or tapir-like animals are found in various parts of the world: so we know that existing tapirs are the survivors of a once numerous race of animals.

Such cases as this are taken as evidence of the former union, direct or indirect, of countries now widely separated, some animals being much more important witnesses than others. Birds, which pass over long distances with ease, are of comparatively small importance as evidence, although they have some value, while fresh-water shells, and, above all,

[1]The fauna of a country is the sum total of its animal life, the flora, of its plant life, while the term biota embraces both, meaning the entire plant and animal life of any region or period.

fresh-water fishes, furnish testimony of the most value. The lung-fishes, Dipnoi, one of which is found in Australia, one in South America, and one in Africa, are usually brought forward as a case in point. It is extremely improbable that such peculiar fishes could have originated independently in three widely separated parts of the world, and as they inhabit fresh water they could not have crossed the sea; it is also known that they belong to an old group of former wide distribution, their fossil remains being found in Europe and North America. So it is considered that at some very distant period of the world's history there was a land connection between Australia, Africa, and South America, and that during this period the distribution of the Dipnoi took place, a conclusion that derives some support from other evidence.

Another view is that these continents have not been directly connected but that they have been populated from the north the few related animals now found there being simply "hold overs" from early geological times.

The story of the past life of the earth is usually considered by itself and that branch of science is termed Palæontology.[1] This is mainly a matter of convenience, because the subject is so great in itself, for the life of the past has its direct bearing on that of the present and to understand one it is necessary to have a knowledge of the other.

NOMENCLATURE

Some things about the study of natural history, or rather about the published results of this study, often seem peculiar and unnecessary, prominent among them being scientific names and the classification of animals, two matters that are intimately related. When men began really to study animals, and to publish the results of their observations, the descriptions were printed in Latin, this being the language used by students and familiar to men of liberal education in all countries. In order that the animals might be readily recognized, it was customary to preface the account of each with a brief description of its more evident characteristics, something much like what is now called a diagnosis. The lion, for example, might be styled the tawny colored cat with a mane; the tiger, the striped cat; the leopard, the large, many spotted cat, and so on. And to this day many naturalists preface their descriptions with a brief Latin diagnosis. As the tide of commerce of the eighteenth cen-

[1]From the Greek *palaios*, ancient, *on*, a being, and *logia*, to speak; in other words, a treatise on ancient beings or life.

tury brought to Europe scores of animals before unknown, the number of recognized species increased so rapidly that it became difficult to keep track of them. To overcome this difficulty, the great Swedish naturalist, Linnæus, devised the plan of giving to each animal two names, the first a general, or generic, name, which should indicate the group to which the animal belonged, the second a special or specific name, to apply to that animal alone, this method of naming animals and plants being known as the binomial (two-name) system of nomenclature. So the lion became *Felis leo*, the lion cat (the adjective comes last in Latin); the tiger *Felis tigris*, the tiger cat; and the leopard *Felis pardalis*, the spotted cat, the common name *felis* indicating that they were of the same genus or kind.

While zoological names thus began in descriptions, they have ended by becoming merely convenient handles by which to lay hold of any particular animal; so at present names do not *necessarily* have any meaning, or contain any reference to the characteristics of the animal to which they are applied, although customarily they do so. It is very much the same with our own names. Time was, long ago to be sure, when the names of people were descriptive, just as they are even now among Indians and savage races. But Black, White, Strong, Smith, and Carpenter have ceased to mean anything save that their bearer is a member of some particular family who has his own special name also. But, it is frequently asked, why can't animals have common as well as scientific names? One reason why many animals have no common names is that they are not commonly known, but a better reason is that there are not enough names to go around. While our largest dictionaries claim to define only some 300,000 words, more than 350,000 species of animals, great and small, have already been described, and at the present rate of discovery the number will probably reach 500,000 within twenty years. Therefore, as they are not commonly known, it is obviously impossible to have a common name for each one, and so they are recorded only by scientific names.

It must also be remembered that a large proportion of these scientific names seem strange and formidable only because they are unfamiliar; and those that have worked their way into our acquaintance, such as elephant, rhinoceros and boa constrictor, do not seem at all strange.

Some may also complain that scientific names are being constantly changed, but this is true only to a limited extent, and is due partly to a few individuals who decline to be guided by any rules, and partly to the working of what is called the law of priority—the rule that the specific

name first applied to any animal is the one that shall be used. As some of these names first appear in rare or little known books, it often happens that a name long current is found to be antedated by another, and must, therefore, be changed.

It will be found that some of the animals described in books have not only two, but three names, and this means that they belong to a particular race, or subspecies, of some well recognized species. It was once thought that species were unchangeable, and that animals were sharply distinguished from one another, but as they were more carefully studied, and more specimens were available, it became evident that individuals from a given part of the range or habitat of a species, might be slightly different from the standard—those dwelling in desert regions being a little paler than the majority, and those residing in damp, wooded localities being somewhat darker. To such local groups or geographical races, the name of *subspecies* (under-kind) is applied, and the study of this is a part of the study of geographical distribution.

CLASSIFICATION

Classification is merely the orderly arrangement of animals, or other objects, placing those most closely related to one another in a class by themselves and arranging the groups thus formed with reference to their degree of relationship. In the case of animals, this results in the formation of groups of varying size and importance, the principal being Species, Genus, Family, Order, Class, and Phylum, while for purposes of greater exactness intermediate assemblages may be made, such as superorder, subclass, subfamily, and so on, the prefix *super*, above, meaning greater than, and *sub*, under, less than.

The entire Animal Kingdom is divided into large branches or phyla, a Phylum[1] being a large assemblage of animals that have had a common line of descent and agree in some very important character. Thus the classes Mammals, Birds, Reptiles, Batrachia, and Fishes form parts of the Branch or Phylum Vertebrata, or backboned animals, which are distinguished by having a more or less complete internal skeleton of cartilage or bone.

The first division of animals was into vertebrates and invertebrates, according as they did or did not have a backbone, but it was soon recognized that the invertebrates differed among themselves quite as much as they did from the vertebrates. So Cuvier divided them into Radiates,

[1]From the Greek *phylon*, a tribe.

Mollusks, and Articulates, and as our knowledge of animals has increased so also has the number of groups into which they are divided: for a system of classification is merely an expression of the present state of our knowledge of animals.

Phyla are divided into Classes[1] whose many (often thousands) members are constructed on the same general plan. The mammals, for example, have hot blood, a four-chambered heart, and suckle their young; all birds have feathers; reptiles have cold blood and are never clad in either hair or feathers. But while these are very apparent differences they are associated with others, equally important if not so obvious, which can be expressed only in technical language.

Classes in turn are divided into Orders[2] which embrace one or several Families. Thus the cats so closely resemble one another in structure that all living and many extinct species are included in the family *Felidæ*, whose most evident character is the great development of the canine teeth, the reduction in number of the jaw teeth and the adaptation of a few of them for cutting flesh; whence these teeth are called sectorial teeth.

Another familiar order is that containing the gnawing animals, or rodents, known as Glires. This contains more species and individuals than any other order of mammals, a large proportion being included in the well known family *Muridæ* that embraces the rats and mice.

Related families are the *Hystricidæ* or porcupines, *Dipodidæ*, jerboas, and *Sciuridæ* or squirrels.

The order Bruta contains those stupid, brutish creatures the sloths, anteaters and armadillos. It has also been termed Edentata, or toothless, some of the members lacking teeth altogether, while all agree in being destitute of front or incisor teeth. To the Ungulata, or hoofed quadrupeds, in whose ranks are found the deer, *Cervidæ*, belong also the sheep, goats and cattle of the family *Bovidæ* and the horses of *Equidæ*.

The dogs form the family *Canidæ*, the bears the *Ursidæ*, these, with several others, being embraced in the order *Feræ*, known also as *Carnivora* or flesh eaters—the beasts of prey—which contains those animals not merely adapted for a predatory life, but agreeing in some important characters of teeth and skeleton. The mere fact that any animal is a flesh eater does not make it a member of the order *Feræ*, any more than living in the water makes a creature a fish, for habits are not characters, although they may be characteristic. Some of the Marsupials, or pouched

[1]Latin, *classis*, a class.

[2]Latin *ordo*, a row or series, hence an order is a series of animals.

mammals, are flesh eaters and prey upon other animals, but they are very different from the true carnivores. While whales live in the water they breathe air by means of lungs, and not by gills, their blood is warm, their young are born alive and are nourished on milk, their back and tail fins have no fin rays, and the bones of the side fins are like those of the fore leg of a quadruped. In all these points they differ from fishes and agree with other mammals.

The Genus[1] is next below the family and includes animals that have some character or characters in common, though differing from one another in smaller, or specific characters. Like the groups already dealt with a genus may contain one, or many species; for one species may differ so much from any other as to require a place, or genus, by itself, while a number of distinct species may possess some common character. Thus a large proportion of all squirrels belong in the genus *Sciurus*, and the true cats, great and small, the lion and the common cat (for size has nothing to do with relationship) are included in the genus *Felis;* the short-tailed cats are placed in the genus *Lynx*, and the hunting leopard or cheetah, whose claws are only partly retractile, and cannot be drawn within their sheaths as in other cats, in the genus *Cynælurus*.

Lastly comes the Species[2], whose members constantly resemble one another in all essential particulars of form, size and color, the exceptions being the geographical races or subspecies mentioned elsewhere. The species may be called the unit of classification, and subspecies may be looked upon as fractions.

Still using the lion as an illustration, the various groups to which this animal belongs are: Phylum, *Vertebrata;* Class, *Mammalia;* Order, *Feræ*, Suborder, *Fissipedia* (split-footed or clawed); Family, *Felidæ;* Genus, *Felis;* Species, *Leo*. This is clearly shown in the accompanying table illustrating the position of the Lion in the Animal Kingdom.

Anyone who examines a few systems of classification may find that they do not agree with one another in all points; this, however, is no more surprising than that people differ in matters of religion, politics, or schools of medicine. Any system is to some extent an expression of individual opinion, and two persons will rarely agree on all questions, even in natural history.

It may appear strange that one order should contain only one or two species, while another comprises hundreds, even thousands. But the importance of a group does not depend on the number of species it in-

---

[1]Latin *genus*, a race or kind.

[2]Latin *species*, a particular sort; be sure never to say *specie*.

DIVISIONS OF THE ANIMAL KINGDOM

ILLUSTRATING THE POSITION OF THE LION

(Extinct Groups are not included)

PHYLA or BRANCHES	CLASSES	ORDERS	FAMILIES	GENERA	SPECIES
ANIMALS 370,000 species					
Vertebrata Back-boned Animals	*Mammalia* Mammals	*Primates* Man and Monkeys			
		Feræ Beasts of Prey	*Felidæ* Cats	*Felis* True Cats	*Felis leo* Lion
					Felis tigris Tiger
				Cynælurus Cheetah	*Felis leopardus* Leopard
				Lynx Lynxes	*Felis onca* Jaguar
					Felis concolor Cougar or Puma
			Viverridæ Civets		*Felis uncia* Ounce
			Hyænidæ Hyænas		*Felis pardalis* Ocelot
			Protelidæ Aard Wolves		*Felis catenata* Linked Ocelot
			Canidæ Dogs		*Felis macroura* Long-tailed Ocelot
			Ursidæ Bears		*Felis tigrina* Margay
			Procyonidæ Raccoons		*Felis serval* Serval
			Mustelidæ Weasels		*Felis domesticus* Domestic Cat
			Otariidæ Eared Seals		*Felis caffra* Egyptian Cat
			Phocidæ Earless Seals		*Felis chaus* Jungle-cat
			Odobænidæ Walruses		*Felis ornata* Indian Desert-cat
		Chiroptera Bats			*Felis manul* Pallas's Cat
		Insectivora Moles and Shrews			*Felis pajeros* Pampas-cat
		Glires or *Rodentia* Gnawers			*Felis catus* Wild Cat
		Proboscidea Elephants			
		Hyraccidea Hyraxes			
		Ungulata Hoofed Animals			
		Cete or *Cetacea* Whales			
		Sirenia Manatees			
		Bruta or *Edentata* Sloths, etc.			
		Effodientia Pangolins, etc.			
		Marsupialia Pouched Mammals			
		Monotremata Echidnas, etc.			
	Aves Birds				
	Reptilia Reptiles				
	Amphibia Frogs, etc.				
	Pisces Fishes				
	Marsipobranchii Lampreys				
Arthropoda Jointed Animals, as Crabs, Insects, etc.					
Mollusca Shell-fish					
Molluscoidea Brachiopods, etc.					
Vermes Worms					
Echinodermata Sea-urchins, Starfish					
Coelenterata Sea-anemones, Corals					
Porifera Sponges					
Protozoa Single-celled Animals					

Fissipedia

Pinnipedia

cludes, but on the extent to which these resemble or differ from those of other groups, orders, or families, as the case may be; fifty cents make a larger pile than does a single dollar, but they do not form a more important assemblage. So the order Proboscidea contains only two living species of elephants, but zoologically it is even more important than the Glires, or rodents, which includes the majority of all mammals.

This classifying of animals may be compared to the organization of an army composed of thousands of individuals (species) distinguished as officers and privates (genera) formed into companies (families), regiments (orders) and brigades (classes) which in turn constitute divisions (phyla), the whole vast total forming an army like the animal kingdom.

So the classification of animals is merely an expression of their degrees of relationship to one another and enables the naturalist to place his species as a general does his soldiers.

LIFE AND TIME

The existing plant and animal life of the world is the result of evolution through long geologic ages, during which race after race of animals came into being, flourished for a time, and wholly or largely died out. The table on a following page shows the estimated age of the world, the length of different periods in the past during which this evolution took place, the predominant life of these periods, and the point of origin, so far as known from fossils, when this life began.

As we are dependent on fossils for our knowledge of the life of the past it may be well to devote a few lines to the subject of

HOW FOSSILS ARE FORMED

based on Dr. Matthew's account in the **General Guide**. A fuller description may be found in **Animals of the Past.**

In a general way, fossils are the petrified remains of plants or animals that lived at some past period of the earth's history, but they include such things as trails left by worms and other creeping things and footprints of animals on the sands of time. In many instances we have not the objects themselves but only their casts or impressions in the rocks. This is particularly the case with shells. Sometimes, as with the bones of the great Irish elk, the objects have been buried in swamps or bogs, and in a few rare instances, as with the mammoth and woolly rhinoceros, entire animals have been preserved for thousands of years in ice or frozen mud. Fossils are found in localities where the

dead animals or plants have gradually been buried under layers of sediment to such a depth that they come in contact with the mineral waters of the earth and finally become petrified, the essential point being that they are covered by water, or at least buried in wet ground. Later through subsequent upheaval and erosion they are again brought to or near the surface of the earth. Petrifaction is the slow replacement of animal or vegetable material by such minerals as carbonate of lime or silica. The process is very slow and for this reason flesh is never petrified.

As it takes thousands of years for the various layers of earth to accumulate over the bones, and for the latter to become petrified, the study of fossils and the strata in which they are found is an important aid in determining the age of the earth and the succession of life thereon.

The **Divisions of Geologic Time** are based on the character of their life as indicated by fossils.

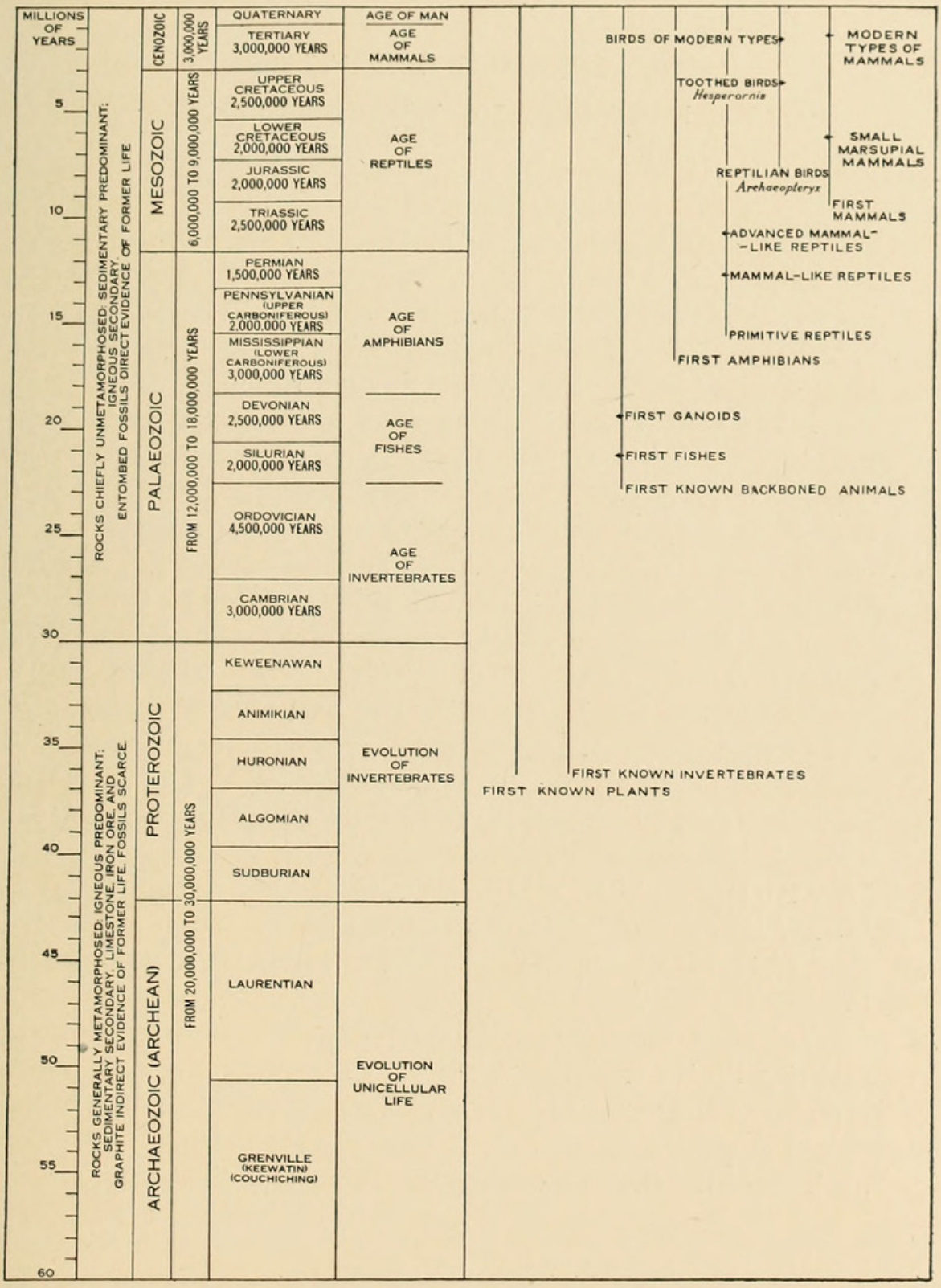
The estimated **Duration of Geologic Time** is based largely on the thickness of the rocks.

Exhibits relating to the geologic history of the earth, and its past life, will be found on the fourth floor of the Museum. Those in the Hall of Geology illustrate the structure of the earth, include examples of the various rocks of which it is composed, and are accompanied by fossils showing the general character of the life of the different geologic periods and the steps or stages that have led to the animal life of the present.

Proceeding to the Southeast Pavilion and going westward, one passes from the hall devoted to fossil fishes, through those containing reptiles and mammals, coming finally to the Hall of the Age of Man, and in a few minutes witnesses changes that required millions of years for their accomplishment. The strange armor-clad fishes, unlike any now living, were succeeded by amphibians and reptiles, among them curious creatures like Naosaurus and the great dinosaurs which in their day were the rulers of the earth. Here are huge herbivorous reptiles like Brontosaurus and Triceratops and the flesh-eating creatures that preyed upon them, including Tyrannosaurus, the most formidable beast of prey that ever lived. They passed out of existence and gave place to the mammals, and these underwent many changes before the forms of to-day appeared. Lastly came man, a weakling compared with the animals by which he was surrounded, which include such forms as the mammoth, mastodon and great ground sloths, and yet, by reason of his superior brain and its servant, the hand, coming to dominate them all.

Many of the animals shown in these halls are described in Handbook **Animals of the Past**, another is devoted to **Dinosaurs**, and leaflets discuss **Mammoths and Mastodons** and the **Evolution of the Horse.**

LIFE AND TIME



Prepared by Dr. Chester A. Reeds.

Based upon time estimates of Walcott and Schuchert.

SOME MUSEUM PUBLICATIONS

OF USE IN CONNECTION WITH THIS LEAFLET

ANIMALS OF THE PAST. By Frederic A. Lucas

A popular account of some of the creatures of the Ancient World; tells of Mammoth and Mastodon, the great Sea Reptiles, the Dinosaurs and giant Birds. 200 pages with illustrations by Charles R. Knight and Joseph Gleeson. Cloth, 75 cents.

No. 5. DINOSAURS. By W. D. Matthew, Ph.D., Curator of Vertebrate Palæontology. New edition, in preparation.

An account of these huge monsters, describing also the conditions under which they lived and flourished and telling of their distribution in the days when the earth was young and how their bones are discovered, collected and mounted.

No. 36. THE EVOLUTION OF THE HORSE IN NATURE AND UNDER DOMESTICATION. By W. D. Matthew, Ph.D., Curator, Department of Vertebrate Palæontology, and S. H. Chubb. September, 1913, 64 pages, 39 illustrations. Price, 20 cents.

The past geologic history of the Horse affords the most complete and convincing illustration of evolution among mammals. This leaflet, based upon material in this Museum, describes the successive stages in its evolution from the four-toed "*Eohippus* no bigger than a fox" to the single-toed horse of to-day.

No. 57. GUIDE TO THE HALL OF MAMMALS. By Frederic A. Lucas, Director of The American Museum of Natural History. New edition, October, 1923, 16 pages, 11 illustrations, 1 chart. Price 10 cents.

Intended especially for the use of Teachers and pupils in connection with the exhibits. Tells what Mammals are, gives a brief synopsis of the various orders of Mammals, touches on the principals of classification and calls attention to the bearing of the modifications of the skeleton on an animal's mode of life.