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ABSTRACT

Written in 1964, the document represents experimental material of the Anthropology Curriculum Study Project. The objectives of the project were to discuss the evolution of man as distinguished from the evolution of other species and as related to culture, and to emphasize human diversity. Three brief essays are presented. The first, "The Species Concept," explains factors used to determine the classification of animals into species. The second essay, "Man As A Species," defines species as sexually producing organisms that actually or potentially interbreed and produce fertile offspring. The geographical factors of human variation are discussed. The third essay, "The Species, Man," summarizes the characteristics of man by describing anatomical function and comparing man's body with other living creatures. (KC)

MAN AS A SPECIES

INTRODUCTION TO THE STUDY OF HUMAN HISTORY

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THE SPECIES CONCEPT[1]

Alan Solem

In recognizing that there are different "kinds" of animals, a person has taken the first important step in learning the meaning of "species." Every city dweller knows that dogs and cats are different, although the same person can easily fail to realize that red and grey squirrels belong to separate species. People living in rural areas are better at knowing animal "kinds" and members of primitive societies devoted to hunting and food gathering are even more sophisticated in classifying the local animals. For example, one New Guinea mountain tribe had separate words for 137 of 138 species of birds found near the village. Scientists have named more than 1,000,000 species of living animals, mostly insects and animals without backbones, but there are over 8,600 species of birds and 3,500 species of mammals.

The basic criterion used by scientists in recognizing species is whether animals are actually or potentially capable of interbreeding under natural conditions and producing fully fertile young. Animals which do not meet this requirement belong to different species. However, for most of the 1,000,000 species we identify there is, as yet; no proof as to breeding capabilities, and we must depend on physical differences to distinguish species. Usually members of the same species will show only minor differences from each other, but will have at least a few characteristics quite unlike those in related species. The red fox is found in both Alaska and Alabama. While the Alaskan animals may be slightly smaller and lighter in color than those from Alabama, they are obviously very closely related to each other. In contrast, a grey fox from Alabama shows many sharp and obvious differences from Alabama red foxes. The red foxes are considered to belong to one species, but the grey fox is a distinct species. This is only one of thousands of examples of how species differ. Some species vary greatly in physical characters within the species. Siamese and persian cats do not look alike, and a great dane and a dachshund could hardly seem less similar. Yet every city alley and every farm contain living proof that the "breeds" of cats and dogs can interbreed quite freely and successfully.

Some animals that belong to different species can be mated in captivity, but will produce young that are sterile or have greatly reduced fertility. Zebras and horses are easily crossed, but the offspring have rarely been fertile. A mule is the sterile offspring of a male ass and a female horse.

Even breeding in captivity that results in fertile offspring is not proof that only one species is involved. Many species apparently can breed with closely related species, if no member of their species is present at the breeding season. If these animals can choose one of their own species instead, then they will mate with their own kind. Groups in which it is difficult to recognize or determine species in no way lessen the validity of the species concept. They only indicate that the process of evolution is still occurring and that the difficult forms are of recent origin.

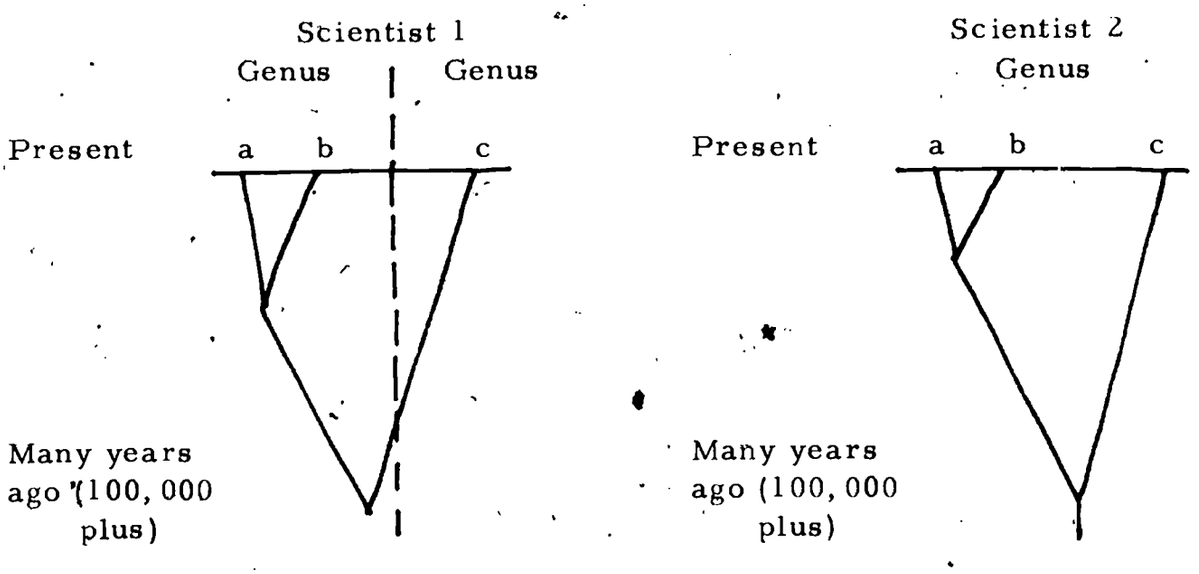
Generally, each species has a clearly defined geographic range. Lions are found over most of Africa and part of India, but not in China. The lynx lives in Canada and the northern tip of the United States, as does the moose. These ranges, however, are not unchanging. Within the last 100 years the wolverine, mountain lion, and American buffalo have vanished from the Midwest and Eastern United States. At the same time the opossum has spread northward from Tennessee and Virginia to northern Wisconsin and Ontario, and the armadillo from the Mexican border into Kansas and Missouri. Man's activities have been responsible for these changes, but natural causes also continue to alter the ranges of other animals.

The cattle egret is an African bird that within historical times has spread to the Americas. First reported from British Guiana in the 1870's, the first specimen was not collected until 1935. Since then it has spread throughout the West Indies and South America as far south as Bolivia. In the 1940's it reached Florida and has been seen as far north as Massachusetts and as far west as Illinois. The Colorado Potato Beetle was a harmless insect feeding on weeds in the Rocky Mountain areas until the potato was brought in by man. The beetle fed on plants belonging to the same family of plants as the potato, and thus found the potato quite acceptable. The beetle followed the potato plantings east and eventually was introduced to Europe. While man provided the new food, the beetle simply followed natural processes in multiplying to make use of a new food source.

In contrast with the species, which has a rather precise definition based on breeding capabilities and close similarity in body structures, the "genus" is a category with a variable meaning. A genus contains a group of species, presumed to have descended from the same ancestors, that show decided structural differences from other such groups of species. Genera are a way to indicate relationships of species. Often it is solely a matter of personal opinion on the part of different scientists as to whether a genus contains few or many species. The lion, tiger, house cat, panther, leopard, cougar, and jaguar can be placed in one genus, or else separated into several genera. Most zoologists prefer to have several species in a genus, since this helps indicate relationships, but many species show no close similarities to any other species. A

large number of genera have only one species while others may have more than 100 species. Good examples of a monotypic genus (only one species) are the wood ibis (Mycteria, the only North American stork), the osprey (Pandion), false killer whale (Pseudorca) and the platypus (Ornithorhynchus). Groups with many species include the deer mice (Peromyscus), rats (Rattus), and cone shells (Conus).

If a scientist places two species (a and b) in the same genus, then they are thought to be more closely related than are two species (a and c) that he placed in different genera. It is quite possible, however, for another scientist to say that while a and b are more closely related to each other than are a and c, nonetheless a and c are not sufficiently distinct to belong to different genera. Both scientists agree as to the type of relationship between species a, b, and c, but they differ in how best to recognize the relationship. This can be quite confusing to a non-zoologist trying to find out how closely certain species are related, but the genus is not a concept that can be rigidly defined. (See illustration.)



Many species are divided by scientists into subspecies. This is a term that can be misunderstood. The prefix "sub-" sometimes gives the impression of "inferior." The zoological meaning of "sub-" is quite different, merely indicating that a larger category has been divided into several parts. The fact that one subspecies of the mink is named Mustela vison mink and another Mustela vison vison tells us nothing as to whether one race is larger, more common, better, or worse than the other.

For example, the scientific name of the Red Squirrel is Tamiasciurus hudsonicus. It ranges over most of the Northern United States and Canada. In studying many specimens from different parts of the range, it has been recognized that specimens from one area may show small but characteristic differences in color pattern, size, etc. from

specimens collected in another area. Thus the species is divided into about 25 geographic races or subspecies. In the midwest states alone there are four subspecies. Tamiasciurus hudsonicus hudsonicus[1] is found in Canada, Tamiasciurus hudsonicus minnesota in much of the middle west, T. h. loquax in the eastern and southern parts of the range, and T. h. regalis is found only on Isle Royale, Michigan. There is absolutely no meaning of inferiority or superiority attached to such a division. Each subspecies is simply a slight variation within the species.

Such subspecies are usually based on small physical differences associated with differing geographic range. Specimens from the central part of the subspecies may look quite distinct, but generally there is an area near the boundary between the subspecies where specimens will show some characters of one subspecies and some of the other. The presence of such intermediate individuals is one of the best indications that these are subspecies and not full species.

Often subspecies are referred to as "incipient species." This follows from the generally accepted belief that most species evolved under conditions of geographic isolation. At one time a species might have a continuous range across North America, but not show sufficient differences to warrant division into subspecies. During the climatic changes of the Ice Ages, which took place very slowly over thousands of years, the range might have become broken up into several fragments. Populations would be isolated in perhaps Washington, central California, the Ozarks and the Smoky Mountains. After many generations and with further changes in climate, the living conditions might have become slightly different in each of these areas. The process of natural selection would result in the animals best suited to the living conditions in each area usually producing more offspring than those less well suited. In time, the animals in each area would look less and less like those in the other areas. After many generations they would not be able to successfully breed with their former relatives and thus would have become separate species.

Currently living species, then, were not suddenly created but evolved slowly, new species are now evolving, and additional species will continue to evolve. Since the evolution of species is a continuing process, it is to be expected that many cases will be found where it is extremely difficult to tell whether animals still belong to one species, or if they are now distinct species.

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[1] The rules governing the scientific names of animals demand that one subunit use the same name as the larger category.

With rare exceptions, the splitting of one species into two or more has probably been a fairly slow process. Yet man has a few dramatic examples of how quickly changes in structure and physiology can occur when natural selection is very intensive. The most amazing is the speed with which flies and mosquitos appeared after World War II that were immune to DDT and other insecticides. In some cases less than five years after mass spraying was started, the chemicals were no longer effective because the remaining flies were immune. This was not a magic response or the result of any great change in the flies. Apparently a very few flies were always present that were naturally immune to DDT. When mass spraying killed off the vast majority of flies that did not have immunity, this left ample food and breeding sites for the new immune flies. The great majority of their young were immune to DDT and survived to breed. In a short time, flies were as numerous as before, but DDT was no longer effective.

Just as children in the same family or on the same block will differ in weight, size, hair and eye color, intelligence, physical prowess, etc., so do animals; any minor change that increases the chances of becoming adult and having offspring will tend to become more prevalent after several generations.

The fact that species are continually changing presents great problems for people studying fossils. Zoologists have trouble enough with animals living at the same time. If we examine specimens from now, 10,000, 50,000, 100,000, and 500,000 years ago, it may be obvious that the living specimens are quite different from those that lived 500,000 years ago, but those from an intermediate time are intermediate in structure. When did the species of 500,000 years ago become the species of today? This is an unanswerable question. In other cases, animals that lived many thousands of years ago in the Ozarks may be intermediate between one species now living in the Rocky Mountains and another in the Appalachians. Almost certainly the two living species were derived from the extinct species.

There has been some form of life on earth for probably four billion years. The accumulation of minor changes through natural selection has produced the great variety of animals and plants. Species have slowly divided into subspecies, which later became species or became extinct. This process occurred in the past, is happening today, and will continue in the foreseeable future.

MAN AS A SPECIES[1]

Marston Bates

All living men belong to a single biological species, Homo sapiens. "Species" in sexually reproducing organisms is usually defined as a population of similar individuals that actually or potentially interbreed and that are separated from individuals of other similar populations by barriers to breeding. We have to say "actually or potentially" capable of interbreeding because, in fact, individuals in Cuba, for instance, usually have no chance to breed with individuals in Jamaica. In most cases the taxonomist is forced to guess about the status of such geographically separated populations. If he thinks they would interbreed if not separated by some barrier like the sea, he calls them a single species; if they look rather different and he thinks the difference is so great that they would not interbreed even if the opportunity arose, they are classed as two separate species.

With man, we do not have to guess. There is ample evidence that the most different-looking individuals from the most remotely separated parts of the world can interbreed if given the opportunity. Norwegians, Australian aborigines, Bushmen, Malays, and South American Indians are all perfectly capable of interbreeding and producing healthy, completely fertile offspring. The differences among them are at the subspecies rather than at the species level.

The differences in appearance among men are considerable, however. There is a great variation in size, from the tall peoples of northern Europe and of the upper Nile to the pygmies of the Congo forest. Skin color ranges from shiny black to very pale. Large differences also exist in the texture and distribution of hair on the body, in the shape of the skull, and in the shape of soft parts like nose and lips. No species of wild animal shows anything like this range of variation. The only species with comparable variation are the domesticated ones, dogs, swine, poultry, etc.—which leads some to believe that man is a "self-domesticated" animal.

Human variation is basically geographical: Mongoloid peoples inhabit eastern Asia, Negroid peoples Africa, Caucasoid peoples Europe. The geographical pattern has been greatly disturbed by the large migrations of modern times, especially of Europeans to America, Australia, and South Africa, and of Negroid peoples to America; but it is still apparent. No wild animal is as widely distributed over the earth as man, but land animals very commonly show geographical variation within their ranges, and there is no reason to suppose that human variation differs in principle from that of other animals.

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[1]from Marston Bates, Man in Nature. Copyright 1961, reprinted by permission of Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Sometimes each island of an archipelago will be inhabited by a slightly different variety (or subspecies) of a given species. On a continent, a gradual change in the appearance of a species will sometimes occur as one moves from north to south or east to west; these changes may be more abrupt, so that a series of different populations can be recognized with rather narrow transition zones between them. The first case is said to constitute a cline, the second a Rassenkreis or series of subspecies.

This geographical variation is easily understood in terms of genetic theory. Since a new mutation can only spread through the parts of a population that are in contact, when populations are separated by geographical barriers they tend to follow distinct evolutionary histories, and in time they will become so different that even if they did come together again they could not fuse, for they would have evolved into distinct species. When a species inhabits a variety of climates, as on a continent, a mutation favorable in one environment might not be favorable in others, and again lead to geographical differentiation.

Many students of evolution believe that geographical variation, resulting from complete or partial isolation of populations, is the chief or even the only way in which a single species population can evolve into two or more species populations. One is led to wonder, then, why man, with so many geographical differences, has remained one species instead of evolving into several.

Modern methods of communication have brought all human populations into contact with each other to some degree, and the sort of isolation that could result in species formation is now clearly impossible. In fact, racial differences are tending to diminish today as large-scale shifts in population increase, and in time geographical variation in human physical appearance will perhaps disappear entirely.

All through man's history, his tendency to collect in discrete groups has probably been counterbalanced by his desire—and ability—to move. In early and middle Pleistocene, a number of distinct hominid types apparently lived in the Old World tropics and subtropics. We can only guess, of course, about whether these types were biological species, for we do not know whether Pithecanthropus could breed with Sinanthropus, or whether Sinanthropus could breed with Australopithecus. The latter two, at any rate, were so different that hybridization seems unlikely.

But out of this variety of types only one, Homo sapiens, survived. Wherever sapiens started—subtropical Africa seems the most likely place—he probably exterminated other hominid types as he encountered them. We can glimpse this process in Europe, where Cro-Magnon man (a true sapiens) eliminated Neanderthal man, by the dual procedures of extermination and hybridization. Sapiens certainly spread widely and (in geological

perspective) rapidly. He reached North America something like 35,000 years ago, probably by way of the Bering Strait, and in a few thousand years he inhabited both American continents from Alaska to Tierra del Fuego. He must have gotten as far as Australia a very long time ago also, and then remained there in almost complete isolation.

Thus Homo sapiens, we can conclude, has been scattered over the earth long enough for the process of subspeciation to start, but the various populations have not been separated long enough, and the separation has not been complete enough, for different biological species to form.

THE SPECIES, MAN[1]

Frederick S. Hulse

In the first place, we are by far the most numerous of the giant forms of life: human bodies probably contain more living material than the bodies of any other single species. Of course, in comparison to whales and even elephants we do not appear to be giants, but very few creatures attain dimensions such as theirs. A walk through the countryside or a visit to the zoo will reveal that most animals and plants are smaller than we are. A look through a microscope will show even more minute forms of life. These are almost innumerable; and, indeed, the numbers of individuals in any single species may exceed us by millions of times, yet their total bulk would be far less than that of a single man. And, among the few animals which are larger than man, the number in any one species is far less in almost all cases; while among the plants which are larger, the percentage of living tissue is relatively small.

Secondly, man is a widely scattered species geographically. Our only close competitors are those creatures which we have carried with us, such as rats, lice, and a variety of parasitic microorganisms. We have devised techniques which enable us to contend successfully with almost all environmental conditions and to extract a living from areas having the most varied sorts of resources. There can be no question but that we are the most successful form of life which has appeared upon the planet up to now. This is all very flattering, but we had better not let our success make us vain. Our present dominant position provides no guarantee for the future. Indeed, some scholars have compared the human species to a rapidly metastasizing cancer because of the speed with which we are consuming the resources of our host, the earth.

Such past success must be explained in terms of the characteristics of the creature concerned. What biological characteristics in anatomy, physiology, and overt behavior do we possess which may help us to understand our accomplishments? Let us begin with as simple a description as we can, thinking of anatomical detail in functional terms and comparing our bodies and our activities to those of other living creatures in those instances where such a comparison is illuminating.

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[1]from Frederick S. Hulse, The Human Species. Copyright 1963 by Random House, Inc., reprinted by permission.

Obviously, being so large, we are multicellular; indeed, there are billions of cells in a human brain alone. We are not rooted or sessile; on the contrary, we are capable of very rapid movement. Containing no chlorophyll, we cannot synthesize our food and so must devour living things for our sustenance and expel rather than take in carbon dioxide in our metabolic processes. These are the characteristics of animals rather than plants, and we can without doubt be classified as animals. In basic pattern, people are among those animals which are constructed like segmented tubes and which are bilaterally symmetrical; that is to say, we have easily distinguishable fore and hind ends, and bellies and backs, while organs and appendages tend to be arranged in pairs associated with the different segments. By far the greater number of biologically successful animal varieties share all of these characteristics with us, from angleworms and ants to fish and birds.

We have, furthermore, a closed circulatory system provided with a single heart which carries all necessary materials in solution to and from all cells of the body. Our digestive system, unlike that of a clam, for instance, provides for one-way traffic: in at the head end, and out at the other. It lies along the belly or ventral side of the body, whereas the central nervous system is closer to the back, or dorsal side. Specialized receptor sense organs are, for the most part, concentrated at the head end, and—perhaps in association with this fact—a great elaboration of the central nervous system is also located at the head end. We have an internal skeleton composed of over two hundred separate bones in articulation with each other, rather than an external shell such as those of insects and lobsters.

Our species is bisexual, consisting of males and females, so that we do not reproduce by simple budding-off of new individuals as some creatures do. Neither can we practice self-fertilization nor change our sex from time to time, like a number of others, Indeed, internal fertilization is required to continue the species and in this we differ from some fish and frogs. The organs and ducts used in this process are in close association with the urinary system, an anatomical oddity which, from a purely functional point of view, seems like poor engineering and from the aesthetic, like poor design. The mother's body retains the fertilized eggs, there giving them nourishment and protection until the time of birth, instead of providing them with a toughened shell and laying them in a nest to be hatched later, like turtles and birds. Indeed, even after birth, the mother continues to nourish her offspring with milk which her breasts secrete. This is a remarkably efficient reproductive system which both permits and encourages a low birth rate.

Our digestive system is highly efficient, too. Our mouths have jaws, of which the lower moves up and down, and both jaws have teeth. The teeth are of various sorts so that food may be sliced, pierced, and

ground up before it is swallowed; the first set of teeth is entirely replaced by more firmly rooted ones during the growth period. A variety of glands produce digestive fluids, and symbiotic microorganisms which exist in the gut further aid the process of digestion. We are practically omnivorous as a species, although every tribe of humans practices food tabus of one sort or another. Americans refuse to eat dogs or caterpillars, while some other peoples will not consume fish, or pigs, or maize.

Human beings are terrestrial in habitat and have four appendages, each consisting of several articulated segments and terminating in five digits. They are unique in the type of difference between the hind and fore limbs, and in the method of attachment of the hind limbs, which are capable of supporting the entire body in a vertical position. The fore limbs are far more flexible. At the end of each is a hand with an opposable thumb, as well as four fingers. This makes grasping and manipulating all sorts of objects very easy. Paired lungs permit oxygen to be absorbed from and carbon dioxide returned to the atmosphere. The lungs, however, must be moist at all times. The body's ability to regulate its temperature and keep it warm enough for rapid metabolism also makes life outside the water easier. Unlike most but not all warm-blooded creatures, man lacks the insulation of fur or feathers.

The brain is both relatively and absolutely large, although not uniquely so, and continues to grow after birth to a most unusual extent. Of the specialized senses, man appears to depend upon vision to the greatest extent, and he can do this because of the excellence of his eyes. Unlike most creatures except apes and monkeys, he can distinquish various wave-lengths of light and also judge distances very accurately by focusing both eyes upon an object. Hearing is also well developed in man, and his fingertips are especially rich in nerve endings, and so are very sensitive to such things as texture, moisture, and temperature. Our sense of smell, on the contrary, is clearly less well developed than that of other creatures which resemble us.

The frontal and temporal lobes of man's brain are especially well developed, and it has been surmised that this may be associated with the high degree to which his behavior is organized under conscious control. In simple learning ability, we do not appear to excel such laboratory animals as rats, but the complexities of human mental behavior remain obvious. We grow slowly and live long, we are constantly exposed to one another in society, and the type as well as extent of our learning and memory are both related to these facts. With our eyes and our fingers we can gratify and thus perhaps sharpen the inquisitiveness which we share with many other creatures. Our manipulative ability is supreme. Humans alone of all animals can

communicate by means of language, which has profoundly influenced our imaginations. Our childhood is so long, our life so easy, and our excess energy so great that play activity has assumed a very great importance in guiding behavior. We are among the relatively few animals without a mating season, so that adult males are more or less constantly attracted to females, and sexual activity continues throughout the entire year. This has also had a profound effect on our mode of life.

This is a most brief and incomplete summary of verifiable data concerning the biology of mankind. It is enough, however, to make anyone realize the degree to which we share characteristics of structure and behavior with other living creatures. We are members of the community of life. To investigate more deeply whether the phenomenon of man can be explained in natural terms should be worthwhile.